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(54) **NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF**

(71) Applicant: **JUUL Labs, Inc.**, San Francisco, CA (US)

(72) Inventors: **Adam Bowen**, San Francisco, CA (US); **Chenyue Xing**, San Francisco, CA (US)

(73) Assignee: **JUUL LABS, INC.**, San Francisco, CA (US)

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CPC ***A24B 15/167*** (2016.11); ***A24B 15/16*** (2013.01); ***A61K 9/007*** (2013.01); ***A61K 9/12*** (2013.01); ***A61K 31/465*** (2013.01); ***A61K 31/60*** (2013.01); ***A61K 47/10*** (2013.01); *A24F 40/10* (2020.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

374,584 A 12/1887 Cook
576,653 A 2/1897 Bowlby

(Continued)

FOREIGN PATENT DOCUMENTS

CA 2641869 A1 5/2010
CN 85106876 A 9/1986

(Continued)

OTHER PUBLICATIONS

"A Randomised Placebo-Controlled Trial of a Nicotine Inhaler and Nicotine Patches for Smoking cessation," 5 pages, available at http://www.otago.ac.nz/wellington/otago047634.pdf.

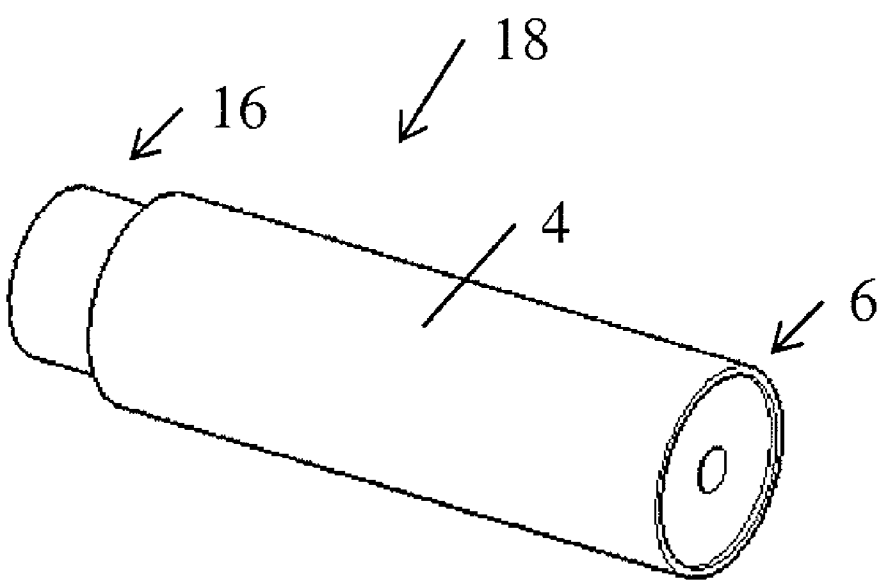
(Continued)

Primary Examiner — Dionne W. Mayes
(74) *Attorney, Agent, or Firm* — Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C.

(57) **ABSTRACT**

A nicotine salt liquid formulation for generating an inhalable aerosol in an electronic cigarette comprising nicotine salt that forms about 0.5% to about 20% nicotine is provided.

19 Claims, 8 Drawing Sheets



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(56) **References Cited**

U.S. PATENT DOCUMENTS

595,070 A 12/1897 Oldenbusch
720,007 A 2/1903 Dexter
799,844 A 9/1905 Fuller
968,160 A 8/1910 Johnson
969,076 A 8/1910 Pender
1,067,531 A 7/1913 MacGregor
1,163,183 A 12/1915 Stoll
1,299,162 A 4/1919 Fisher
1,505,748 A 8/1924 Louis
1,552,877 A 9/1925 Phillipps et al.
1,632,335 A 6/1927 Hiering
1,706,244 A 3/1929 Louis
1,845,340 A 2/1932 Ritz
1,972,118 A 9/1934 McDill
1,998,683 A 4/1935 Montgomery
2,031,363 A 2/1936 Elof
2,039,559 A 5/1936 Segal
2,104,266 A 1/1938 McCormick
2,159,698 A 5/1939 Harris et al.
2,177,636 A 10/1939 Coffelt et al.
2,195,260 A 3/1940 Rasener
2,231,909 A 2/1941 Hempal
2,327,120 A 8/1943 McCoon
2,460,427 A 2/1949 Musselman et al.
2,483,304 A 9/1949 Rudolf
2,502,561 A 4/1950 Ludwig
2,765,949 A 10/1956 Swan
2,830,597 A 4/1958 Kummli
2,860,638 A 11/1958 Bartolomeo
2,897,958 A 8/1959 Tarleton et al.
2,935,987 A 5/1960 Ackerbauer
3,146,937 A 9/1964 Joseph
3,258,015 A 6/1966 Ellis et al.
3,271,719 A 9/1966 Ovshinsky
3,292,634 A 12/1966 Beucler
3,373,915 A 3/1968 Anderson et al.
3,420,360 A 1/1969 Young
3,443,827 A 5/1969 Acker et al.
3,456,645 A 7/1969 Brock
3,479,561 A 11/1969 Janning
3,567,014 A 3/1971 Feigelman
3,675,661 A 7/1972 Weaver
3,707,017 A 12/1972 Paquette
3,792,704 A 2/1974 Parker
3,815,597 A 6/1974 Goettelman
3,861,523 A 1/1975 Fountain et al.
3,878,850 A 4/1975 Gibson et al.
3,941,300 A 3/1976 Troth
4,020,853 A 5/1977 Nuttall
4,049,005 A 9/1977 Hernandez et al.
4,066,088 A 1/1978 Ensor
4,207,976 A 6/1980 Herman
4,215,708 A 8/1980 Bron
4,219,032 A 8/1980 Tabatznik et al.
4,303,083 A 12/1981 Burruss, Jr.
4,312,367 A 1/1982 Seeman
4,506,683 A 3/1985 Cantrell et al.
4,519,319 A 5/1985 Howlett
4,520,938 A 6/1985 Finke
4,579,858 A 4/1986 Ferno et al.
4,595,024 A 6/1986 Greene et al.
4,597,961 A 7/1986 Etscorn
4,648,393 A 3/1987 Landis et al.
4,708,151 A 11/1987 Shelar
4,735,217 A 4/1988 Gerth et al.
4,771,796 A 9/1988 Myer
4,793,365 A 12/1988 Sensabaugh, Jr. et al.
4,794,323 A 12/1988 Zhou et al.
4,798,310 A 1/1989 Kasai et al.
4,813,536 A 3/1989 Willis
4,819,665 A 4/1989 Roberts et al.
4,830,028 A 5/1989 Lawson et al.
4,836,224 A 6/1989 Lawson et al.
4,846,199 A 7/1989 Rose
4,848,374 A 7/1989 Chard et al.
4,848,563 A 7/1989 Robbins
4,893,639 A 1/1990 White
4,907,606 A 3/1990 Lilja et al.
4,941,483 A 7/1990 Ridings et al.
4,944,317 A 7/1990 Thal
4,947,874 A 8/1990 Brooks et al.
4,947,875 A 8/1990 Brooks et al.
5,005,759 A 4/1991 Bouche
5,020,548 A 6/1991 Farrier et al.
5,027,836 A 7/1991 Shannon et al.
5,031,646 A 7/1991 Lippiello et al.
5,042,509 A 8/1991 Banerjee et al.
5,050,621 A 9/1991 Creighton et al.
5,060,671 A 10/1991 Counts et al.
5,065,776 A 11/1991 Lawson et al.
5,076,297 A 12/1991 Farrier et al.
5,105,831 A 4/1992 Banerjee et al.
5,105,838 A 4/1992 White et al.
5,123,530 A 6/1992 Lee
5,133,368 A 7/1992 Neumann et al.
5,141,004 A 8/1992 Porenski
5,144,962 A 9/1992 Counts et al.
5,152,456 A 10/1992 Ross et al.
5,183,062 A 2/1993 Clearman et al.
5,224,498 A 7/1993 Deevi et al.
5,240,012 A 8/1993 Ehrman et al.
5,249,586 A 10/1993 Morgan et al.
5,261,424 A 11/1993 Sprinkel, Jr.
5,269,237 A 12/1993 Baker et al.
5,269,327 A 12/1993 Counts et al.
5,303,720 A 4/1994 Banerjee et al.
5,322,075 A 6/1994 Deevi et al.
5,324,498 A 6/1994 Streusand et al.
5,372,148 A 12/1994 McCafferty et al.
5,388,574 A 2/1995 Ingebrethsen
5,449,078 A 9/1995 Akers
5,456,269 A 10/1995 Kollasch
5,497,791 A 3/1996 Bowen et al.
5,529,078 A 6/1996 Rehder et al.
5,579,934 A 12/1996 Buono
5,591,368 A 1/1997 Fleischhauer et al.
5,605,226 A 2/1997 Hernlein
5,626,866 A 5/1997 Ebert et al.
5,641,064 A 6/1997 Goserud
5,649,552 A 7/1997 Cho et al.
5,666,977 A 9/1997 Higgins et al.
5,666,978 A 9/1997 Counts et al.
5,708,258 A 1/1998 Counts et al.
5,730,118 A 3/1998 Hermanson
5,730,158 A 3/1998 Collins et al.
5,746,587 A 5/1998 Racine et al.
5,810,164 A 9/1998 Rennecamp
5,819,756 A 10/1998 Mielordt
5,845,649 A 12/1998 Saito et al.
5,865,185 A 2/1999 Collins et al.
5,878,752 A 3/1999 Adams et al.
5,881,884 A 3/1999 Podosek
5,894,841 A 4/1999 Voges
5,931,828 A 8/1999 Durkee
5,934,289 A 8/1999 Watkins et al.
5,938,018 A 8/1999 Keaveney et al.
5,944,025 A 8/1999 Cook et al.
5,954,979 A 9/1999 Counts et al.
5,967,310 A 10/1999 Hill
5,975,415 A 11/1999 Zehnal

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,979,460 A 11/1999 Matsumura
5,994,025 A 11/1999 Iwasa et al.
5,996,589 A 12/1999 St. Charles
6,053,176 A 4/2000 Adams et al.
6,089,857 A 7/2000 Matsuura et al.
6,095,153 A 8/2000 Kessler et al.
6,102,036 A 8/2000 Slutsky et al.
6,125,853 A 10/2000 Susa et al.
6,155,268 A 12/2000 Takeuchi
6,164,287 A 12/2000 White
6,196,232 B1 3/2001 Chkadua
6,211,194 B1 4/2001 Westman et al.
6,234,169 B1 5/2001 Bulbrook et al.
6,269,966 B1 8/2001 Pallo et al.
6,324,261 B1 11/2001 Merte
6,344,222 B1 2/2002 Cherukuri et al.
6,349,728 B1 2/2002 Pham
6,358,060 B2 3/2002 Pinney et al.
6,381,739 B1 4/2002 Breternitz, Jr. et al.
6,386,371 B1 5/2002 Parsons
6,431,363 B1 8/2002 Hacker
6,446,793 B1 9/2002 Layshock
6,510,982 B2 1/2003 White et al.
6,532,965 B1 3/2003 Abhulimen et al.
6,536,442 B2 3/2003 St. Charles et al.
6,557,708 B2 5/2003 Polacco
6,598,607 B2 7/2003 Adiga et al.
6,603,924 B2 8/2003 Brown et al.
6,606,998 B1 8/2003 Gold
6,612,404 B2 9/2003 Sweet et al.
6,615,840 B1 9/2003 Fournier et al.
6,622,867 B2 9/2003 Menceles
6,655,379 B2 12/2003 Clark et al.
6,672,762 B1 1/2004 Faircloth et al.
6,688,313 B2 2/2004 Wrenn et al.
6,726,006 B1 4/2004 Funderburk et al.
6,772,756 B2 8/2004 Shayan
6,799,576 B2 10/2004 Farr
6,803,545 B2 10/2004 Blake et al.
6,805,545 B2 10/2004 Slaboden
6,810,883 B2 11/2004 Felter et al.
6,827,573 B2 12/2004 St. Charles et al.
6,874,507 B2 4/2005 Farr
6,893,654 B2 5/2005 Pinney et al.
6,909,840 B2 6/2005 Harwig et al.
6,954,979 B2 10/2005 Logan
7,000,775 B2 2/2006 Gelardi et al.
7,015,796 B2 3/2006 Snyder
7,025,066 B2 4/2006 Lawson et al.
D557,209 S 12/2007 Ahlgren et al.
7,374,048 B2 5/2008 Mazurek
7,387,788 B1 6/2008 Carrara et al.
7,428,905 B2 9/2008 Mua
7,488,171 B2 2/2009 St. Charles et al.
D590,990 S 4/2009 Hon
D590,991 S 4/2009 Hon
7,546,703 B2 6/2009 Johnske et al.
7,621,403 B2 11/2009 Althoff et al.
7,644,823 B2 1/2010 Gelardi et al.
D611,409 S 3/2010 Green et al.
7,726,320 B2 6/2010 Robinson et al.
7,766,013 B2 8/2010 Wensley et al.
7,767,698 B2 8/2010 Warchol et al.
D624,238 S 9/2010 Turner
7,801,573 B2 9/2010 Yazdi et al.
7,815,332 B1 10/2010 Smith
7,832,410 B2 11/2010 Hon
7,886,507 B2 2/2011 McGuinness, Jr.
D642,330 S 7/2011 Turner
D644,375 S 8/2011 Zhou
7,988,034 B2 8/2011 Pezzoli
8,003,080 B2 8/2011 Rabinowitz et al.
D649,932 S 12/2011 Symons
8,079,371 B2 12/2011 Robinson et al.
D653,803 S 2/2012 Timmermans
8,141,701 B2 3/2012 Hodges
8,156,944 B2 4/2012 Han
8,251,060 B2 8/2012 White et al.
8,308,624 B2 11/2012 Travers et al.
8,314,235 B2 11/2012 Dixit et al.
8,322,350 B2 12/2012 Lipowicz
D674,748 S 1/2013 Ferber et al.
8,371,310 B2 2/2013 Brenneise
8,375,957 B2 2/2013 Hon
8,381,739 B2 2/2013 Gonda
8,387,612 B2 3/2013 Damani et al.
8,443,534 B2 5/2013 Goodfellow et al.
8,464,867 B2 6/2013 Holloway et al.
D686,987 S 7/2013 Vanstone et al.
8,479,747 B2 7/2013 O'Connell
8,490,629 B1 7/2013 Shenassa et al.
8,511,318 B2 8/2013 Hon
8,539,959 B1 9/2013 Scatterday
8,541,401 B2 9/2013 Mishra et al.
D691,324 S 10/2013 Saliman
8,550,069 B2 10/2013 Alelov
D695,450 S 12/2013 Benassayag et al.
8,596,460 B2 12/2013 Scatterday
D700,572 S 3/2014 Esses
8,671,952 B2 3/2014 Winterson et al.
8,707,965 B2 4/2014 Newton
D704,629 S 5/2014 Liu
D704,634 S 5/2014 Eidelman et al.
8,714,150 B2 5/2014 Alelov
D707,389 S 6/2014 Liu
8,741,348 B2 6/2014 Hansson et al.
8,794,245 B1 8/2014 Scatterday
8,794,434 B2 8/2014 Scatterday et al.
8,809,261 B2 8/2014 Elsohly et al.
8,820,330 B2 9/2014 Bellinger et al.
8,851,081 B2 10/2014 Fernando et al.
8,851,083 B2 10/2014 Oglesby et al.
8,881,737 B2 11/2014 Collett et al.
8,899,238 B2 12/2014 Robinson et al.
8,905,040 B2 12/2014 Scatterday et al.
8,910,641 B2 12/2014 Hon
8,915,254 B2 12/2014 Monsees et al.
8,919,561 B2 12/2014 Boisseau
8,925,555 B2 1/2015 Monsees et al.
8,931,492 B2 1/2015 Scatterday
D725,310 S 3/2015 Eksouzian
D725,823 S 3/2015 Scatterday et al.
8,991,402 B2 3/2015 Bowen et al.
9,004,073 B2 4/2015 Tucker et al.
9,010,335 B1 4/2015 Scatterday
9,072,321 B2 7/2015 Liu
9,089,166 B1 7/2015 Scatterday
9,095,175 B2 8/2015 Terry et al.
9,215,895 B2 * 12/2015 Bowen A61K 47/10
9,220,302 B2 12/2015 DePiano et al.
9,226,526 B2 1/2016 Liu
9,254,002 B2 2/2016 Chong et al.
9,255,277 B2 2/2016 Bakker et al.
9,271,525 B2 3/2016 Liu
9,271,529 B2 3/2016 Alima
9,272,103 B2 3/2016 Storz
9,277,768 B2 3/2016 Xiu
9,277,769 B2 3/2016 Liu
9,282,772 B2 3/2016 Tucker et al.
9,282,773 B2 3/2016 Greim et al.
9,289,014 B2 3/2016 Tucker et al.
9,308,336 B2 4/2016 Newton
9,315,890 B1 4/2016 Frick et al.
9,319,865 B2 4/2016 Van Phan et al.
9,326,547 B2 5/2016 Tucker et al.
9,345,269 B2 5/2016 Liu
9,351,522 B2 5/2016 Safari
9,380,810 B2 7/2016 Rose et al.
9,420,829 B2 8/2016 Thorens et al.
9,427,022 B2 8/2016 Levin et al.
9,456,632 B2 10/2016 Hon
9,462,832 B2 10/2016 Lord
9,497,995 B2 11/2016 Liu
9,510,624 B2 12/2016 Li et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,538,781 B2 1/2017 Zheng
9,554,597 B2 1/2017 Liu
9,596,881 B2 3/2017 Chiolini et al.
9,623,592 B2 4/2017 Liu
9,629,391 B2 4/2017 Dube et al.
9,635,886 B2 5/2017 Tu
9,642,397 B2 5/2017 Dai et al.
9,648,905 B2 5/2017 Levitz et al.
9,675,108 B2 6/2017 Liu
9,682,203 B2 6/2017 Dahne et al.
9,682,204 B2 6/2017 Matsumoto et al.
9,687,025 B2 6/2017 Cyphert et al.
9,687,027 B2 6/2017 Poston et al.
9,693,584 B2 7/2017 Hearn et al.
9,717,274 B2 8/2017 Daehne et al.
9,717,279 B2 8/2017 Hon
10,058,129 B2 8/2018 Monsees et al.
10,463,069 B2 * 11/2019 Bowen A24B 15/16
10,952,468 B2 * 3/2021 Bowen A24B 15/16
11,478,021 B2 10/2022 Bowen et al.
11,510,433 B2 11/2022 Bowen et al.
2001/0015209 A1 8/2001 Zielke
2001/0032643 A1 10/2001 Hochrainer et al.
2001/0032795 A1 10/2001 Weinstein et al.
2001/0052480 A1 12/2001 Kawaguchi et al.
2002/0043554 A1 4/2002 White et al.
2002/0059939 A1 5/2002 Fox
2002/0078951 A1 6/2002 Nichols et al.
2002/0175164 A1 11/2002 Dees et al.
2003/0005926 A1 1/2003 Jones et al.
2003/0089377 A1 5/2003 Hajaligol et al.
2004/0002520 A1 1/2004 Soderlund et al.
2004/0031495 A1 2/2004 Steinberg
2004/0050382 A1 3/2004 Goodchild
2004/0099266 A1 5/2004 Cross et al.
2004/0149296 A1 8/2004 Rostami et al.
2004/0149624 A1 8/2004 Wischusen et al.
2004/0168950 A1 * 9/2004 Barker B65D 75/26
206/528
2004/0173224 A1 9/2004 Burgard et al.
2004/0173229 A1 9/2004 Crooks et al.
2004/0182403 A1 9/2004 Andersson et al.
2004/0191322 A1 9/2004 Hansson
2004/0221857 A1 11/2004 Dominguez
2004/0237974 A1 12/2004 Min
2005/0016549 A1 1/2005 Banerjee et al.
2005/0016550 A1 1/2005 Katase
2005/0034723 A1 2/2005 Bennett et al.
2005/0053665 A1 3/2005 Ek et al.
2005/0061759 A1 3/2005 Doucette
2005/0118545 A1 6/2005 Wong
2005/0145533 A1 7/2005 Seligson
2005/0169849 A1 8/2005 Farr
2005/0172976 A1 8/2005 Newman et al.
2005/0244521 A1 11/2005 Strickland et al.
2005/0268911 A1 12/2005 Cross et al.
2006/0018840 A1 1/2006 Lechuga-Ballesteros et al.
2006/0054676 A1 3/2006 Wischusen
2006/0102175 A1 5/2006 Nelson
2006/0150991 A1 7/2006 Lee
2006/0157072 A1 7/2006 Albino et al.
2006/0191546 A1 8/2006 Takano et al.
2006/0191548 A1 8/2006 Strickland et al.
2006/0196518 A1 9/2006 Hon
2006/0243290 A1 11/2006 Reich et al.
2006/0254948 A1 11/2006 Herbert et al.
2006/0255105 A1 11/2006 Sweet
2007/0006889 A1 1/2007 Kobal et al.
2007/0045288 A1 3/2007 Nelson
2007/0062548 A1 3/2007 Horstmann et al.
2007/0074734 A1 4/2007 Braunshteyn et al.
2007/0098148 A1 5/2007 Sherman
2007/0102013 A1 5/2007 Adams et al.
2007/0144514 A1 6/2007 Yeates et al.
2007/0163610 A1 7/2007 Lindell et al.
2007/0215164 A1 9/2007 Mehio
2007/0235046 A1 10/2007 Gedevanishvili
2007/0267031 A1 11/2007 Hon
2007/0267033 A1 11/2007 Mishra et al.
2007/0277816 A1 12/2007 Morrison et al.
2007/0280652 A1 12/2007 Williams
2007/0283972 A1 12/2007 Monsees et al.
2008/0000763 A1 1/2008 Cove
2008/0023003 A1 1/2008 Rosenthal
2008/0029095 A1 2/2008 Esser
2008/0092912 A1 4/2008 Robinson et al.
2008/0121610 A1 5/2008 Nagata et al.
2008/0138423 A1 6/2008 Gonda
2008/0149118 A1 6/2008 Oglesby et al.
2008/0216828 A1 9/2008 Wensley et al.
2008/0228214 A1 9/2008 Hoan et al.
2008/0241255 A1 10/2008 Rose et al.
2008/0257367 A1 10/2008 Paterno et al.
2008/0276947 A1 11/2008 Martzel
2008/0286340 A1 11/2008 Andersson et al.
2008/0302375 A1 12/2008 Andersson et al.
2009/0001085 A1 1/2009 Bartz et al.
2009/0004249 A1 1/2009 Gonda
2009/0023819 A1 1/2009 Axelsson
2009/0095287 A1 4/2009 Emarlou
2009/0095311 A1 4/2009 Han
2009/0111287 A1 4/2009 Lindberg et al.
2009/0126745 A1 5/2009 Hon
2009/0133691 A1 5/2009 Yamada et al.
2009/0139533 A1 6/2009 Park et al.
2009/0151717 A1 6/2009 Bowen et al.
2009/0230117 A1 9/2009 Fernando et al.
2009/0255534 A1 10/2009 Paterno
2009/0267252 A1 10/2009 Ikeyama
2009/0272379 A1 11/2009 Thorens et al.
2009/0283103 A1 11/2009 Nielsen et al.
2009/0288668 A1 11/2009 Inagaki
2009/0288669 A1 11/2009 Hutchens
2009/0293892 A1 12/2009 Williams et al.
2009/0293895 A1 12/2009 Axelsson et al.
2010/0000672 A1 1/2010 Fogle
2010/0006092 A1 1/2010 Hale et al.
2010/0024834 A1 2/2010 Oglesby et al.
2010/0031968 A1 2/2010 Sheikh et al.
2010/0156193 A1 6/2010 Rhodes et al.
2010/0163063 A1 7/2010 Fernando et al.
2010/0186757 A1 7/2010 Crooks et al.
2010/0200006 A1 8/2010 Robinson et al.
2010/0200008 A1 8/2010 Taieb
2010/0236562 A1 9/2010 Hearn et al.
2010/0242974 A1 9/2010 Pan
2010/0242976 A1 9/2010 Katayama et al.
2010/0260688 A1 10/2010 Warchol et al.
2010/0275938 A1 11/2010 Roth et al.
2010/0276333 A1 11/2010 Couture
2010/0307116 A1 12/2010 Fisher
2011/0005535 A1 1/2011 Xiu
2011/0030706 A1 2/2011 Gibson et al.
2011/0036346 A1 2/2011 Cohen et al.
2011/0041861 A1 2/2011 Sebastian et al.
2011/0049226 A1 3/2011 Moreau et al.
2011/0094523 A1 4/2011 Thorens et al.
2011/0108023 A1 5/2011 McKinney et al.
2011/0155153 A1 6/2011 Thorens et al.
2011/0162667 A1 7/2011 Burke et al.
2011/0168194 A1 7/2011 Hon
2011/0180433 A1 7/2011 Rennecamp
2011/0192397 A1 8/2011 Saskar et al.
2011/0226236 A1 9/2011 Buchberger
2011/0226266 A1 9/2011 Tao
2011/0232654 A1 9/2011 Mass
2011/0236002 A1 9/2011 Oglesby et al.
2011/0240047 A1 10/2011 Adamic
2011/0265806 A1 11/2011 Alarcon et al.
2011/0268809 A1 11/2011 Brinkley et al.
2011/0274628 A1 11/2011 Borschke
2011/0277780 A1 11/2011 Terry et al.
2011/0278189 A1 11/2011 Terry et al.
2011/0293535 A1 12/2011 Kosik et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0315701	A1	12/2011	Everson
2012/0006342	A1	1/2012	Rose et al.
2012/0039981	A1	2/2012	Pedersen et al.
2012/0060853	A1	3/2012	Robinson et al.
2012/0111347	A1	5/2012	Hon
2012/0152265	A1	6/2012	Dube et al.
2012/0192880	A1	8/2012	Dube et al.
2012/0199146	A1	8/2012	Marangos
2012/0204889	A1	8/2012	Xiu
2012/0227753	A1	9/2012	Newton
2012/0255567	A1	10/2012	Rose et al.
2012/0260927	A1	10/2012	Liu
2012/0261286	A1	10/2012	Holloway et al.
2012/0267383	A1	10/2012	Van Rooyen
2012/0273589	A1	11/2012	Hon
2012/0285475	A1	11/2012	Liu
2012/0291791	A1	11/2012	Pradeep
2012/0325227	A1	12/2012	Robinson et al.
2012/0325228	A1	12/2012	Williams
2013/0042865	A1	2/2013	Monsees et al.
2013/0068239	A1	3/2013	Youn
2013/0081642	A1	4/2013	Safari
2013/0098377	A1	4/2013	Borschke et al.
2013/0140200	A1	6/2013	Scatterday
2013/0152922	A1	6/2013	Benassayag et al.
2013/0186416	A1	7/2013	Gao et al.
2013/0192615	A1	8/2013	Tucker et al.
2013/0192617	A1	8/2013	Thompson
2013/0199528	A1	8/2013	Goodman et al.
2013/0213417	A1	8/2013	Chong et al.
2013/0213419	A1	8/2013	Tucker et al.
2013/0228191	A1	9/2013	Newton
2013/0247924	A1	9/2013	Scatterday et al.
2013/0248385	A1	9/2013	Scatterday et al.
2013/0255702	A1	10/2013	Griffith, Jr. et al.
2013/0276802	A1	10/2013	Scatterday
2013/0284190	A1	10/2013	Scatterday et al.
2013/0284191	A1	10/2013	Scatterday et al.
2013/0298905	A1	11/2013	Levin et al.
2013/0312742	A1	11/2013	Monsees et al.
2013/0313139	A1	11/2013	Scatterday et al.
2013/0319435	A1	12/2013	Flick
2013/0319440	A1	12/2013	Capuano
2013/0333700	A1	12/2013	Buchberger
2013/0333712	A1	12/2013	Scatterday
2013/0340775	A1	12/2013	Juster et al.
2014/0000638	A1	1/2014	Sebastian et al.
2014/0007891	A1	1/2014	Liu
2014/0014124	A1	1/2014	Glasberg et al.
2014/0014126	A1	1/2014	Peleg et al.
2014/0041655	A1	2/2014	Barron et al.
2014/0041658	A1	2/2014	Goodman et al.
2014/0053856	A1	2/2014	Liu
2014/0053858	A1	2/2014	Liu
2014/0060552	A1	3/2014	Cohen
2014/0060556	A1	3/2014	Liu
2014/0083442	A1	3/2014	Scatterday
2014/0096781	A1	4/2014	Sears et al.
2014/0096782	A1	4/2014	Ampolini et al.
2014/0109921	A1	4/2014	Chen
2014/0116455	A1	5/2014	Youn
2014/0123990	A1	5/2014	Timmermans
2014/0144429	A1	5/2014	Wensley et al.
2014/0150810	A1	6/2014	Hon
2014/0166028	A1	6/2014	Fuisz et al.
2014/0174459	A1	6/2014	Burstyn
2014/0190501	A1	7/2014	Liu
2014/0190503	A1	7/2014	Li et al.
2014/0196731	A1	7/2014	Scatterday
2014/0196735	A1	7/2014	Liu
2014/0202472	A1	7/2014	Levitz et al.
2014/0202474	A1	7/2014	Peleg et al.
2014/0209105	A1	7/2014	Sears et al.
2014/0216450	A1	8/2014	Liu
2014/0217092	A1	8/2014	Kawka et al.
2014/0230835	A1	8/2014	Saliman
2014/0261474	A1	9/2014	Gonda
2014/0261486	A1	9/2014	Potter et al.
2014/0261487	A1	9/2014	Chapman et al.
2014/0261507	A1	9/2014	Balder
2014/0270727	A1	9/2014	Ampolini et al.
2014/0271946	A1	9/2014	Kobal et al.
2014/0299137	A1	10/2014	Kieckbusch et al.
2014/0301721	A1	10/2014	Ruscio et al.
2014/0305450	A1	10/2014	Xiang
2014/0345631	A1	11/2014	Bowen et al.
2014/0345633	A1	11/2014	Talon et al.
2014/0345635	A1	11/2014	Rabinowitz et al.
2014/0355969	A1	12/2014	Stern
2014/0366898	A1	12/2014	Monsees et al.
2014/0378790	A1	12/2014	Cohen
2015/0020823	A1	1/2015	Lipowicz et al.
2015/0020824	A1	1/2015	Bowen et al.
2015/0020825	A1	1/2015	Galloway et al.
2015/0020830	A1	1/2015	Koller
2015/0020831	A1	1/2015	Weigensberg et al.
2015/0027457	A1	1/2015	Janardhan et al.
2015/0027468	A1	1/2015	Li et al.
2015/0027472	A1	1/2015	Amir
2015/0034103	A1	2/2015	Hon
2015/0034104	A1	2/2015	Zhou
2015/0038567	A1	2/2015	Herkenroth et al.
2015/0040929	A1	2/2015	Hon
2015/0042412	A1	2/2015	Imbornone et al.
2015/0101625	A1	4/2015	Newton et al.
2015/0101945	A1	4/2015	Scatterday
2015/0122252	A1	5/2015	Frija
2015/0122274	A1	5/2015	Cohen et al.
2015/0128965	A1	5/2015	Lord
2015/0128966	A1	5/2015	Lord
2015/0128967	A1	5/2015	Robinson et al.
2015/0128976	A1	5/2015	Verleur et al.
2015/0136153	A1	5/2015	Lord
2015/0136158	A1	5/2015	Stevens et al.
2015/0142387	A1	5/2015	Alarcon et al.
2015/0144147	A1	5/2015	Li et al.
2015/0150308	A1	6/2015	Monsees et al.
2015/0157054	A1	6/2015	Liu
2015/0157056	A1	6/2015	Bowen et al.
2015/0157893	A1	6/2015	Canevari
2015/0157901	A1	6/2015	Mace et al.
2015/0164141	A1	6/2015	Newton
2015/0164144	A1	6/2015	Liu
2015/0164147	A1	6/2015	Verleur et al.
2015/0165067	A1	6/2015	Balderes et al.
2015/0181928	A1	7/2015	Liu
2015/0189695	A1	7/2015	Xiang
2015/0196059	A1	7/2015	Liu
2015/0196060	A1	7/2015	Wensley et al.
2015/0208729	A1	7/2015	Monsees et al.
2015/0208731	A1	7/2015	Malamud et al.
2015/0216237	A1	8/2015	Wensley et al.
2015/0223521	A1	8/2015	Menting et al.
2015/0224268	A1	8/2015	Henry et al.
2015/0237917	A1	8/2015	Lord
2015/0237918	A1	8/2015	Liu
2015/0245654	A1	9/2015	Memari et al.
2015/0245660	A1	9/2015	Lord
2015/0257445	A1	9/2015	Henry, Jr. et al.
2015/0258289	A1	9/2015	Henry, Jr. et al.
2015/0272220	A1	10/2015	Spinka et al.
2015/0272222	A1	10/2015	Spinka et al.
2015/0282525	A1	10/2015	Plojoux et al.
2015/0282527	A1	10/2015	Henry, Jr.
2015/0305409	A1	10/2015	Verleur et al.
2015/0313275	A1	11/2015	Anderson et al.
2015/0313285	A1	11/2015	Waller et al.
2015/0320114	A1	11/2015	Wu
2015/0335074	A1	11/2015	Leung
2015/0351456	A1	12/2015	Johnson et al.
2015/0359264	A1	12/2015	Fernando et al.
2015/0366265	A1	12/2015	Lansing
2015/0366266	A1	12/2015	Chen
2016/0021931	A1	1/2016	Hawes et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0021932	A1	1/2016	Silvestrini et al.
2016/0021933	A1	1/2016	Thorens et al.
2016/0021934	A1	1/2016	Cadieux et al.
2016/0029694	A1	2/2016	Clements et al.
2016/0029697	A1	2/2016	Shafer
2016/0029698	A1	2/2016	Xiang
2016/0044967	A1	2/2016	Bowen et al.
2016/0044968	A1	2/2016	Bowen et al.
2016/0053988	A1	2/2016	Quintana
2016/0057811	A1	2/2016	Alarcon et al.
2016/0058071	A1	3/2016	Hearn
2016/0058072	A1	3/2016	Liu
2016/0073692	A1	3/2016	Alarcon et al.
2016/0081393	A1	3/2016	Black
2016/0081395	A1	3/2016	Thorens et al.
2016/0095355	A1	4/2016	Hearn
2016/0106154	A1	4/2016	Lord
2016/0106155	A1	4/2016	Reevell
2016/0106936	A1	4/2016	Kimmel
2016/0109115	A1	4/2016	Lipowicz
2016/0120218	A1	5/2016	Schennum et al.
2016/0120220	A1	5/2016	Malgat et al.
2016/0120227	A1	5/2016	Levitz et al.
2016/0120228	A1	5/2016	Rostami et al.
2016/0135503	A1	5/2016	Liu
2016/0143359	A1	5/2016	Xiang
2016/0143365	A1	5/2016	Liu
2016/0157524	A1	6/2016	Bowen et al.
2016/0166564	A1	6/2016	Myers et al.
2016/0174603	A1	6/2016	Abayarathna et al.
2016/0174611	A1	6/2016	Monsees et al.
2016/0200463	A1	7/2016	Hodges et al.
2016/0227839	A1	8/2016	Zuber et al.
2016/0227840	A1	8/2016	Xiang
2016/0242466	A1	8/2016	Lord et al.
2016/0249680	A1	9/2016	Liu
2016/0250201	A1	9/2016	Rose et al.
2016/0270451	A1	9/2016	Hon
2016/0278435	A1	9/2016	Choukroun et al.
2016/0295924	A1	10/2016	Liu
2016/0295926	A1	10/2016	Zuber
2016/0302471	A1	10/2016	Bowen et al.
2016/0302483	A1	10/2016	Liu
2016/0302484	A1	10/2016	Gupta et al.
2016/0302486	A1	10/2016	Eroch
2016/0309784	A1	10/2016	Silvestrini et al.
2016/0324215	A1	11/2016	Mironov et al.
2016/0331033	A1	11/2016	Hopps et al.
2016/0331038	A1	11/2016	Farine et al.
2016/0331040	A1	11/2016	Nakano et al.
2016/0338402	A1	11/2016	Buehler et al.
2016/0338410	A1	11/2016	Batista et al.
2016/0338411	A1	11/2016	Liu
2016/0345627	A1	12/2016	Liu
2016/0345630	A1	12/2016	Mironov et al.
2016/0366939	A1	12/2016	Alarcon et al.
2016/0368670	A1	12/2016	Beardsall
2016/0371464	A1	12/2016	Bricker
2016/0374390	A1	12/2016	Liu
2016/0374398	A1	12/2016	Amir
2017/0019951	A1	1/2017	Louveau et al.
2017/0049155	A1	2/2017	Liu
2017/0064999	A1	3/2017	Perez et al.
2017/0071257	A1	3/2017	Lin
2017/0079329	A1	3/2017	Zitzke
2017/0079331	A1	3/2017	James et al.

FOREIGN PATENT DOCUMENTS

CN	1122213	A	5/1996
CN	1298294	A	6/2001
CN	1541577	A	11/2004
CN	1607950	A	4/2005
CN	1887126	A	1/2007
CN	101742985	A	6/2010
CN	101756352	A	6/2010
CN	101869356	A	10/2010
CN	102014995	A	4/2011
CN	102316850	A	1/2012
CN	102355914	A	2/2012
CN	102612361	A	7/2012
CN	102754924	A	10/2012
CN	102892413	A	1/2013
CN	102933199	A	2/2013
CN	105263345	A	1/2016
DE	4200639	A1	7/1992
DE	19854005	A1	5/2000
DE	19854012	A1	5/2000
EP	0148749	A2	7/1985
EP	0283672	A2	9/1988
EP	0354661	A2	2/1990
EP	0532194	A1	3/1993
EP	0535695	A2	4/1993
EP	0283672	B1	9/1993
EP	1458388	A1	9/2004
EP	1618803	A1	1/2006
EP	1618803	B1	12/2008
EP	2022349	A1	2/2009
EP	2022350	A1	2/2009
EP	2110033	A1	10/2009
EP	2152313	A1	2/2010
EP	2186507	A2	5/2010
EP	2319934	A2	5/2011
EP	2325093	A1	5/2011
EP	2609821	A1	7/2013
EP	2856893	A1	4/2015
EP	2908675	A1	8/2015
EP	3024343	A2	6/2016
EP	3062646	A1	9/2016
EP	3065581	A2	9/2016
EP	3068244	A1	9/2016
EP	3214957	B1	9/2017
EP	2915443	B1	8/2019
ES	2118034	A1	9/1998
GB	1025630	A	4/1966
GB	1065678	A	4/1967
IE	S20050051		2/2005
IE	S20050563		8/2005
IE	20050615		9/2005
JP	S61254170	A	11/1986
JP	62278975		12/1987
JP	6437276		2/1989
JP	02-145179		6/1990
JP	H02145179	A	6/1990
JP	A-03-049671		3/1991
JP	03049671		4/1991
JP	03180166		6/1991
JP	09-075058		3/1997
JP	10-501999		2/1998
JP	11178563		6/1999
JP	2000203639	A	7/2000
JP	2000236865	A	9/2000
JP	2001165437	A	6/2001
JP	2005034021	A	2/2005
JP	2006504430	A	2/2006
JP	2006-524494	A	11/2006
JP	2009108082	A	5/2009
JP	2010531188	A	9/2010
JP	2010532672	A	10/2010
JP	2012506263	A	3/2012
JP	2013505240	A	2/2013
JP	2016513030	A	5/2016
JP	6877141	B2	12/2016
KR	10-0193885	B1	6/1999
KR	0193885		6/1999
KR	100694546	B1	3/2007
KR	20100034029	A	3/2010
KR	10-2010-0088626	B1	8/2010
KR	10-2011-0094118	B1	8/2011
KR	101074619	B1	10/2011
MX	2015015175	A	1/2016
RU	94815	U1	6/2010
UA	67598	U	2/2012
WO	WO-9501137	A1	1/1995

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	WO-9712639	A1	4/1997
WO	WO-0028842	A1	5/2000
WO	WO-03055486	A1	7/2003
WO	WO-03056948	A1	7/2003
WO	WO-03082031	A1	10/2003
WO	WO-03094900	A1	11/2003
WO	WO-2003103387	A2	12/2003
WO	WO-2004002446	A1	1/2004
WO	WO-2004064548	A1	8/2004
WO	WO-2004076289	A2	9/2004
WO	WO-2004080216	A1	9/2004
WO	WO-2005020726	A1	3/2005
WO	WO-2006004646	A1	1/2006
WO	WO-2006015070	A1	2/2006
WO	WO-2006053082	A2	5/2006
WO	WO-2006082571	A1	8/2006
WO	WO-2007026131	A1	3/2007
WO	WO-2007078273	A1	7/2007
WO	WO-2008077271	A1	7/2008
WO	WO-2008121610	A1	10/2008
WO	WO-2009001085	A2	12/2008
WO	WO-2009069519	A1	6/2009
WO	WO-2009079641	A2	6/2009
WO	WO-2010023561	A1	3/2010
WO	WO-2010045671	A1	4/2010
WO	WO-2011033396	A2	3/2011
WO	WO-2011034723	A1	3/2011
WO	WO-2011038104	A2	3/2011
WO	WO-2011/117580	A2	9/2011
WO	WO-2011109849	A1	9/2011
WO	WO-2011139684	A2	11/2011
WO	WO-2012021972	A1	2/2012
WO	WO-2012027350	A2	3/2012
WO	WO-2012/085207	A1	6/2012
WO	WO-2012120487	A2	9/2012
WO	WO-2012134380	A1	10/2012
WO	WO-2013013808	A1	1/2013
WO	WO-2013044537	A1	4/2013
WO	WO-2013050934	A1	4/2013
WO	WO-2013083631	A1	6/2013
WO	WO-2013083635	A1	6/2013
WO	WO-2013088230	A1	6/2013
WO	WO-2013089551	A1	6/2013
WO	WO-2013/098398	A2	7/2013
WO	WO-2013116558	A1	8/2013
WO	WO-2013116561	A1	8/2013
WO	WO-2013141906	A1	9/2013
WO	WO-2013141907	A1	9/2013
WO	WO-2013141994	A1	9/2013
WO	WO-2013141998	A2	9/2013
WO	WO-2013142671	A1	9/2013
WO	WO-2013142678	A1	9/2013
WO	WO-2014004648	A1	1/2014
WO	WO-2014040915	A1	3/2014
WO	WO-2014093127	A2	6/2014
WO	WO-2014101734	A1	7/2014
WO	WO-2014113592	A1	7/2014
WO	WO-2014118286	A2	8/2014
WO	WO-2014139611	A1	9/2014
WO	WO-2014140087	A1	9/2014
WO	WO-2014150245	A1	9/2014
WO	WO-2014150704	A2	9/2014
WO	WO-2014151434	A2	9/2014
WO	WO-2014159250	A1	10/2014
WO	WO-2014159982	A1	10/2014
WO	WO-2014177859	A1	11/2014
WO	WO-2014182736	A1	11/2014
WO	WO-2014187763	A1	11/2014
WO	WO-2014187770	A2	11/2014
WO	WO-2014190079	A2	11/2014
WO	WO-2014205263	A1	12/2014
WO	WO-2015/006652	A1	1/2015
WO	WO-2015/009862	A2	1/2015
WO	WO-2015028815	A1	3/2015
WO	WO-2015040180	A2	3/2015
WO	WO-2015042412	A1	3/2015
WO	WO-2015058387	A1	4/2015
WO	WO-2015/063126	A1	5/2015
WO	WO-2015066136	A1	5/2015
WO	WO-2015073975	A1	5/2015
WO	WO-2015/082652	A1	6/2015
WO	WO-2015084544	A1	6/2015
WO	WO-2015089711	A1	6/2015
WO	WO-2015091258	A1	6/2015
WO	WO-2015100361	A1	7/2015
WO	WO-2015101651	A1	7/2015
WO	WO-2015109616	A1	7/2015
WO	WO-2015/124878	A1	8/2015
WO	WO-2015/148547	A1	10/2015
WO	WO-2015/149647	A1	10/2015
WO	WO-2015148649	A2	10/2015
WO	WO-2015157893	A1	10/2015
WO	WO-2015157901	A1	10/2015
WO	WO-2015165067	A1	11/2015
WO	WO-2015167629	A1	11/2015
WO	WO-2015168828	A1	11/2015
WO	WO-2015169127	A1	11/2015
WO	WO-2015175979	A1	11/2015
WO	WO-2015179292	A1	11/2015
WO	WO-2015179641	A1	11/2015
WO	WO-2015193456	A1	12/2015
WO	WO-2016012769	A1	1/2016
WO	WO-2016014652	A1	1/2016
WO	WO-2016020675	A1	2/2016
WO	WO-2016030661	A1	3/2016
WO	WO-2016040575	A1	3/2016
WO	WO-2016041114	A1	3/2016
WO	WO-2016041140	A1	3/2016
WO	WO-2016/062777	A1	4/2016
WO	WO-2016050247	A1	4/2016
WO	WO-2016054580	A1	4/2016
WO	WO-2016058189	A1	4/2016
WO	WO-2016063775	A1	4/2016
WO	WO-2016065606	A1	5/2016
WO	WO-2016071705	A1	5/2016
WO	WO-2016071706	A1	5/2016

OTHER PUBLICATIONS

"How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attibutable Disease," U.S. Department of Health and Human Services, 2010.

"Substantially" entry from dictionary.com, printed from internet on Dec. 21, 2020.

Goniewicz, et al., "Nicotine levels in electronic cigarettes," Nicotine Tobacco Research, 15(1), pp. 158-166, Jan. 2013.

(https://www.e-cigarette-forum.com/forum/threads/any-interest-in-determining-nicotine-by-dvap.35922/); blog posts dated: 2009; 8 pgs.; print/retrieval date: Jul. 31, 2014.

3: In vitro toxicity of whole smoke; Food and Chemical Toxicology; 36(3); pp. 191-197; Mar. 1998.

Adam, Thomas, Stefan Mitschke, and Richard R. Baker. "Investigation of tobacco pyrolysis gases and puff-by-puff resolved cigarette smoke by single photon ionisation (SPI)-time-of-flight mass spectrometry (TOFMS)." Beitrage zur Tabakforschung International/Contributions to Tobacco Research 23.4 (2009): 203-226.

Baker et al.; The pyrolysis of tobacco ingredients; J. Anal. Appl. Pyrolysis; 71(1); pp. 223-311; Mar. 2004.

Baker, R., et al., "An overview of the effects of tobacco ingredients on smoke chemistry and toxicity," Food and Chemical Toxicology, 42S, 2004.

Baker, R., et al., "The effect of tobacco ingredients on smoke chemisty. Part II: Casing ingredients," Food and Chemical Toxicology, 42S, 2004.

Bao, M., et al., "An improved headspace solid-phase microextraction method for the analysis of free-base nicotine in particulate phase of mainstream cigarette smoke," Analytica Chimic Acta, 49-54, 2010.

Bastin, R., et al., "Salt Selection and Optimisation Procedures for Pharmaceutical New Checmical Entities," Organic Process Research & Development, 4, 427-435 (2000).

(56) **References Cited**

OTHER PUBLICATIONS

Bates, "Tobacco Additives: Cigarette Engineering and Nicotine Addiction," ASH UK Report, 1999.
Bertholon, J. F., et al. "Comparison of the aerosol produced by electronic cigarettes with conventional cigarettes and the shisha." Revue des maladies respiratoires 30.9 (2013): 752-757.
Bertholon, J. F., et al. "Electronic cigarettes: a short review." Respiration 86.5 (2013): 433-438.
Bombick et al.; Chemcal and biological studies of a new cigarette that primarily heats tobacco; Part.
Bombick et al.; Chemical and biological studies of a new cigarette that primarily heats tobacco; Part 2: In vitro toxicology of mainstream smoke condesnsate; Food and Chemical Toxicology; 36(3); pp. 183-190; Mar. 1998.
Borgerding et al.; Chemcal and biological studies of a new cigarette that primarily heats tobacco; Part 1: Chemical composition of mainstream smoke; Food and Chemical Toxicology; 36(3); pp. 169-182; Mar. 1998.
Bowen et al.; U.S. Appl. No. 15/101,303 entitled "Nicotine liquid formulations for aerosol devices and methods thereof," filed Jun. 2, 2016.
Bowen et al.; U.S. Appl. No. 14/960,259 entitled "Calibrated Dose Control", filed Dec. 4, 2015.
Bradley et al.; Electronic cigarette aerosol particle size distribution measurements; Inhal. Toxicol.; 24(14); pp. 976-984; Dec. 2012.
Brown, Christopher J., et al., "Electronic cigarettes: product characterisation and design considerations." Tobacco control 23.suppl 2 (2014): ii4-ii10.
Brown, Christopher, et al.,"Caffeine and Cigarette Smoking: Behavioral, Cardiovascular, and Metabolic Interactions," Pharmacology Biochemistry and Behavior, vol. 34, pp. 565-570, 1989.
Bullen et al.; Effect of an electronic nicotine delivery device (e cigarette) on desire to smoke and withdrawal, user preferences and nicotine delivery: randomised cross-over trial; Tobacco Control; 19(2); pp. 98-103; Apr. 2010.
Bullen, Chris, et al. "Study protocol for a randomised controlled trial of electronic cigarettes versus nicotine patch for smoking cessation." BMC public health 13.1 (2013): 210.
Bullen, Christopher, et al. "Effect of an electronic nicotine delivery device (e cigarette) on desire to smoke and withdrawal, user preferences and nicotine delivery: randomised cross-over trial." Tobacco control 19.2 (2010): 98-103.
Burch et al.; Effect of pH on nicotine absorption and side effects produced by aerosolized nicotine; Journal of Aerosol Medicine: Deposition, Clearance, and Effects in the Lung; 6(1); pp. 45-52; 1993.
Burch, et al., "Effect of pH on nicotine absorption and side effects produced by areosolized nicotine," Journal of Aerosol Medicine: Deposition, Clearance, and Effects in the Lung, 6(1), pp. 45-52. 1993.
Burn et al., "Action of Nicotine on the Heart", Excretion of Piperazine Salts, British Medical Journal, Jan. 18, 1958, pp. 137-139.
Cahn, Zachary, et al., "Electronic cigarettes as a harm reduction strategy for tobacco control: a step forward or a repeat of past mistakes?." Journal of public health policy 32.1 (2011): 16-31.
Caldwell, B., et al., "A Systematic Review of Nicotine by Inhalation: Is There a Role for the Inhaled Route?," Nicotine & Tobacco Research, pp. 1-13 (2012).
Callicutt, C.H., "The role of ammonia in the transfer of nicotine from tobacco to mainstream smoke," Regulatory Toxicology and Pharmacology, 46, 2006.
Caponnetto, Pasquale, et al. "EffiCiency and Safety of an eLectronic cigAreTte (ECLAT) as tobacco cigarettes substitute: a prospective 12-month randomized control design study." PloS one 8.6 (2013): e66317.
Caponnetto, Pasquale, et al. "The emerging phenomenon of electronic cigarettes." Expert review of respiratory medicine 6.1 (2012): 63-74.
Capponnetto et al.; Successful smoking cessation with cigarettes in smokers with a documented history of recurring relapses: a case series; Journal of Medical Case Reports; 5(1); 6 pages; (year of pub. sufficiently earlier than effective US filing date and any foreign priority date); 2011.
Cheng, Tianrong. "Chemical evaluation of electronic cigarettes." Tobacco control 23.suppl 2 (2014): ii11-ii17.
Cig Buyer.com 2013 Inside E-Cigarette Liquids and Vapor.
Cisternino, S., et al., "Coexistence of Passive and Proton Anitporter-Mediated Processes in Nicotine Transport at the Mouse Blood-Brain Barrier," The AAPS Journal, vol. 15, No. 2, Apr. 2013.
Clayton, et al., "Spectroscopic investigations into the acid-base properties of nicotine at different temperatures", Analytical Methods, 2013, pp. 81-88, vol. 5.
Dawkins, Lynne, et al. "The electronic-cigarette: effects on desire to smoke, withdrawal symptoms and cognition." Addictive behaviors 37.8 (2012): 970-973.
Dawkins, Lynne, et al., "Acute electronic cigarette use: nicotine delivery and subjective effects in regular users," Psychopharmacology, 2013.
Dawkins, Lynne, John Turner, and Eadaoin Crowe. "Nicotine derived from the electronic cigarette improves time-based prospective memory in abstinent smokers." Psychopharmacology 227.3 (2013): 377-384.
Definition of "aerosol", Merriam-Webster Dictionary, [online], no date, retrieved from the Internet, [retrieved Jun. 8, 2017], <URL: https://www.merriam-webster.com/dictionary/aerosol>.
Dezelic, M., et al., "Determination of structure of some salts of nicotine, pyridine and N-methylpyrrolidine on the basis of their infra-red spectra," Spectrochimica Acta, vol. 23A, 1967.
Dixon, M., "On the Transfer of Nicotine from Tobacco to the Smoker. A Brief Review of Ammonia and "pH" Factors," Contributions to Tobacco Research, vol. 19, No. 2, Jul. 2000.
Dong, J.Z., et al., "A Simple Technique for Determining the pH of Whole Cigarette Smoke," Contributions to Tobacco Research, vol. 19, No. 1, Apr. 2000.
Drummond, M. Bradley, et al., "Electronic cigarettes. Potential harms and benefits." Annals of the American Thoracic Society 11.2 (2014): 236-242.
E-Cigarette Forum; pg-gv-peg (discussion/posting); retrieved from the internet: <https://e-cigarette-forum.com/forum/threads/pg-vg-peg.177551;> 7 pgs.; Apr. 8, 2011.
ECF; Any interest in determining nicotine—by DVAP.
Effros, R., et al., "The In Vivo pH of the Extravascular Space of the Lung," The Journal of Clinical Investigation, vol. 48, 1969.
Eissenberg, Thomas. "Electronic nicotine delivery devices: ineffective nicotine delivery and craving suppression after acute administration." Tobacco control 19.1 (2010): 87-88.
Etter, Jean-Francois, et al., "Analysis of refill liquids for electronic cigarettes." Addiction 108.9 (2013): 1671-1679.
Etter, Jean-Francois. "Levels of saliva cotinine in electronic cigarette users." Addiction 109.5 (2014): 825-829.
Farsalinos et al.; Electronic cigarettes do not damage the heart; European Society of Cardiology; 4 pages; retrieved from the internet (http://www.escardio.org/The-ESC/Press-Office/Press-releases/Electronic-cigarettes-do-not-damage-the-heart); Aug. 25, 2012.
Farsalinos, Konstantinos E., et al. "Characteristics, perceived side effects and benefits of electronic cigarette use: a worldwide survey of more than 19,000 consumers." International journal of environmental research and public health 11.4 (2014): 4356-4373.
Farsalinos, Konstantinos E., et al. "Evaluating nicotine levels selection and patterns of electronic cigarette use in a group of "vapers" who had achieved complete substitution of smoking." Substance abuse: research and treatment 7 (2013): SART-512756.
Farsalinos, Konstantinos E., et al. "Impact of flavour variability on electronic cigarette use experience: an internet survey." International journal of environmental research and public health 10.12 (2013): 7272-7282.
Farsalinos, Konstantinos E., et al. "Nicotine absorption from electronic cigarette use: comparison between first and new-generation devices." Scientific reports 4 (2014): 4133.

(56) **References Cited**

OTHER PUBLICATIONS

Farsalinos, Konstantinos E., et al., "Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review." Therapeutic advances in drug safety 5.2 (2014): 67-86.
Flouris et al.; Acute impact of active and passive electronic cigarette smoking on serum cotinine and lung function; Inhal. Toxicol.; 25(2); pp. 91-101; Feb. 2013.
Food & Drug Administration; Warning letter to the Compounding Pharmacy; retrieved Oct. 10, 2014 from http://www.fda.gov/ICECI/EnfocementActions/WarningLetters/2002/ucm144843.htm; 3 pgs.; Apr. 9, 2002.
Fournier, J., "Thermal Pathways for the Transfer of Amines, Including Nicotine, to the Gas Phase and Aerosols," Heterocycles, vol. 55, No. 1, 2001.
Gonda, I., et al. "Smoking cessation approach via deep lung delivery of 'clean'nicotine." RDD Europe (2009): 57-61.
Goniewicz, Maciej L., et al., "Nicotine content of electronic cigarettes, its release in vapour and its consistency across batches: regulatory implications." Addiction 109.3 (2014): 500-507.
Grotenhermen, et al., Developing science-based per se limits for driving under the influence of cannabis (DUIC): findings and recommendations by an expert panel; retreived Feb. 9, 2017 from (http://www.canorml.org/healthfacts/DUICreport.2005.pdf); Sep. 2005.
Harris, Mark. "Warning cigarettes may be about to become fashionable again." Engineering & Technology 6.1 (2011): 38-31.
Harvest Vapor; American Blend Tobacco (product info.); retrieved from the internet (http://harvestvapor.com/); 2 pgs.; print/retrieval date: Oct. 10, 2014.
Henningfield, et al., "Tobacco Control", 1995, pp. 57-61, vol. 4.
Heyder, J., "Alveolar deposition of inhaled particles in humans," American Industrial Hygiene Association Journal, 43:11, 864-866, 2010.
https://www.industrydocumentslibrary.ucsf.edu/tobacco/docs/ytyg0100.
Hurt et al.; Treating tobacco dependence in a medical setting; CA: A Cancer Journal for Clinicians; 59(5); pp. 314-326; Sep. 2009.
Hurt, R., et al., "Prying Open the Door to the Tobacco Industry's Secrets About Nicotine," The Journal of the American Medical Association, vol. 280, 1998.
Inchem; Benzoic Acid; JECFA Evaluation Summary; retrieved Oct. 10, 2014 from http://www.inchem.org/documents/jecfa/feceval/jec_184.htm; 2 pgs . . . ; May 28, 2005.
Inchem; Levulinic Acid; JECFA Evaluation Summary; retrieved Oct. 10, 2014 from http://www.inchem.org/documents/jecfa/feceval/jec_1266.htm; 1 pg.; Mar. 10, 2003.
Inchem; Pyruvic Acid; JECFA Evaluation Summary; retrieved Oct. 10, 2014 from http://www.inchem.org/documents/jecfa/feceval/jec_2072.htm; 1 pg.; Jan. 29, 2003.
Inchem; Sorbic Acid; JECFA Evaluation Summary; retrieved Oct. 10, 2014 from http://www.inchem.org/documents/jecfa/feceval/jec_2181.htm; 1 pg.; May 29, 2005.
Ingebrethsen et al.; Electronic cigarette aerosol particle size distribution measurements; Inhalation Toxicology; 24(14); pp. 976-984; Dec. 2012.
Keithly, Lois., et al., "Industry research on the use and effects of levulinic acid: A case study in cigarette additives," Nicotine & Tobacco Research vol. 7, No. 5, 761-771, 2005.
Kosmider, L., et al. "Electronic cigarette—a safe substitute for tobacco cigarette or a new threat?." Przeglad lekarski 69.10 (2012): 1084-1089. [including English language translation thereof].
Kuo et al.; Appendix D: Particle size—U.S. sieve size and tyler screen mesh equivalents; Applications of Turbulent and Multiphase Combustion; John Wiley & Sons, Inc.; pp. 541-543; May 1, 2012.
Lauterbach, J.H, "Comparison of Mainstream Cigarette Smoke pH With Mainstream E-Cigarette Aerosol pH" Tob. Sci. Res. Conf., 2013, 67, abstr. 78. 2013.
Lauterbach, J.H., "A Critical Assessment of Recent Work on the Application of Gas/Particle Partitioning Theories to Cigarette Smoke," Contributions to Tobacco Research, vol. 19, No. 2, Jul. 2000.
Lauterbach, J.H., "Comment on Gas/Particle Partitioning of Two Acid-Base Active Compounds in Mainstream Tobacco Smoke: Nicotine and Ammonia," J. Agric. Food Chem., vol. 58, No. 16, 2010.
Lauterbach, J.H., "Free-base nicotine in tobacoo products. Part 1. Determination of free-base nicotine in the particulate phase of mainstream cigarette smoke and the relevance of these findings to product design parameters," Regulatory Toxicology and Pharmacology, 2010.
Lauterback (2013) "GC-MS analysis of e-liquids taken from e-cigarettes and e-liquids (e-juice) before use in e-cigarettes" Presentation Slides Coresta.
Lee, L.-Y., et al., "Airway irritation and cough evoked by inhaled cigarette smoke: Role of neuronal nicotinic acetylcholine receptors," Pulmonary Pharmacology & Therapeutics, vol. 20, 2007.
Leffingwell, et al., "Basic chemical constituents of tobacco: production, chemistry and Technology", Blackwell Science, 1999.
Leffingwell, J., et al., "Tobacco Flavoring for Smoking Products," R.J. Reynolds Tobacco Company, 1972.
Lim, Heung Bin, et al., "Inhallation of e-cigarette cartridge solution aggravates allergen-induced airway inflammation and hyper-responsiveness in mice." Toxicological research 30.1 (2014): 13.
Lippiello, P., et al., "Enhancement of Nicotine Binding to Nicotinic Receptors by Nicotine Levulinate and Levulinic Acid," 1989.
Lux, J.E., et al., "Subjective Responses to Inhaled and Intravenous Injected Nicotine," American Society for Clinical Pharmacology and Therapeutics, 1988.
Lux, J.E., et al., :Generation of a submicrometre nicotine aerosol for inhalation, Med. & Biol. Eng. & Comput. 26, 232-234, 1988.
Monseeset al.; U.S. Appl. No. 15/257,760 entitled "Vaporizer apparatus," filed Sep. 6, 2016.
MacDougall, James., et al., "Selective Cardiovascular Effects of Stress and Cigarette Smoking," Journal of Human Stress, 9:3. 13-21, 1983.
Maier, et al., "Polypropylene: the defintive user's guide and databook", 1998.
McCann et al.; Detection of carcinogens as mutagens in the salmonella/microsome test: Assay of 300 chemicals: Discussion; Proc. Nat. Acad. Sci.; 73(3); pp. 950-954; Mar. 1976.
McQueen, Amy, et al., "Interviews with "vapers": implications for future research with electronic cigarettes." Nicotine & Tobacco Research 13.9 (2011): 860-867.
McRobbie, Hayden, et al. "Electronic cigarettes for smoking cessation and reduction." Cochrane Database Syst. Rev 12 (2012).
Mirriam-Webster Online Dictionary; Lighter; retrieved Jan. 4, 2013 from the internet: (http://www.merriam-webster.com/dictionary/lighter?show=0&t=1357320593); 2 pgs.; print date: Jan. 4, 2013.
Monsees et al.; U.S. Appl. No. 15/257,748 entitled "Cartridge for use with a vaporizer device," filed Sep. 6, 2016.
Monsees et al.; U.S. Appl. No. 15/165,954 entitled "Devices for vaporization of a substance," filed May 26, 2016.
Monsees et al.; U.S. Appl. No. 15/165,972 entitled "Portable devices for generating an inhalable vapor," filed May 26, 2016.
Monsees et al.; U.S. Appl. No. 15/166,001 entitled "Electronic vaporization device," filed May 26, 2016.
Monsees et al.; U.S. Appl. No. 15/257,768 entitled "Vaporizer apparatus," filed Sep. 6, 2016.
Monsees et al.; U.S. Appl. No. 15/261,823 entitled "Low temperature electronic vaporization device and methods," filed Sep. 9, 2016.
Monsees, J.; U.S. Appl. No. 12/115,400 entitled "Method and System for Vaporization of a Substance", filed May 5, 2008.
Nicoli et al.; Mammalian tumor xenografts induce neovascularization in Zebrafish embryos; Cancer Research; 67(7); pp. 2927-2931; Apr. 1, 2007.
Nicotine Salts. RJ Reynolds Records. Nov. 9, 1990.
Oldendorf, W., et al., "Blood-brain barrier penetration abolished by N-methyl quaternization of nicotine," Proc. Natl. Acad. Sci, vol. 90, pp. 307-311, 1993.
Oldendorf, W., et al., "pH Dependence of Blood-Brain Barrier Permeability to Lactate and Nicotine," Stroke, vol. 10, No. 5, 1979.
Omole, Olufemi Babatunde, et al., "Review of alternative practices to cigarette smoking and nicotine replacement therapy: how safe are they?. " South African Family Practice 53.2 (2011): 154-160.

(56) **References Cited**

OTHER PUBLICATIONS

Pachke, T., et al., "Effects of Ingredients on Cigarette Smoke Composition and Biological Activity: A Literature Overview," Contributions to Tobacco Research, vol. 20, No. 2, Aug. 2002.
Pankow, et al., "Conversion of Nicotine in Tobacco Smoke to Its Volatile and Available Free-Base form Through the Action of Gaseous Ammonia," Eniron. Sci. Technol. 31 (8), 1997.
Pankow, James F. "A consideration of the role of gas/particle partitioning in the deposition of nicotine and other tobacco smoke compounds in the respiratory tract." Chemical research in toxicology 14.11 (2001): 1465-1481.
Perfetti, "Structural study of nicotine salts," Beitrage Zur Tabakforschung International, Contributions to Tobacco Research, 12(2), pp. 43-54. Jun. 1983.
Perfetti, T., "Investigation of Nicotine Transfer to Mainstream Smoke I. Synthesis of Nicotine Salts," 1978.
Perfetti, Transfer of Nicotine salts to mainstream smoke (2000) https://www.industrydocumentslibrary.ucstedu/tobacco/docs/#id=rzwp0187.
Polosa, Riccardo, et al. "A fresh look at tobacco harm reduction: the case for the electronic cigarette." Harm reduction journal 10.1 (2013): 19.
Polosa, Riccardo, et al. "Effect of smoking abstinence and reduction in asthmatic smokers switching to electronic cigarettes: evidence for harm reversal." International journal of environmental research and public health 11.5 (2014): 4965-4977.
Polosa, Riccardo, et al. "Effectiveness and tolerability of electronic cigarette in real-life: a 24-month prospective observational study." Internal and emergency medicine 9.5 (2014): 537-546.
Polosa, Riccardo, et al., "Effect of an electronic nicotine delivery device (e-Cigarette) on smoking reduction and cessation: a prospective 6-month pilot study." BMC public health 11.1 (2011): 786.
Prignot, J., "Electronic Nicotine Delivery Systems (Electronic Cigarettes, Cigars, Pipes)," Louvain Medical, V. 132, No. 10, Dec. 2013. [including English language translation thereof].
U.S. Appl. No. 61/826,318, filed May 22, 2013.
U.S. Appl. No. 61/856,286, filed Jul. 19, 2013.
U.S. Appl. No. 61/856,374, filed Jul. 19, 2013.
U.S. Appl. No. 61/891,626, filed Oct. 16, 2013.
U.S. Appl. No. 61/969,650, filed Mar. 24, 2014.
U.S. Appl. No. 61/971,340, filed Mar. 27, 2014.
Riggs, et al., "The Thermal Stability of Nicotine Salts," R.J. Reynolds Tobacco Company, 2000.
Robertson, C., et al., "In their own words: an epoch of deceit and deception," Chapter 5 (find out from which book).
Rose, J., "Nicotine and nonnicotine factors in cigarette addiction," Psychopharmacology, 184:274-285, 2006.
Rose, J., "Pulmonary Delivery of Nicotine Pyruvate: Sensory and Pharmacokinetic Characteristics," Experimental and Clinical Psychopharmacology, vol. 18, No. 5, 2010.
Sahu, S.K., et al., "Particle Size Distribution of Mainstream and Exhaled Cigarette Smoke and Predictive Deposition in Human Repiratory Tract," Aerosol and Air Quality Research, 13: 324-332, 2013.
Scenihr, "Addictiveness and Attractiveness of Tobacco Additives," Scientific Committee on Emerging and Newly Identified Health Risks, Nov. 12, 2010.
Schripp, Tobias, et al. "Does e-cigarette consumption cause passive vaping?." Indoor air 23.1 (2013): 25-31.
Schroeder, Megan J., et al., "Electronic cigarettes and nicotine clinical pharmacology." Tobacco control 23.suppl 2 (2014): ii30-ii35.
Seeman et al.; The form of nicotine in tobacco. Thermal transfer of nicotine and nicotine acid salts to nicotine in the gas phase; J Aric Food Chem.; 47(12); pp. 5133-5145; Dec. 1999.
Seeman, J., "Possible Role of Ammonia on the Deposition, Retention, and Absorption of Nicotine in Humans while Smoking," Chemical Research in Toxicology, 20, 2007.
Seeman, J., "Using 'Basic Principles' to Understand Complex Science: Nicotine Smoke Chemistry and Literature Analogies," Journal of Chemical Education, vol. 82, No. 10, 2005.
Seeman, J., et al., "On the Deposition of Volatiles and Semivolatiles from Cigarette Smoke Aerosols: Relative Rates of Transfer of Nicotine and Ammonia from Particles to the Gas Phase," Chemical Research in Toxicology, 17, 2004.
Seeman, J., et al., "The possible role of ammonia toxicity on the exposure, deposition, retention, and the bioavailability of nicotine during smoking," Food and Chemical Toxicology, 46, 2008.
Sensabaugh, A.J., et al., "A New Technique for Determining the pH of Whole Tobacco Smoke," Tobacco Science.
Shahab, L., et al., "Novel Delivery Systems for Nicotine Replacement Therapy as an Aid to Smoking Cessation and for Harm Reduction: Rationale, and Evidence for Advantages over Existing Systems," CNS Drugs, 27: 1007-1019, 2013.
Snowdon, Christopher. "Harm reduction and tobacco: a new opportunity or a step too far?." Drugs and Alcohol Today 13.2 (2013): 86-91.
Stepanov, et al., "Bringing attention to e-cigarette pH as an important element for research and regulation", Tob. Control, May 14, 2014, vol. 24, No. 4.
Stevenson, T., et al., "The Secret and Soul of Marlboro," Public Health Then and Now, American Journal of Public Health, vol. 98, No. 7, 2008.
Teague, "Implications and Activites Arising from Correlation of Smoke pH with Nicotine Impact, Other Smoke Qualities and Cigarette Sales," 1983.
Tomar, S., et al., "Review of the evidence that pH is a determinant of nicotine dosage from oral use of smokeless tobacco," Tobacco Control, 6:219-225, 1997.
Torikai et al.; Effects of temperature, atmosphere and pH on the generation of smoke compounds duriung tobacco pyrolysis; Food and Chemical Toxicology; 42(9); pp. 1409-1417; Sep. 2004.
Torrie, B., "Nicotine inhaler gives instant 'hit'," 2 pages (2013), available at http://www.stuff.co.nz/national/health/8822875/Nicotine-inhaler-gives-instant-hit.
Travell, J., "The Influence of the Hydrogen Ion Concentration on the Absorption of Alkaloids from the Stomach," The Journal of Pharmacology, Jan. 1940.
Trehy, Michael L., et al. "Analysis of electronic cigarette cartridges, refill solutions, and smoke for nicotine and nicotine related impurities." Journal of Liquid Chromatography & Related Technologies 34.14 (2011): 1442-1458.
Uchiyama, Shigehisa, et al. "Determination of carbonyl compounds generated from the E-cigarette using coupled silica cartridges impregnated with hydroquinone and 2, 4-dinitrophenylhydrazine, followed by high-performance liquid chromatography." Analytical sciences 29.12 (2013): 1219-1222.
Vansickel et al.; A clinical laboratory model for evaluating the acute effects of electronic cigarettes: Nicotine delivery profile and cardiovascular and subjective effects; Cancer Epidemiology Biomarkers Prevention; 19(8); pp. 1945-1953; (online) Jul. 20, 2010.
Vansickel, Andrea R., et al. "A clinical laboratory model for evaluating the acute effects of electronic "cigarettes": nicotine delivery profile and cardiovascular and subjective effects." Cancer Epidemiology and Prevention Biomarkers 19.8 (2010): 1945-1953.
Vansickel, Andrea Rae, et al., "Electronic cigarettes: effective nicotine delivery after acute administration." Nicotine & Tobacco Research 15.1 (2012): 267-270.
Vansickel, et al., "Electronic cigarettes: effective nicotine delivery after acute administration," Nicotine & Tobacco Research, 15(1), pp. 267-270. Jan. 2013.
Ward; Green leaf threshing and redrying tobacco; Section 10B; in Tobacco Production, Chemistry and Technology; Davis and Nielsen (Eds.); Blackwell Science Ltd.; pp. 330-333; Jul. 15, 1999.
Wayne, G., et al., "Brand differences of free-base nicotine delivery in cigarette smoke: the view of the tobacco industry documents," Tobacco Control, 15:189-198, 2006.
Weiss, G., "The Effect of pH on Nicotine-Induced Contracture and Ca45 Movements in Frog Sartorius Muscle," The Journal of Pharmacology and Experimental Therapeutics, vol. 154, No. 3, 1966.

(56) **References Cited**

OTHER PUBLICATIONS

Wells; Glycerin as a constituent of cosmetics and toilet preparations; Journal of the Society of Cosmetic Chemists; 9(1); pp. 19-25; Jan. 1958.
World Health Organization, :Health Effects of Interations Between Tobacco Use and Exposure to Other Agents, Environmental Health Criteria 211, 83 pages (1999), available at http://www.inchem.org/documents/ehc/ehc/ehc211.htm.
Wynn III, William P., et al. "The pharmacist "toolbox" for smoking cessation: a review of methods, medicines, and novel means to help patients along the path of smoking reduction to smoking cessation." Journal of pharmacy practice 25.6 (2012): 591-599.
YouTube; Firefly Vaporizor Review w/ Usage Tips by the Vape Critic; retrieved from the internet (http://www.youtube.com/watch?v=1J38NOAV7wl); 1 pg.; published Dec. 10, 2013; download/print date: Feb. 18, 2015.
Zenzen, Volker, et al. "Reduced exposure evaluation of an Electrically Heated Cigarette Smoking System. Part 2: Smoke chemistry and in vitro toxicological evaluation using smoking regimens reflecting human puffing behavior." Regulatory Toxicology and Pharmacology 64.2 (2012): S11-S34.
Zhang et al.; In vitro particle size distributions in electronic and conventional cigarette aerosols suggest comparable deposition patterns; Nicotine Tobacco Research; 15(2); pp. 501-508; Feb. 2013.
Zhang, Yaping, et al., "In vitro particle size distributions in electronic and conventional cigarette aerosols suggest comparable deposition patterns." Nicotine & Tobacco Research 15.2 (2012): 501-508.
Burn and Rand, Action of Nicotine on the Heart, British Medical Journal, pp. 137-139 (Jan. 18, 1958).
E-Cigarette Forum: pg-gv-peg (discussion/posting); retrived from the internet: https://e-cigarette-forum.com/forum/threads/pg-vg-peg.177551, 7 pages (Apr. 8, 2011).
Notice of Opposition to European Patent No. 2 993 999 B1 by JT International S.A., 38 pages (Oct. 26, 2021).
Notice of Opposition to European Patent No. 2 993 999 B1 by Nicoventures Trading Limited, 26 pages (Oct. 26, 2021).
Notice of Opposition to European Patent No. 2 993 999 B1 by Philip Morris Products S.A., 22 pages (Oct. 27, 2021).
Preliminary Opinion of the Opposition Division to the Oppositions in European Patent No. 2 993 999 B1, 17 pages (Aug. 30, 2022).
Interlocutory Decision in Opposition Proceedings received for European Application No. 14794206.4 mailed on May 19, 2023, 25 pages.
Duell, Nicotine in Tobacco Product Aerosols: 'it's Déjà Vu All Over Again', Tobacco Control, 7 pages. 2020.
Electronic Cigarette,Merriam-Webster,1 page.
Influence of pH on Absorption of Nicotine from Urinary Bladder and Subcutaneous Tissues.
Inventor Bowen to Ploom—61-820,128, Assignment of Jun. 3, 2013,2 pages.
Inventors Bowen, Xing to Ploom—61-912,507, Assignment of May 1, 2014,4 pages.
IUPAC Compendium of Chemical Terminology, 2nd ed. (the "Gold Book").
Pax to JUUL, Recorded Change of Name of Aug. 14, 2017,11 pages.
Pax to JUUL, Recorded Corrective Assignment of Aug. 6, 2018,15 pages.
Ploom to Pax, Recorded Assignment of Mar. 3, 2015,8 pages.
(2014) The Art of Medicine: Electronic Cigarettes and History.
(2016) The Efficacy and Short-Term Effects of Electronic Cigarettes as a Method for Smoking Cessation: A Systematic Review and a Meta-Analysis.
(2015) Web record in respect of U.S. Appl. No. 14/271,071, 2 pages.
Hatton et al.; U.S. Appl. No. 15/396,584 entitled "Leak-resistant vaporizer cartridges for use with cannabinoids," filed Dec. 31, 2016.
Clayton, P. et al., "Use of chiroptical spectroscopy to determine the ionisation status of (S)- nicotine in e-cigarette formulations", Presentation Coresta Gongress, (Oct. 16, 2014), 2 pages.
Chen, et al., (Aug. 2011), "Organic Chemistry," Beijing Institute of Technology Press, 251-252.
Declaration by Dr. Bradley James Ingebrethsen, on Sep. 4, 2015, 64 pages.
Goldenson, et al., (2020) "Nicotine Uptake Following the Use of E-liquids with Different Organic Acid Salts and Nicotine Concentrations among Adult Smokers", Juul Labs, Inc. and Pinney Associates, Inc., 1 page.
Shao, et al., (Dec. 13, 2012) "Nicotine Delivery to Rats via Lung Alveolar Region-Targeted Aerosol Technology Produces Blood Pharmacokinetics Resembling Human Smoking", Nicotine Tob Res., vol. 15, No. 7, pp. 1248-1258.

* cited by examiner

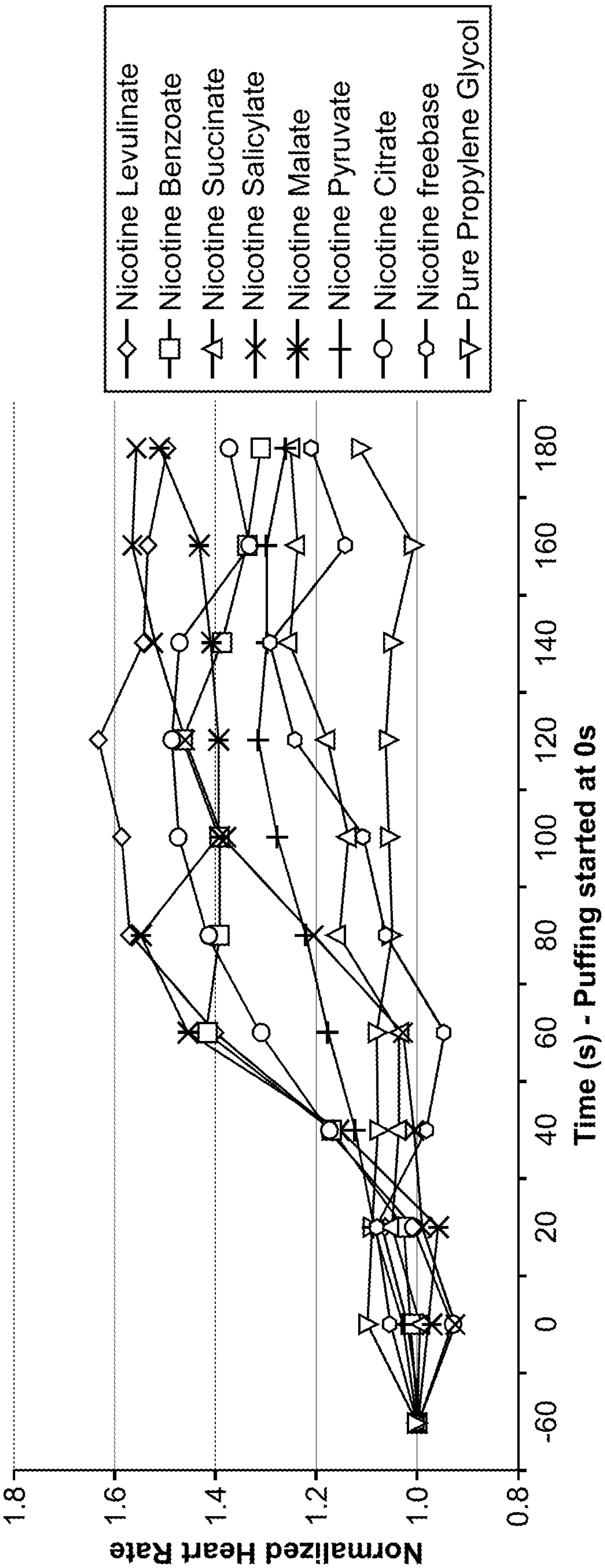

Nicotine Levulinate
Nicotine Benzoate
Nicotine Succinate
Nicotine Salicylate
Nicotine Malate
Nicotine Pyruvate
Nicotine Citrate
Nicotine freebase
Pure Propylene Glycol
Normalized Heart Rate
1.8
1.6
1.4
1.2
1.0
0.8
-60
0
20
40
60
80
100
120
140
160
180
Time (s) - Puffing started at 0s

FIG. 1

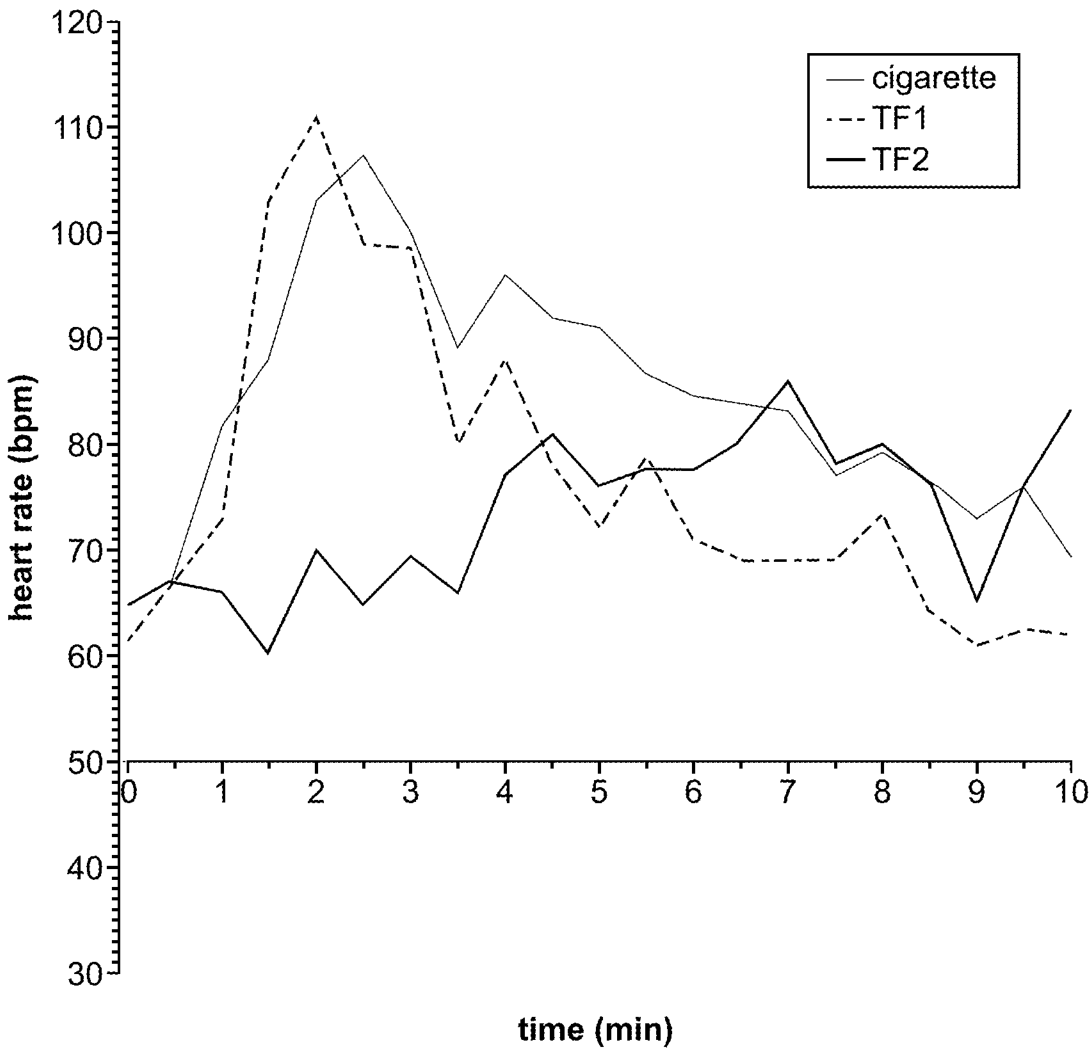

120
110
100
90
80
70
60
50
40
30
heart rate (bpm)
0
1
2
3
4
5
6
7
8
9
10
time (min)
cigarette
TF1
TF2

FIG. 2

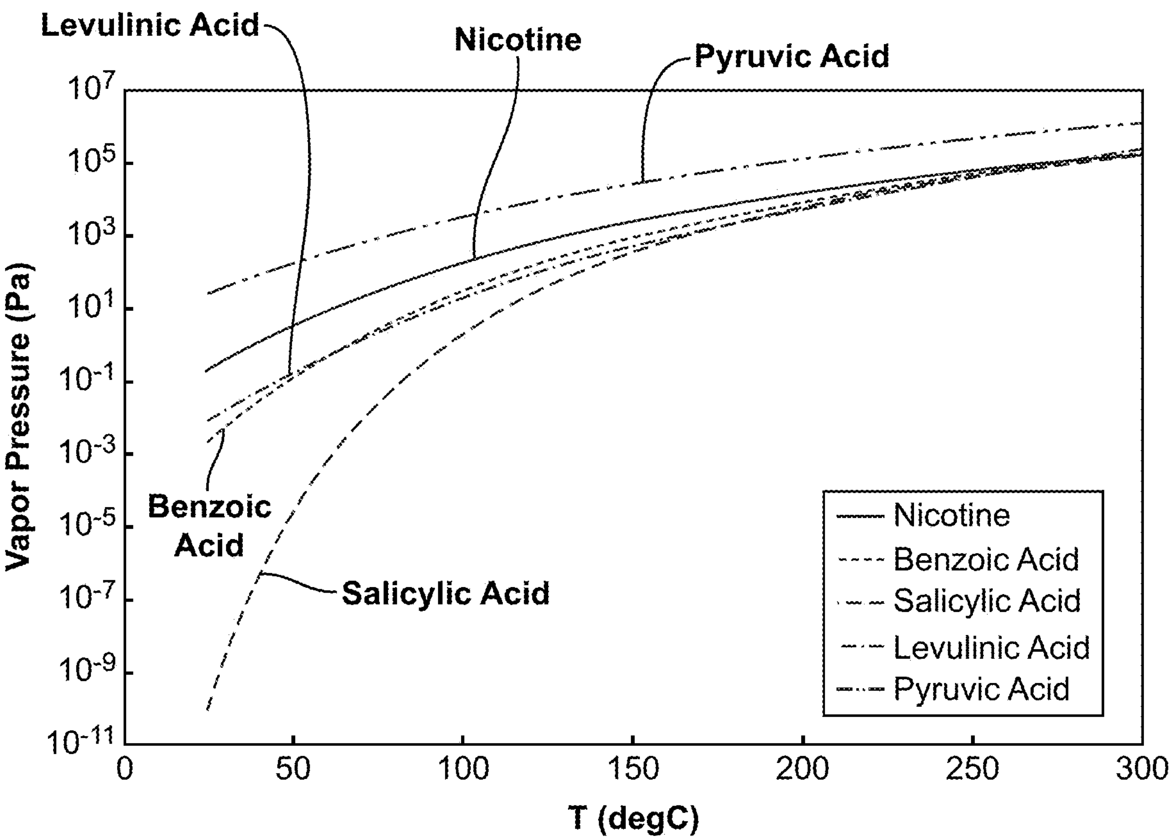

Levulinic Acid
Nicotine
Pyruvic Acid
Benzoic Acid
Salicylic Acid
Vapor Pressure (Pa)
10^7
10^5
10^3
10^1
10^-1
10^-3
10^-5
10^-7
10^-9
10^-11
0
50
100
150
200
250
300
T (degC)
Nicotine
Benzoic Acid
Salicylic Acid
Levulinic Acid
Pyruvic Acid

FIG. 3

FIG. 4

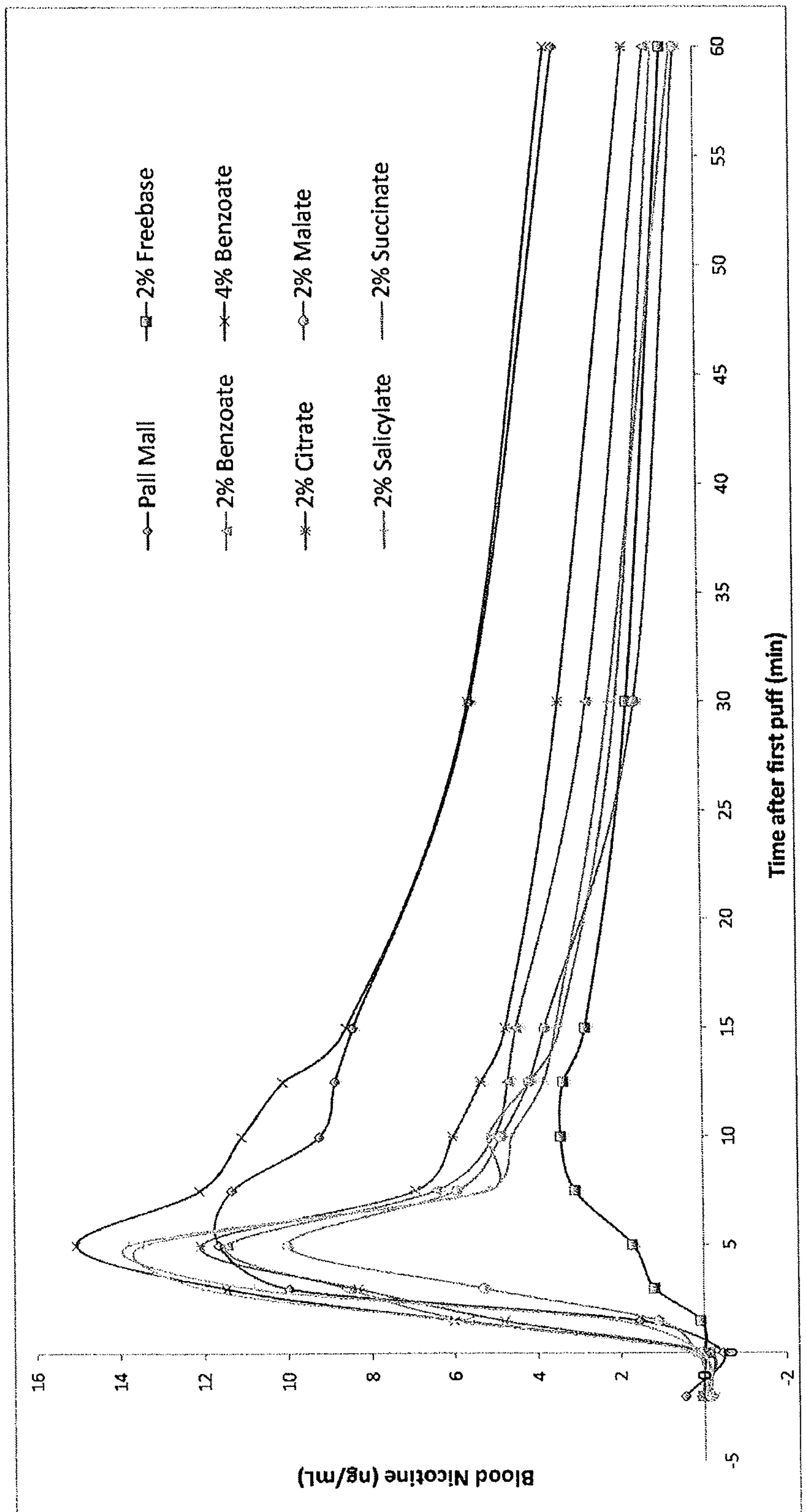
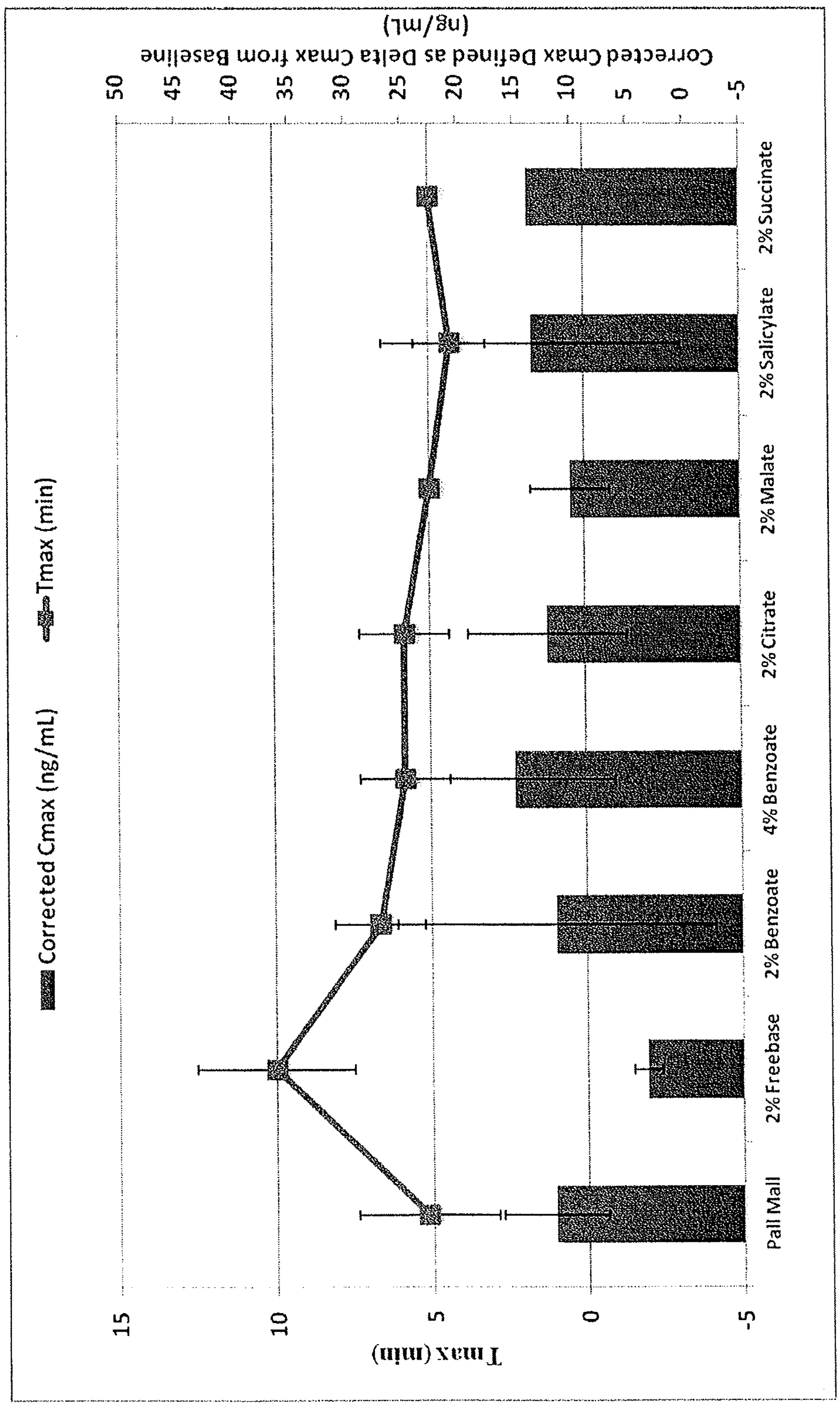

Pall Mall
2% Freebase
2% Benzoate
4% Benzoate
2% Citrate
2% Malate
2% Salicylate
2% Succinate
Blood Nicotine (ng/mL)
Time after first puff (min)
16
14
12
10
8
6
4
2
-2
-5
5
10
15
20
25
30
35
40
45
50
55
60

FIG. 5



Corrected Cmax (ng/mL)
Tmax (min)
Corrected Cmax Defined as Delta Cmax from Baseline (ng/mL)
T max (min)
Pall Mall
2% Freebase
2% Benzoate
4% Benzoate
2% Citrate
2% Malate
2% Salicylate
2% Succinate

FIG. 6

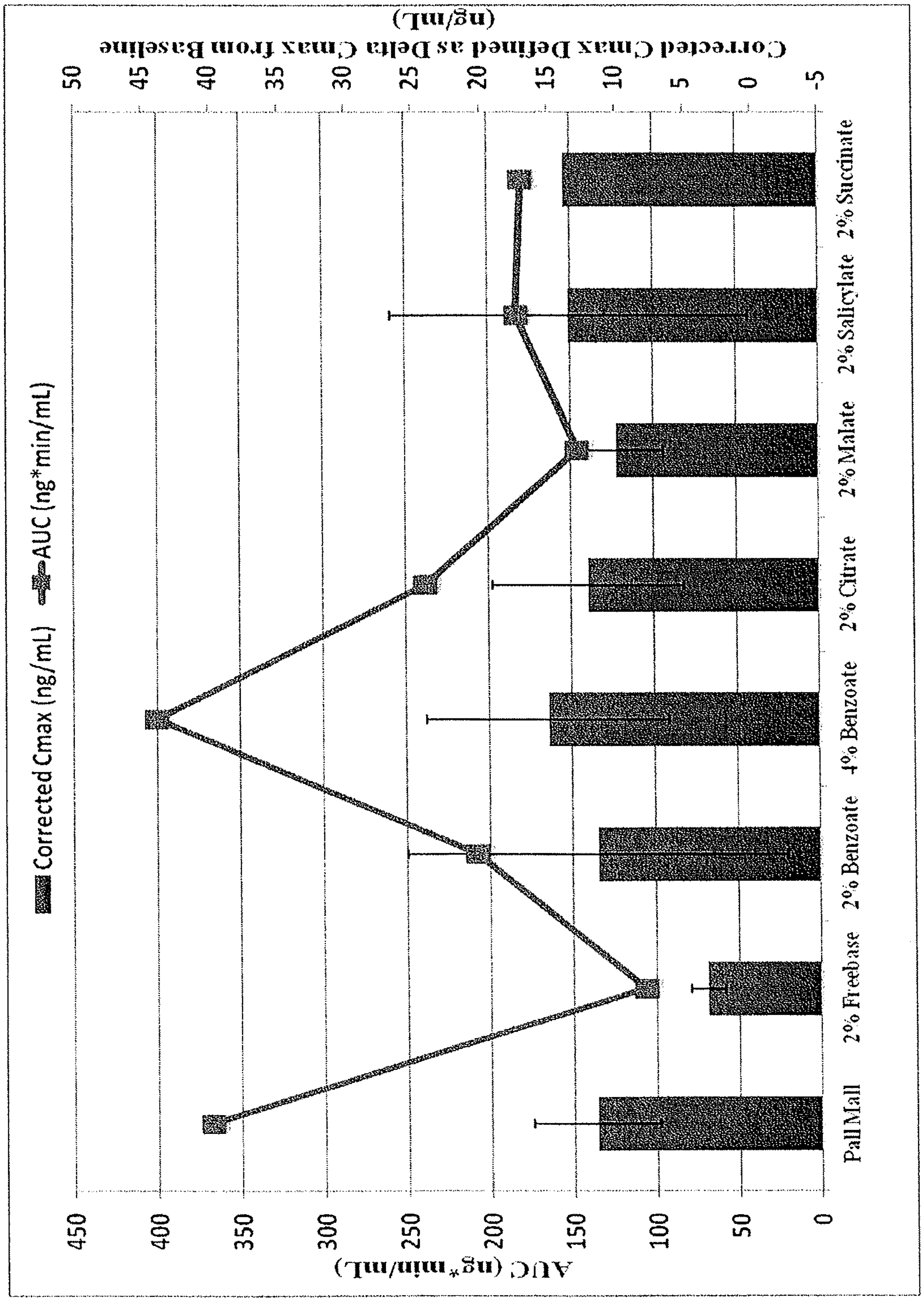
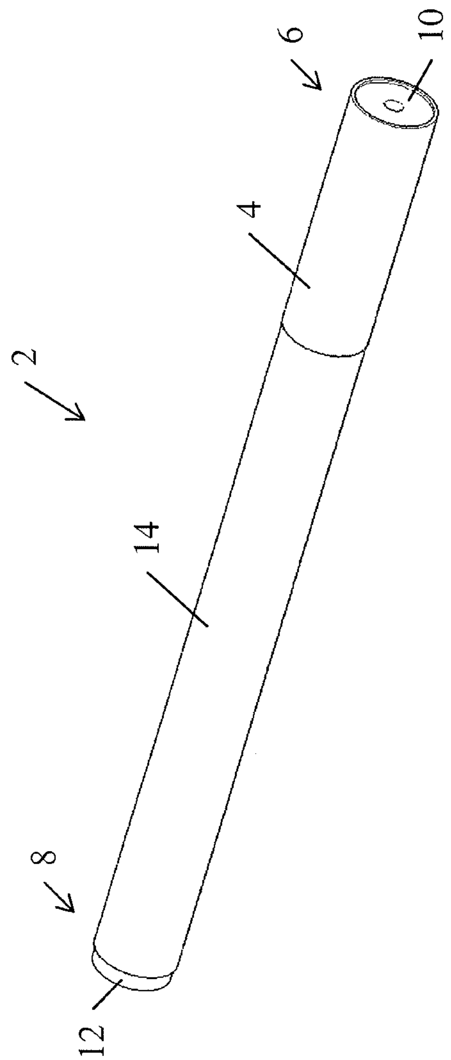

Corrected Cmax (ng/mL)
AUC (ng*min/mL)
AUC (ng*min/mL)
Corrected Cmax Defined as Delta Cmax from Baseline (ng/mL)
Pall Mall
2% Freebase
2% Benzoate
4% Benzoate
2% Citrate
2% Malate
2% Salicylate
2% Succinate
0
50
100
150
200
250
300
350
400
450
-5
0
5
10
15
20
25
30
35
40
45
50

FIG. 7



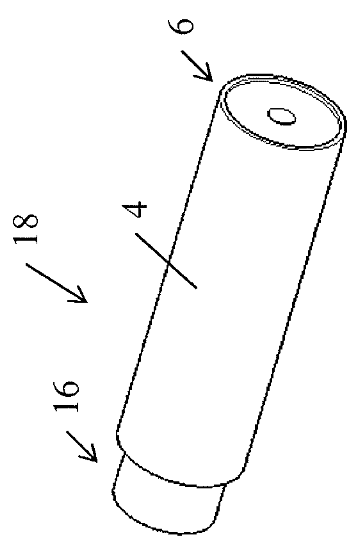


FIG. 8

NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF

CROSS REFERENCE

This application is a continuation of U.S. application Ser. No. 14/925,961 filed Oct. 28, 2015, issued as U.S. Pat. No. 10,952,468, which is a continuation of U.S. application Ser. No. 14/271,071 filed May 6, 2014, which claims the benefit of priority to U.S. Application No. 61/912,507 filed Dec. 5, 2013, and U.S. Application No. 61/820,128 filed May 6, 2013, which are incorporated herein by reference in their entireties. This application is related to U.S. application Ser. No. 14/512,311, issued as U.S. Pat. No. 9,215,895, and to U.S. application Ser. No. 14/925,968.

SUMMARY OF THE INVENTION

Provided herein is a method of delivering nicotine to a user comprising operating an electronic cigarette to a user wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C., and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

Provided herein is a method of delivering nicotine to a user comprising operating an electronic cigarette to a user wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C., and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

Provided herein is a method of delivering nicotine to a user comprising operating an electronic cigarette wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point, and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

Provided herein is a method of delivering nicotine to a user comprising providing an electronic cigarette to a user wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point, and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

Provided herein is a method of delivering nicotine to the blood of a user, said method comprising providing an aerosol that is inhaled by the user from an electronic cigarette that comprises a nicotine salt formulation wherein providing the aerosol comprises the electronic cigarette heating the formulation thereby generating the aerosol, wherein the aerosol is effective in delivering a level of nicotine in the blood of the user that is at least 5 ng/mL at

about 1.5 minutes after a first puff of ten puffs of the aerosol, each puff taken at 30 second intervals.

Provided herein is a nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

Provided herein is a nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

Provided herein is a nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

Provided herein is a nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

Provided herein is a nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

Provided herein is a nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

Provided herein is a nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C., and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

Provided herein is a use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C., and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

Provided herein is a use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point, and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

Provided herein is a use of a nicotine salt formulation for delivery of nicotine to the blood of a user from an electronic cigarette, wherein the nicotine salt formulation in the electronic cigarette is heated to form an aerosol which delivers a level of nicotine in the blood of the user that is at least 5 ng/mL at about 1.5 minutes after a first puff of ten puffs of the aerosol, each puff taken at 30 second intervals.

Provided herein is a use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point, and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

Provided herein is a cartomizer for an electronic cigarette comprising:

- a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.;
- an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and
- a fluid storage compartment that stores the nicotine salt liquid formulation.

Provided herein is a cartomizer for an electronic cigarette comprising:

- a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.;
- an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and
- a fluid storage compartment that stores the nicotine salt liquid formulation.

Provided herein is a cartomizer for an electronic cigarette comprising:

- a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point;
- an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and
- a fluid storage compartment that stores the nicotine salt liquid formulation.

Provided herein is a cartomizer for an electronic cigarette comprising:

- a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point;
- an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and
- a fluid storage compartment that stores the nicotine salt liquid formulation.

Provided herein is an electronic cigarette for generating an inhalable aerosol comprising:

- a fluid storage compartment;
- a heater; and
- a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.;

a battery; and
a mouthpiece.

Provided herein is an electronic cigarette for generating an inhalable aerosol comprising:

a fluid storage compartment;
a heater; and
a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.;
a battery; and
a mouthpiece.

Provided herein is an electronic cigarette for generating an inhalable aerosol comprising:

a fluid storage compartment;
a heater; and
a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point;
a battery; and
a mouthpiece.

Provided herein is an electronic cigarette for generating an inhalable aerosol comprising:

a fluid storage compartment;
a heater; and
a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point;
a battery; and
a mouthpiece.

Provided herein is a cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

Provided herein is a cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

Provided herein is a cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

Provided herein is a kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

Provided herein is a kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

Provided herein is a kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

Provided herein is a kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic ciga-

rette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point;
iii. a heater;
iv. a battery; and
v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

INCORPORATION BY REFERENCE

All publications, patents and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are used, and the accompanying drawings of which:

FIG. **1** illustrates results of heart rate data measured for six minutes from start of puffing. Y-axis is heart rate (bpm) and X-axis represent duration of the test (−60 to 180 seconds);

FIG. **2** illustrates results of heart rate data measured for ten minutes from start of puffing. Y-axis is heart rate (bpm) and X-axis represents duration of the test (0 to 10 minutes);

FIG. **3** illustrates the calculated vapor pressures of various acids relative to nicotine;

FIG. **4** illustrates the pharmacokinetic profiles for eight test articles in a blood plasma study;

FIG. **5** illustrates the comparison of C_{max} and T_{max} for eight test articles in a blood plasma study;

FIG. **6** illustrates the comparison of C_{max} and AUC for eight test articles in a blood plasma study;

FIG. **7** depicts an example embodiment of an electronic cigarette having a fluid storage compartment comprising an embodiment nicotine salt formulation described herein; and

FIG. **8** depicts an example embodiment of an electronic cigarette cartomizer having a fluid storage compartment, a heater, and comprising an embodiment nicotine salt formulation described herein.

DETAILED DESCRIPTION OF THE INVENTION

Nicotine is a chemical stimulant and increases heart rate and blood pressure when provided to an individual or animal. Nicotine transfer to an individual is associated with a feeling of physical and/or emotional satisfaction. Conflicting reports have been published regarding the transfer efficiency of free base nicotine in comparison to mono- or di-protonated nicotine salts. Studies on the transfer efficiency of free base nicotine and nicotine salts are complex and have yielded unpredictable results. Further, such transfer efficiency studies have been performed under extremely high temperature conditions, comparable to smoking; therefore, they offer scant guidance on the transfer efficiency of free base nicotine and nicotine salts under low-temperature vaporization conditions. Some reports have posited that nicotine free base should give rise to a greater satisfaction in a user than any corresponding nicotine salt.

It has been unexpectedly discovered herein that certain nicotine salt formulations provide satisfaction in an individual superior to that of free base nicotine, and more comparable to the satisfaction in an individual smoking a traditional cigarette. The satisfaction effect is consistent with an efficient transfer of nicotine to the lungs of an individual and a rapid rise of nicotine absorption in the plasma as shown, for non-limiting example, in Example 8, at least. It has also been unexpectedly discovered herein that certain nicotine salt formulations provide greater satisfaction than other nicotine salt formulations, and such effect has been shown in blood plasma levels of example nicotine salt formulations herein, for non-limiting example, in Example 8, at least. These results show a difference in rate of nicotine uptake in the blood that is higher for some nicotine salt formulations aerosolized by an electronic cigarette than for other nicotine salt formulations, and likewise higher than nicotine freebase formulations, while the peak concentration of the nicotine in the blood and total amount of nicotine delivered appears comparable to a traditional cigarette, and do not appear to vary significantly between the various nicotine formulations. Therefore, described herein are nicotine salt formulations for use in an electronic cigarette, or the like, that provide a general satisfaction effect consistent with an efficient transfer of nicotine to the lungs of an individual and a rapid rise of nicotine absorption in the plasma. Provided herein, therefore, are devices, formulation of nicotine salts, systems, cartomizers, kits and methods that are used to inhale an aerosol generated from a nicotine salt liquid formulation through the mouth or nose as described herein or as would be obvious to one of skill in the art upon reading the disclosure herein.

Consistent with these satisfaction effects, it has unexpectedly been found herein that there is a difference between the C_{max} (maximum concentration) and T_{max} (time at which the maximum concentration is measured) when measuring blood plasma nicotine levels of freebase nicotine formulations inhaled using a low temperature vaporization device, i.e. electronic cigarette, as compared to the C_{max} and T_{max} (similarly measuring blood plasma nicotine levels) of a traditional cigarette. Also consistent with these satisfaction effects, it has unexpectedly been found herein that there is a difference between the C_{max} (maximum concentration) and T_{max} (time at which the maximum concentration is measured) when measuring blood plasma nicotine levels of freebase nicotine formulations inhaled using a low temperature vaporization device, i.e. electronic cigarette, as compared to the C_{max} and T_{max} (similarly measuring blood plasma nicotine levels) of nicotine salt formulations inhaled using a low temperature vaporization device, i.e. electronic cigarette. Additionally, it has unexpectedly been found that there is a difference between the rate of nicotine uptake in the plasma of users inhaling freebase nicotine formulations using a low temperature vaporization device, i.e. electronic cigarette, as compared to the rate of nicotine uptake in the plasma of users inhaling smoke of a traditional cigarette. Furthermore, it has unexpectedly been found that there is a difference between the rate of nicotine uptake in the plasma of users inhaling freebase nicotine formulations using a low temperature vaporization device, i.e. electronic cigarette, as compared to the rate of nicotine uptake in the plasma of users inhaling nicotine salt formulations using a low temperature vaporization device, i.e. electronic cigarette.

Thus, looking at freebase nicotine as a source of nicotine in compositions used in e-cigarettes, freebase nicotine compositions' delivery of nicotine to blood when inhaled using is not necessarily comparable in blood plasma levels (C_{max}

and T_{max}) to a traditional cigarette's nicotine delivery to blood when inhaled. Freebase nicotine compositions' delivery of nicotine to blood when inhaled using is not necessarily comparable in blood plasma levels (C_{max} and T_{max}) to nicotine salt formulations' nicotine delivery to blood when inhaled. Freebase nicotine compositions' delivery of nicotine to blood when inhaled using is not necessarily comparable in blood plasma levels when measuring the rate of nicotine uptake in the blood within the first 0-5 minutes to a traditional cigarette's nicotine delivery to blood when inhaled. Freebase nicotine compositions' delivery of nicotine to blood when inhaled using necessarily is not comparable in blood plasma levels when measuring the rate of nicotine uptake in the blood within the first 0-5 minutes to nicotine salt formulations' nicotine delivery to blood when inhaled.

Also consistent with these satisfaction effects, it has unexpectedly been found herein that while there appears to be comparable C_{max} and T_{max} values (measuring blood plasma nicotine levels) of nicotine salt formulations inhaled using a low temperature vaporization device, i.e. electronic cigarette, as compared to the C_{max} and T_{max} (similarly measuring blood plasma nicotine levels) of a traditional cigarette, there is a demonstrable difference between the rate of nicotine uptake in the plasma of users inhaling certain nicotine salt formulations using a low temperature vaporization device, i.e. electronic cigarette, as compared to the rate of nicotine uptake in the plasma of users inhaling other nicotine salt formulations using a low temperature vaporization device, i.e. electronic cigarette. It is also unexpected that while the C_{max} and T_{max} values are comparable to those of a traditional cigarette, (or are approaching that of a traditional cigarette), the rate of nicotine uptake in the plasma of blood of users is higher in certain nicotine salt formulations than that of the traditional cigarette. The nicotine salt formulations which demonstrate the quickest rate of nicotine uptake in the plasma were more preferred in satisfaction evaluations, and were rated more equivalent to cigarette satisfaction than the nicotine salt formulations showing the slowest rates of rise of nicotine in the subjects' blood plasma. In addition, doubling the concentration of the nicotine salt in the formulation may not necessarily impact the rate of absorption of nicotine in the blood (see, for non-limiting example Example 8, nicotine benzoate tested in 4% and 2% concentrations).

Thus, looking at nicotine salt formulations used in e-cigarettes, nicotine salt formulations delivered using an e-cigarette appear comparable in C_{max} and T_{max} values (measuring blood plasma nicotine levels), however, not all nicotine salts perform similarly to each other or to a traditional cigarette with respect to the rate of nicotine uptake in the blood at early time periods (0-1.5 minutes). These results are unexpected. Nicotine salt formulations made using acids having a Vapor Pressure between 20-300 mmHg @ 200° C., or Vapor Pressure >20 mmHg @ 200° C., or a Vapor Pressure from 20 to 300 mmHg @ 200° C., or a Vapor Pressure from 20 to 200 mmHg @ 200° C., a Vapor Pressure between 20 and 300 mmHg @ 200° C. appear to have a higher rate of nicotine uptake in the blood at early time periods (0-1.5 minutes, 0-3 minutes, 0-2 minutes, 0-4 minutes for non-limiting example) than other nicotine salt formulations, however, they also provide satisfaction comparable to a traditional cigarette or closer to a traditional cigarette (as compared to other nicotine salt formulations or as compared to nicotine freebase formulations). For non-limiting example, acids that meet one or more criteria of the prior sentence include salicylic acid, sorbic acid, benzoic acid, lauric acid, and levulinic acid. Nicotine salt formulations made using acids that have a difference between boiling point and melting point of at least 50° C., and a boiling point greater than 160° C., and a melting point less than 160° C. appear to have a higher rate of nicotine uptake in the blood at early time periods (0-1.5 minutes, 0-3 minutes, 0-2 minutes, 0-4 minutes for non-limiting example) than other nicotine salt formulations, however, they also provide satisfaction comparable to a traditional cigarette or closer to a traditional cigarette (as compared to other nicotine salt formulations or as compared to nicotine freebase formulations). For non-limiting example, acids that meet the criteria of the prior sentence include salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid. Nicotine salt formulations made using acids that have a difference between boiling point and melting point of at least 50° C., and a boiling point at most 40° C. less than operating temperature, and a melting point at least 40° C. lower than operating temperature appear to have a higher rate of nicotine uptake in the blood at early time periods (0-1.5 minutes, 0-3 minutes, 0-2 minutes, 0-4 minutes for non-limiting example) than other nicotine salt formulations, however, they also provide satisfaction comparable to a traditional cigarette or closer to a traditional cigarette (as compared to other nicotine salt formulations or as compared to nicotine freebase formulations). Operating temperature can be 100° C. to 300° C., or about 200° C., about 150° C. to about 250° C., 180 C to 220° C., about 180° C. to about 220° C., 185° C. to 215° C., about 185° C. to about 215° C., about 190° C. to about 210° C., 190° C. to 210° C., 195° C. to 205° C., or about 195° C. to about 205° C. For non-limiting example, acids that meet the criteria of the prior sentence include salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid. Combinations of these criteria for preference of certain nicotine salt formulations are contemplated herein.

Other reasons for excluding certain acids from formulations may be unrelated to the rate of nicotine uptake, however. For example, an acid may be inappropriate for use with the device materials (corrosive or otherwise incompatible). Sulfuric acid is an example of this, which may be inappropriate for the e-cigarette device. An acid may be inappropriate for use in inhalation or for toxicity reasons—thus not be compatible for human consumption, ingestion, or inhalation. Sulfuric acid again is an example of this, which may be inappropriate for a user of an e-cigarette device, depending on the embodiment of the composition. An acid that is bitter or otherwise bad-tasting may also provide a reason for exclusion, such as acetic acid in some embodiments. Acids that oxidize at room temperature or at operating temperature may be inappropriate for certain embodiments, for example, sorbic acid, as this indicates a decomposition or reaction or instability that may be undesirable in the formulation. Decomposition of acids at room or operating temperatures may also indicate that the acid is inappropriate for use in the embodiment formulations. For example, citric acid decomposes at 175° C., and malic acid decomposes at 140° C., thus for a device operating at 200° C., these acids may not be appropriate. Acids that have poor solubility in the composition constituents may be inappropriate for use in certain embodiments of the compositions herein. For example, nicotine bitartrate with a composition of nicotine and tartaric acid as 1:2 molar ratio will not produce a solution at a concentration of 0.5% (w/w) nicotine or higher and 0.9% (w/w) tartaric acid or higher in propylene glycol (PG) or vegetable glycerin (VG) or any mixture of PG and VG at ambient conditions. As used herein, weight percentage (w/w) refers to the weight of the individual component over the weight of the total formulation.

As used in this specification and the claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

The term "organic acid" as used herein, refers to an organic compound with acidic properties (e.g., by Brønsted-Lowry definition, or Lewis definition). A common organic acid is the carboxylic acids, whose acidity is associated with their carboxyl group —COOH. A dicarboxylic acid possesses two carboxylic acid groups. The relative acidity of an organic is measured by its pK_a value and one of skill in the art knows how to determine the acidity of an organic acid based on its given pKa value. The term "keto acid" as used herein, refers to organic compounds that contain a carboxylic acid group and a ketone group. Common types of keto acids include alpha-keto acids, or 2-oxoacids, such as pyruvic acid or oxaloacetic acid, having the keto group adjacent to the carboxylic acid; beta-keto acids, or 3-oxoacids, such as acetoacetic acid, having the ketone group at the second carbon from the carboxylic acid; gamma-keto acids, or 4-oxoacids, such as levulinic acid, having the ketone group at the third carbon from the carboxylic acid.

The term "electronic cigarette" or "e-cigarette" or "low temperature vaporization device" as used herein, refers to an electronic inhaler that vaporizes a liquid solution into an aerosol mist, simulating the act of tobacco smoking. The liquid solution comprises a formulation comprising nicotine. There are many electronic cigarettes which do not resemble conventional cigarettes at all. The amount of nicotine contained can be chosen by the user via the inhalation. In general, an electronic cigarette contains three essential components: a plastic cartridge that serves as a mouthpiece and a reservoir for liquid, an "atomizer" that vaporizes the liquid, and a battery. Other embodiment electronic cigarettes include a combined atomizer and reservoir, called a "cartomizer" that may or may not be disposable, a mouthpiece that may be integrated with the cartomizer or not, and a battery.

As used in this specification and the claims, unless otherwise stated, the term "about" refers to variations of 1%, 2%, 3%, 4%, 5%, 10%, 15%, or 25%, depending on the embodiment.

Suitable carriers (e.g., a liquid solvent) for the nicotine salts described herein include a medium in which a nicotine salt is soluble at ambient conditions, such that the nicotine salt does not form a solid precipitate. Examples include, but are not limited to, glycerol, propylene glycol, trimethylene glycol, water, ethanol and the like, as well as combinations thereof. In some embodiments, the liquid carrier comprises 0% to 100% of propylene glycol and 100% to 0% of vegetable glycerin. In some embodiments, the liquid carrier comprises 10% to 70% of propylene glycol and 90% to 30% of vegetable glycerin. In some embodiments, the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin. In some embodiments, the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

The formulations described herein vary in concentration. In some formulations, a dilute concentration of the nicotine salt in the carrier is utilized. In some formulations, a less dilute concentration of the nicotine salt in the carrier is utilized. In some formulations the concentration of nicotine in the nicotine salt formulation is about 1% (w/w) to about 25% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is about 1% (w/w) to about 20% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is about 1% (w/w) to about 18% (w/w). In some embodiments the concentration of nicotine in the nicotine salt formulation is about 1% (w/w) to about 15% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is about 4% (w/w) to about 12% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is about 4% (w/w). In some embodiments the concentration of nicotine in the nicotine salt formulation is about 2% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 1% (w/w) to 25% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 1% (w/w) to 20% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 1% (w/w) to 18% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 1% (w/w) to 15% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 4% (w/w) to 12% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 4% (w/w). In some formulations the concentration of nicotine in the nicotine salt formulation is 2% (w/w). In some formulations, a less dilute concentration of one nicotine salt is used in conjunction with a more dilute concentration of a second nicotine salt. In some formulations, the concentration of nicotine in the first nicotine salt formulation is about 1% to about 20%, and is combined with a second nicotine salt formulation having a concentration of nicotine therein from about 1% to about 20% or any range or concentration therein. In some formulations, the concentration of nicotine in the first nicotine salt formulation is 1% to 20%, and is combined with a second nicotine salt formulation having a concentration of nicotine therein from 1% to 20% or any range or concentration therein. As used with respect to concentrations of nicotine in the nicotine salt formulations, the term "about" refers to ranges of 0.05% (i.e. if the concentration is about 2%, the range is 1.95%-2.05%), 0.1 (i.e. if the concentration is about 2%, the range is 1.9%-2.1%), 0.25 (i.e. if the concentration is about 2%, the range is 1.75%-2.25%), 0.5 (i.e. if the concentration is about 2%, the range is 1.5%-2.5%), or 1 (i.e. if the concentration is about 4%, the range is 3%-5%), depending on the embodiment.

Nicotine salts are formed by the addition of a suitable acid, including organic or inorganic acids. In some formulations provided herein, suitable organic acids are carboxylic acids. Examples of organic carboxylic acids disclosed herein are monocarboxylic acids, dicarboxylic acids (organic acid containing two carboxylic acid groups), carboxylic acids containing an aromatic group such as benzoic acids, hydroxycarboxylic acids, heterocyclic carboxylic acids, terpenoid acids, sugar acids; such as the pectic acids, amino acids, cycloaliphatic acids, aliphatic carboxylic acids, keto carboxylic acids, and the like. In some formulations provided herein, the organic acids used herein are monocarboxylic acids. Nicotine salts are formed from the addition of a suitable acid to nicotine. In some formulations provided herein, the stoichiometric ratios of the nicotine to acid (nicotine:acid) are 1:1, 1:2, 1:3, 1:4, 2:3, 2:5, 2:7, 3:4, 3:5, 3:7, 3:8, 3:10, 3:11, 4:5, 4:7, 4:9, 4:10, 4:11, 4:13, 4:14, 4:15, 5:6, 5:7, 5:8, 5:9, 5:11, 5:12, 5:13, 5:14, 5:16, 5:17, 5:18, or 5:19. In some formulations provided herein, the stoichiometric ratios of the nicotine to acid are 1:1, 1:2, 1:3, or 1:4 (nicotine:acid).

Nicotine is an alkaloid molecule that comprises two basic nitrogens. It may occur in different states of protonation. For example, if no protonation exists, nicotine is referred to as the "free base." If one nitrogen is protonated, then the nicotine would be "mono-protonated."

Nicotine salt formulations may be formed by adding a suitable acid to nicotine, stirring the neat mixture at ambient temperature or at elevated temperature, and then diluting the neat mixture with a carrier mixture, such as a mixture of propylene glycol and glycerin. In some embodiments, the suitable acid is completely dissolved by the nicotine prior to dilution. The suitable acid may not completely dissolved by the nicotine prior to dilution. The addition of the suitable acid to the nicotine to form a neat mixture may cause an exothermic reaction. The addition of the suitable acid to the nicotine to form a neat mixture may be conducted at 55° C. The addition of the suitable acid to the nicotine to form a neat mixture may be conducted at 90° C. The neat mixture may be cooled to ambient temperature prior to dilution. The dilution may be carried out at elevated temperature.

Nicotine salt formulations may be prepared by combining nicotine and a suitable acid in a carrier mixture, such as a mixture of propylene glycol and glycerin. The mixture of nicotine and a first carrier mixture is combined with a mixture of a suitable acid in a second carrier mixture. In some embodiments, the first and second carrier mixtures are identical in composition. In some embodiments, the first and second carrier mixtures are not identical in composition. In some embodiments, heating of nicotine/acid/carrier mixture is required to facilitate complete dissolution.

In some embodiments, nicotine salt formulations may be prepared and added to a solution of 3:7 ratio by weight of propylene glycol (PG)/vegetable glycerin (VG), and mixed thoroughly. While described herein as producing 10 g of each of the formulations, all procedures noted infra are scalable. Other manners of formulation may also be employed form the formulations noted infra, without departing from the disclosure herein, and as would be known to one of skill in the art upon reading the disclosure herein.

The optimal nicotine salt formulation may be determined by the vapor pressure of the constituent acid. In some embodiments, the nicotine salt formulations comprise an acid with a vapor pressure that is similar to the vapor pressure of free base nicotine. In some embodiments, the nicotine salt formulations are formed from an acid with a vapor pressure that is similar to the vapor pressure of free base nicotine at the heating temperature of the device. FIG. **3** illustrates this trend. Nicotine salts formed from nicotine and benzoic acid; nicotine and salicylic acid; or nicotine and levulinic acid are salts that produce a satisfaction in an individual user consistent with efficient transfer of nicotine and a rapid rise in nicotine plasma levels. This pattern may be due to the mechanism of action during heating of the nicotine salt formulation. The nicotine salt may disassociate at, or just below, the heating temperature of the device, resulting in a mixture of free base nicotine and the individual acid. At that point, if both the nicotine and acid have similar vapor pressures, they may aerosolize at the same time, giving rise to a transfer of both free base nicotine and the constituent acid to the user.

The nicotine salt liquid formulation for generating an inhalable aerosol upon heating in an electronic cigarette may comprise a nicotine salt in a biologically acceptable liquid carrier; wherein the acid used to form said nicotine salt is characterized by a vapor pressure between 20-4000 mmHg at 200° C. In some embodiments, the acid used to form the nicotine salt is characterized by vapor pressure between 20-2000 mmHg at 200° C. In some embodiments, the acid used to form the nicotine salt is characterized by vapor pressure between 100-300 mmHg at 200° C.

Unexpectedly, different nicotine salt formulations produced varying degrees of satisfaction in an individual. In some embodiments, the extent of protonation of the nicotine salt affected satisfaction, such that more protonation was less satisfying as compared to less protonation. The nicotine salt formed may be monoprotonated. The nicotine salt formed may be diprotonated. The nicotine salt may exist in more than one protonation state, e.g., an equilibrium of mono-protonated and di-protonated nicotine salts. The extent of protonation of the nicotine molecule may be dependent upon the stoichiometric ratio of nicotine:acid used in the salt formation reaction. The extent of protonation of the nicotine molecule may be dependent upon the solvent. The extent of protonation of the nicotine molecule may be unknown. In some embodiments, monoprotonated nicotine salts produced a high degree of satisfaction in the user. For example, nicotine benzoate and nicotine salicylate are mono-protonated nicotine salts and all produce a high degree of satisfaction in the user. The reason for this trend may be explained by a mechanism of action wherein the nicotine is first deprotonated prior to transfer to the vapor with the constituent acid and then retained and stabilized after re-protonated by the acid going down stream to the lungs of the user. It may be easier to remove one proton versus two protons, thus resulting in better transfer efficiency. In addition, the lack of satisfaction of free base nicotine indicates that a second factor may be important. A nicotine salt may be best performing when it is at its optimal extent of protonation, depending on the salt. For example, nicotine pyruvate is a nicotine salt with 1:2 nicotine:acid ratio. The formulation containing nicotine pyruvate (1:2) may deliver more satisfaction to the user than the one containing same amount of nicotine but only half amount of pyruvic acid, i.e. nicotine pyruvate (1:1). This may be explained as 1 mole of nicotine produces a salt with 2 moles of pyruvic acid. When there is not enough pyruvic acid to associate with all nicotine molecules, the free base nicotine left unprotonated in the formulation may reduce the satisfaction the formulation provides.

The flavor of the constituent acid used in the salt formation may be a consideration in choosing the acid. A suitable acid may have minimal or no toxicity to humans in the concentrations used. A suitable acid may be compatible with the electronic cigarette components it contacts or could contact at the concentrations used. That is, such acid does not degrade or otherwise react with the electronic cigarette components it contacts or could contact. The odor of the constituent acid used in the salt formation may be a consideration in choosing a suitable acid. The concentration of the nicotine salt in the carrier may affect the satisfaction in the individual user. In some embodiments, the flavor of the formulation is adjusted by changing the acid. In some embodiments, the flavor of the formulation is adjusted by adding exogenous flavorants. In some embodiments, an unpleasant tasting or smelling acid is used in minimal quantities to mitigate such characteristics. In some embodiments, exogenous pleasant smelling or tasting acid is added to the formulation. Examples of salts which can provide flavor and aroma to the mainstream aerosol at certain levels include nicotine acetate, nicotine oxalate, nicotine malate, nicotine isovalerate, nicotine lactate, nicotine citrate, nicotine phenylacetate and nicotine myristate.

Nicotine salt formulations may generate an inhalable aerosol upon heating in an electronic cigarette. The amount of nicotine or nicotine salt aerosol inhaled may be user-determined. The user may, for example, modify the amount of nicotine or nicotine salt inhaled by adjusting his inhalation strength.

Formulations are described herein comprising two or more nicotine salts. In some embodiments, wherein a formulation comprises two or more nicotine salts, each individual nicotine salt is formed as described herein.

Nicotine salt formulations, as used herein, refer to a single or mixture of nicotine salts with other suitable chemical components used for e-cigarette, such as carriers, stabilizers, diluents, dispersing agents, suspending agents, thickening agents, and/or excipients. In certain embodiments, the nicotine salt formulation is stirred at ambient conditions for 20 minutes. In certain embodiments, the nicotine salt formulation is heated and stirred at 55 C for 20 minutes. In certain embodiments, the nicotine salt formulation is heated and stirred at 90 C for 60 minutes. In certain embodiments, the formulation facilitates administration of nicotine to an organism (e.g., lung).

The nicotine of nicotine salt formulations provided herein is either naturally occurring nicotine (e.g., from extract of nicotineous species such as tobacco), or synthetic nicotine. In some embodiments, the nicotine is (−)-nicotine, (+)-nicotine, or a mixture thereof. In some embodiments, the nicotine is employed in relatively pure form (e.g., greater than about 80% pure, 85% pure, 90% pure, 95% pure, or 99% pure). In some embodiments, the nicotine for nicotine salt formulation provided herein is "water clear" in appearance in order to avoid or minimize the formation of tarry residues during the subsequent salt formation steps.

Nicotine salt formulations used for e-cigarettes described herein, in some embodiments, have a nicotine concentration of about 0.5% (w/w) to about 20% (w/w), wherein the concentration is of nicotine weight to total solution weight, i.e. (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 20% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 18% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 15% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 4% (w/w) to about 12% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 18% (w/w), about 3% (w/w) to about 15% (w/w), or about 4% (w/w) to about 12% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 0.5% (w/w) to about 10% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 0.5% (w/w) to about 5% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 0.5% (w/w) to about 4% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 0.5% (w/w) to about 3% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 0.5% (w/w) to about 2% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 0.5% (w/w) to about 1% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 10% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 5% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 4% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 3% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 1% (w/w) to about 2% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 2% (w/w) to about 10% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 2% (w/w) to about 5% (w/w). In certain embodiments, nicotine salt formulations provided herein have a nicotine concentration of about 2% (w/w) to about 4% (w/w). Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1.0%, 1.1%, 1.2%, 1.3%, 1.4%, 1.5%, 1.6%, 1.7%, 1.8%, 1.9%, 2.0%, 2.1%, 2.2%, 2.3%, 2.4%, 2.5%, 2.6%, 2.7%, 2.8%, 2.9%, 3.0%, 3.1%, 3.2%, 3.3%, 3.4%, 3.5%, 3.6%, 3.7%, 3.8%, 3.9%, 4.0%, 4.5%, 5.0%, 5.5%, 6.0%, 6.5%, 7.0%, 7.5%, 8.0%, 8.5%, 9.0%, 9.5%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, or 20% (w/w), or more, including any increments therein. Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 5% (w/w). Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 4% (w/w). Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 3% (w/w). Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 2% (w/w). Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 1% (w/w). Certain embodiments provide a nicotine salt formulation having a nicotine concentration of about 0.5% (w/w).

The formulation further may comprise one or more flavorants.

Thee suitable acid for the nicotine salt formulation may have a vapor pressure >20 mmHg at 200° C. and is non-corrosive to the electronic cigarette or is non-toxic to humans. In some embodiments, the suitable acid for nicotine salt formation is selected from the group consisting of salicylic acid, formic acid, sorbic acid, acetic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

Thee suitable acid for the nicotine salt formulation may have a vapor pressure of about 20 to 200 mmHg at 200° C. and is non-corrosive to the electronic cigarette or is non-toxic to humans. In some embodiments, the suitable acid for nicotine salt formation is selected from the group consisting of salicylic acid, benzoic acid, lauric acid, and levulinic acid.

Thee suitable acid for the nicotine salt formulation may have a melting point <160° C., a boiling point >160° C., at least a 50-degree difference between the melting point and the boiling point, and is non-corrosive to the electronic cigarette or is non-toxic to humans. In some embodiments, the suitable acid for nicotine salt formation has a melting point at least 40 degrees lower than the operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, at least a 50-degree difference between the melting point and the boiling point, and is non-corrosive to the electronic cigarette or is non-toxic to humans; wherein the operating temperature is 200° C. In some embodiments, the suitable acid for nicotine salt formation is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

Thee suitable acid for the nicotine salt formulation does not decompose at the operating temperature of the electronic cigarette. In some embodiments, the suitable acid for nicotine salt formation does not oxidize at the operating temperature of the electronic cigarette. In some embodiments, the suitable acid for nicotine salt formation does not oxidize at room temperature. In some embodiments, the suitable acid for nicotine salt formation does not provide an unpleasant taste. In some embodiments, the suitable acid for nicotine salt formation has good solubility in a liquid formulation for use in an electronic cigarette.

Provided herein is an electronic cigarette **2** having a fluid storage compartment **4** comprising an embodiment nicotine salt formulation of any embodiment described herein within the fluid storage compartment described herein. An embodiment is shown in FIG. **7**. The electronic cigarette **2** of FIG. **7** includes a mouth end **6**, and a charging end **8**. The mouth-end **6** includes a mouthpiece **10**. The charging end **8** may connect to a battery or a charger or both, wherein the battery is within a body of the electronic cigarette, and the charger is separate from the battery and couples to the body or the battery to charge the battery. In some embodiments the electronic cigarette comprises a rechargeable battery within a body **14** of the electronic cigarette and the charge end **8** comprises a connection **12** for charging the rechargeable battery. In some embodiments, the electronic cigarette comprises a cartomizer that comprises the fluid storage compartment and an atomizer. In some embodiments, the atomizer comprises a heater. In some embodiments the fluid storage compartment **4** is separable from an atomizer. In some embodiments the fluid storage compartment **4** is replaceable as part of a replaceable cartridge. In some embodiments the fluid storage compartment **4** is refillable. In some embodiments, the mouthpiece **10** is replaceable.

Provided herein is a cartomizer **18** for an electronic cigarette **2** having a fluid storage compartment **4** comprising an embodiment nicotine salt formulation of any embodiment described herein within the fluid storage compartment described herein. The cartomizer **18** embodiment of FIG. **8** includes a mouth end **6**, and a connection end **16**. The connection end **16** in the embodiment of FIG. **8** couples the cartomizer **14** to a body of an electronic cigarette, or to a battery of the electronic cigarette, or both. The mouth end **6** includes a mouthpiece **10**. In some embodiments, the cartomizer does not include a mouthpiece, and in such embodiments, the cartomizer can be coupled to a mouthpiece of an electronic cigarette, or the cartomizer can be coupled to a battery or body of an electronic cigarette, while the mouthpiece is also coupled to the battery or the body of the electronic cigarette. In some embodiments, the mouthpiece is integral with the body of the electronic cigarette. In some embodiments, including the embodiment of FIG. **8**, the cartomizer **18** comprises the fluid storage compartment **4** and an atomizer (not shown). In some embodiments, the atomizer comprises a heater (not shown)

EXAMPLES

Example 1: Preparation of Nicotine Salt Formulations

Various nicotine formulations were prepared and added to a solution of 3:7 ratio by weight of propylene glycol (PG)/vegetable glycerin (VG), and mixed thoroughly. The examples shown below were used to make 10 g of each of the formulations. All procedures are scalable.

For example, in order to make nicotine formulations with a final nicotine free base equivalent concentration of 2% (w/w), the following procedures were applied to each individual formulation.

- Nicotine benzoate salt formulation: 0.15 g benzoic acid was added to a beaker followed by adding 0.2 g nicotine to the same beaker. The mixture was stirred at 55° C. for 20 minutes until benzoic acid was completely dissolved and an orange oily mixture was formed. The mixture was cooled down to ambient conditions. 9.65 g PG/VG (3:7) solution was added to the orange nicotine benzoate salt and the mixture was stirred until a visually homogenous formulation solution was achieved.
- Nicotine benzoate salt formulation can also be made by adding 0.15 g benzoic acid to a beaker followed by adding 0.2 g nicotine and 9.65 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 55° C. for 20 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.
- Nicotine citrate salt formulation was made by adding 0.47 g citric acid to a beaker followed by adding 0.2 g nicotine and 9.33 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.
- Nicotine malate salt formulation was made by adding 0.33 g L-malic acid to a beaker followed by adding 0.2 g nicotine and 9.47 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.
- Nicotine succinate salt formulation was made by adding 0.29 g succinic acid to a beaker followed by adding 0.2 g nicotine and 9.51 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.
- Nicotine salicylate salt formulation was made by adding 0.17 g salicylic acid to a beaker followed by adding 0.2 g nicotine and 9.63 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.
- Nicotine salicylate salt formulation can also be made by adding 0.17 g salicylic acid to a beaker followed by adding 0.2 g nicotine to the same beaker. The mixture was stirred at 90° C. for 60 minutes until salicylic acid was completely dissolved and an orange oily mixture was formed. The mixture was either cooled to ambient conditions or kept at 90° C. when 9.63 g PG/VG (3:7) solution was added. The mixture was then stirred at 90° C. until a visually homogenous formulation solution was achieved with no undissolved chemicals.
- Nicotine free base formulation was made by adding 0.2 g nicotine to a beaker followed by adding 9.8 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at ambient conditions for 10 minutes until a visually homogenous formulation solution was achieved.

For example, in order to make nicotine salt formulations with a final nicotine free base equivalent concentration of 3% (w/w), the following procedures were applied to each individual formulation.

- Nicotine benzoate salt formulation: 0.23 g benzoic acid was added to a beaker followed by adding 0.3 g nicotine to the same beaker. The mixture was stirred at 55° C. for 20 minutes until benzoic acid was completely dissolved and an orange oily mixture was formed. The mixture was cooled down to ambient conditions. 9.47 g PG/VG (3:7) solution was added to the orange nicotine benzoate salt and the blend was stirred until a visually homogenous formulation solution was achieved.

Nicotine benzoate salt formulation can also be made by adding 0.23 g benzoic acid to a beaker followed by adding 0.3 g nicotine and 9.47 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 55° C. for 20 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine citrate salt formulation was made by adding 0.71 g citric acid to a beaker followed by adding 0.3 g nicotine and 8.99 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine malate salt formulation was made by adding 0.5 g L-malic acid to a beaker followed by adding 0.3 g nicotine and 9.2 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine levulinate salt formulation was made by adding melted 0.64 g levulinic acid to a beaker followed by adding 0.3 g nicotine to the same beaker. The mixture was stirred at ambient conditions for 10 minutes. Exothermic reaction took place and oily product was produced. The mixture was allowed to cool down to ambient temperature and 9.06 g PG/VG (3:7) solution was added to the same beaker. The mixture was then stirred at ambient conditions for 20 minutes until a visually homogenous formulation solution was achieved.

Nicotine pyruvate salt formulation was made by adding 0.33 g pyruvic acid to a beaker followed by adding 0.3 g nicotine to the same beaker. The mixture was stirred at ambient conditions for 10 minutes. Exothermic reaction took place and oily product was produced. The mixture was allowed to cool down to ambient temperature and 9.37 g PG/VG (3:7) solution was added to the same beaker. The mixture was then stirred at ambient conditions for 20 minutes until a visually homogenous formulation solution was achieved.

Nicotine succinate salt formulation was made by adding 0.44 g succinic acid to a beaker followed by adding 0.3 g nicotine and 9.26 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine salicylate salt formulation was made by adding 0.26 g salicylic acid to a beaker followed by adding 0.3 g nicotine and 9.44 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine salicylate salt formulation can also be made by adding 0.26 g salicylic acid to a beaker followed by adding 0.3 g nicotine to the same beaker. The mixture was stirred at 90° C. for 60 minutes until salicylic acid was completely dissolved and an orange oily mixture was formed. The mixture was either cooled to ambient conditions or kept at 90° C. when 9.44 g PG/VG (3:7) solution was added. The blend was then stirred at 90 C until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine free base formulation was made by adding 0.3 g nicotine to a beaker followed by adding 9.7 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at ambient conditions for 10 minutes until a visually homogenous formulation solution was achieved.

For example, in order to make nicotine salt formulations with a final nicotine free base equivalent concentration of 4% (w/w), the following procedures were applied to each individual formulation.

Nicotine benzoate salt formulation: 0.3 g benzoic acid was added to a beaker followed by adding 0.4 g nicotine to the same beaker. The mixture was stirred at 55° C. for 20 minutes until benzoic acid was completely dissolved and an orange oily mixture was formed. The mixture was cooled down to ambient conditions. 9.7 g PG/VG (3:7) solution was added to the orange nicotine benzoate salt and the blend was stirred until a visually homogenous formulation solution was achieved.

Nicotine benzoate salt formulation can also be made by adding 0.3 g benzoic acid to a beaker followed by adding 0.4 g nicotine and 9.7 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 55° C. for 20 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

For example, in order to make nicotine salt formulations with a final nicotine free base equivalent concentration of 5% (w/w), the following procedures were applied to each individual formulation.

Nicotine benzoate salt formulation: 0.38 g benzoic acid was added to a beaker followed by adding 0.5 g nicotine to the same beaker. The mixture was stirred at 55° C. for 20 minutes until benzoic acid was completely dissolved and an orange oily mixture was formed. The mixture was cooled down to ambient conditions. 9.12 g PG/VG (3:7) solution was added to the orange nicotine benzoate salt and the blend was stirred until a visually homogenous formulation solution was achieved.

Nicotine benzoate salt formulation can also be made by adding 0.38 g benzoic acid to a beaker followed by adding 0.5 g nicotine and 9.12 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 55° C. for 20 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine malate salt formulation was made by adding 0.83 g L-malic acid to a beaker followed by adding 0.5 g nicotine and 8.67 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine levulinate salt formulation was made by adding melted 1.07 g levulinic acid to a beaker followed by adding 0.5 g nicotine to the same beaker. The mixture was stirred at ambient conditions for 10 minutes. Exothermic reaction took place and oily product was produced. The mixture was allowed to cool down to ambient temperature and 8.43 g PG/VG (3:7) solution was added to the same beaker. The mixture was then stirred at ambient conditions for 20 minutes until a visually homogenous formulation solution was achieved.

Nicotine pyruvate salt formulation was made by adding 0.54 g pyruvic acid to a beaker followed by adding 0.5 g nicotine to the same beaker. The mixture was stirred at ambient conditions for 10 minutes. Exothermic reaction took place and oily product was produced. The mixture was allowed to cool down to ambient temperature and 8.96 g PG/VG (3:7) solution was added to the same beaker. The mixture was then stirred at ambient conditions for 20 minutes until a visually homogenous formulation solution was achieved.

Nicotine succinate salt formulation was made by adding 0.73 g succinic acid to a beaker followed by adding 0.5 g nicotine and 8.77 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine salicylate salt formulation was made by adding 0.43 g salicylic acid to a beaker followed by adding 0.5 g nicotine and 9.07 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at 90° C. for 60 minutes until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine salicylate salt formulation can also be made by adding 0.43 g salicylic acid to a beaker followed by adding 0.5 g nicotine to the same beaker. The mixture was stirred at 90° C. for 60 minutes until salicylic acid was completely dissolved and an orange oily mixture was formed. The mixture was either cooled to ambient conditions or kept at 90 C when 9.07 g PG/VG (3:7) solution was added. The blend was then stirred at 90° C. until a visually homogenous formulation solution was achieved with no undissolved chemicals.

Nicotine free base formulation was made by adding 0.5 g nicotine to a beaker followed by adding 9.5 g PG/VG (3:7) solution to the same beaker. The mixture was then stirred at ambient conditions for 10 minutes until a visually homogenous formulation solution was achieved.

Various formulations comprising different nicotine salts can be prepared similarly, or different concentrations of the above-noted nicotine formulations or other nicotine salt formulations can be prepared as one of skill in the art would know to do upon reading the disclosure herein.

Various formulations comprising two or more nicotine salts can be prepared similarly in a solution of 3:7 ratio of propylene glycol (PG)/vegetable glycerin (VG). For example, 0.43 g (2.5% w/w nicotine) of nicotine levulinate salt and 0.34 g (2.5% w/w nicotine) of nicotine acetate salt are added to 9.23 g of PG/VG solution, to achieve a 5% w/w nicotine formulation.

Also provided is another exemplary formulation. For example, 0.23 g (1.33% w/w nicotine) of nicotine benzoate salt (molar ratio 1:1 nicotine/benzoic acid), 0.25 g (1.33% w/w nicotine) of nicotine salicylate salt (molar ratio 1:1 nicotine/salicylic acid) and 0.28 g (1.34% w/w nicotine) of nicotine pyruvate salt (molar ratio 1:2 nicotine/pyruvic acid) are added to 9.25 g of PG/VG solution, to achieve a 5% w/w nicotine formulation.

Example 2: Heart Rate Study of Nicotine Solutions Via e-Cigarette

Exemplary formulations of nicotine levulinate, nicotine benzoate, nicotine succinate, nicotine salicylate, nicotine malate, nicotine pyruvate, nicotine citrate, nicotine freebase, and a control of propylene glycol were prepared as noted in Example 1 in 3% w/w solutions and were administered in the same fashion by an electronic cigarette to the same human subject. About 0.5 mL of each solution was loaded into an "eRoll" cartridge atomizer (joyetech.com) to be used in the study. The atomizer was then attached to an "eRoll" e-cigarette (same manufacturer). The operating temperature was from about 150° C. to about 250° C., or from about 180° C. to about 220° C.

Heart rate measurements were taken for 6 minutes; from 1 minute before start of puffing, for 3 minutes during puffing, and continuing until 2 minutes after end of puffing. The test participant took 10 puffs over 3 minutes in each case. The base heart rate was the average heart rate over the first 1 minute before start of puffing. Heart rate after puffing started was averaged over 20-second intervals. Puffing (inhalation) occurred every 20 seconds for a total of 3 minutes. Normalized heart rate was defined as the ratio between individual heart rate data point and the base heart rate. Final results were presented as normalized heart rate, shown for the first 4 minutes in FIG. **1**.

FIG. **1** summarizes results from heart rate measurements taken for a variety of nicotine salt formulations. For ease of reference in reviewing FIG. **1**, at the 180-second timepoint, from top to bottom (highest normalized heart rate to lowest normalized heart rate), the nicotine formulations are as follows: nicotine salicylate formulation, nicotine malate formulation, nicotine levulinate formulation (nearly identical to nicotine malate formulation at 180 seconds, thus, as a second reference point: the nicotine malate formulation curve is lower than the nicotine levulinate formulation curve at the 160-second time point), nicotine pyruvate formulation, nicotine benzoate formulation, nicotine citrate formulation, nicotine succinate formulation, and nicotine free base formulation. The bottom curve (lowest normalized heart rate) at the 180-second timepoint is associated with the placebo (100% propylene glycol). The test formulations comprising a nicotine salt cause a faster and more significant rise in heart rate than the placebo. The test formulations comprising a nicotine salt also cause faster and more significant rise when compared with a nicotine freebase formulation with the same amount of nicotine by weight. In addition, the nicotine salts (e.g., nicotine benzoate and nicotine pyruvate) prepared from the acids having calculated vapor pressures between 20-200 mmHg at 200° C. (benzoic acid (171.66 mmHg), with the exception of pyruvic acid (having a boiling point of 165 C), respectively) cause a faster rise in heart rate than the rest. The nicotine salts (e.g., nicotine levulinate, nicotine benzoate, and nicotine salicylate) prepared from the acids (benzoic acid, levulinic acid and salicylic acid, respectively) also cause a more significant heart rate increase. Thus, other suitable nicotine salts formed by the acids with the similar vapor pressure and/or similar boiling point may be used in accordance with the practice of the present invention. This experience of increased heart rate theoretically approaching or theoretically comparable to that of a traditional burned cigarette has not been demonstrated or identified in other electronic cigarette devices. Nor has it been demonstrated or identified in low temperature tobacco vaporization devices (electronic cigarettes) that do not burn the tobacco, even when a nicotine salt was used (a solution of 20% (w/w) or more of nicotine salt) as an additive to the tobacco. Thus the results from this experiment are surprising and unexpected.

Example 3: Satisfaction Study of Nicotine Salt Solution Via e-Cigarette

In addition to the heart rate study shown in Example 2, nicotine formulations (using 3% w/w nicotine formulations as described in Example 1) were used to conduct a satisfaction study in a single test participant. The test participant, an e-cigarette and/or traditional cigarette user, was required to have no nicotine intake for at least 12 hours before the test. The participant took 10 puffs using an e-cigarette (same as used in Example 2) over 3 minutes in each case, and then was asked to rate the level of physical and emotional satisfaction he or she felt on a scale of 0-10, with 0 being no physical or emotional satisfaction. The results indicated that the least satisfying compound was the nicotine free base. Nicotine benzoate, nicotine salicylate, and nicotine succinate all performed well, followed by nicotine pyruvate, nicotine citrate, and nicotine pyruvate.

Based on the Satisfaction Study, the nicotine salts formulations with acids having vapor pressure ranges between >20 mmHg @ 200° C., or 20-200 mmHg @ 200° C., or 100-300 mmHg @ 200° C. provide more satisfaction than the rest (except the pyruvic acid which has boiling point of 165° C.). For reference, it has been determined that salicylic acid has a vapor pressure of about 135.7 mmHg @ 200° C., benzoic acid has a vapor pressure of about 171.7 mmHg @ 200° C., lauric acid has a vapor pressure of about 38 mmHg @ 200° C., and levulinic acid has a vapor pressure of about 149 mmHg @ 200° C.

Example 4: Test Formulation 1 (TF1)

A solution of nicotine levulinate in glycerol comprising nicotine salt used: 1.26 g (12.6% w/w) of 1:3 nicotine levulinate 8.74 g (87.4% w/w) of glycerol—Total weight 10.0 g.

Neat nicotine levulinate was added to the glycerol, and mixed thoroughly. L-Nicotine has a molar mass of 162.2 g, and levulinic acid molar mass is 116.1 g. In a 1:3 molar ratio, the percentage of nicotine in nicotine levulinate by weight is given by: 162.2 g/(162.2 g+(3×116.1 g))=31.8% (w/w).

Example 5: Test Formulation 2 (TF2)

A solution of free base nicotine in glycerol comprising 0.40 g (4.00% w/w) of L-nicotine was dissolved in 9.60 g (96.0% w/w) of glycerol and mixed thoroughly.

Example 6: Heart Rate Study of Nicotine Solutions Via e-Cigarette

Both formulations (TF1 and TF2) were administered in the same fashion by an electronic cigarette to the same human subject: about 0.6 mL of each solution was loaded into "eGo-C" cartridge atomizer (joyetech.com). The atomizer was then attached to an "eVic" e-cigarette (same manufacturer). This model of e-cigarette allows for adjustable voltage, and therefore wattage, through the atomizer. The operating temperature of the e-cigarette is from about 150° C. to about 250° C., or from about 180° C. to about 220° C.

The atomizer in both cases has resistance 2.4 ohms, and the e-cigarette was set to 4.24V, resulting in 7.49 W of power. (P=V^2/R)

Heart rate was measured in a 30-second interval for ten minutes from start of puffing. Test participants took 10 puffs over 3 minutes in each case (solid line (2^{nd} highest peak): cigarette, dark dotted line (highest peak): test formulation 1 (TF1-nicotine salt formulation), light dotted line: test formulation 2 (TF2—nicotine formulation). Comparison between cigarette, TF1, and TF2 is shown in FIG. **2**.

It is clearly shown in FIG. **2** that the test formulation with nicotine levulinate (TF1) causes a faster rise in heart rate than just nicotine (TF2). Also, TF1 more closely resembles the rate of increase for a cigarette. Other salts were tried and also found to increase heart rate relative to a pure nicotine solution. Thus, other suitable nicotine salts that cause the similar effect may be used in accordance with the practice of the present invention. For example, other keto acids (alpha-keto acids, beta-keto acids, gamma-keto acids, and the like) such as pyruvic acid, oxaloacetic acid, acetoacetic acid, and the like. This experience of increased heart rate comparable to that of a traditional burned cigarette has not been demonstrated or identified in other electronic cigarette devices, nor has it been demonstrated or identified in low temperature tobacco vaporization devices that do not burn the tobacco, even when a nicotine salt was used (a solution of 20% (W/W) or more of nicotine salt) as an additive to the tobacco. Thus the results from this experiment are surprising and unexpected.

In addition, the data appears to correlate well with the previous findings shown in FIG. **2**.

As previously noted in the Satisfaction Study, the nicotine salts formulations with acids having vapor pressures between 20-300 mmHg @ 200° C. provide more satisfaction than the rest, with the exception of the nicotine salt formulation made with pyruvic acid, which has a boiling point of 165° C., as noted in FIG. **3**. Based on the findings herein, it was anticipated that these nicotine salt formulations having either:

- a Vapor Pressure between 20-300 mmHg @ 200° C.,
- a Vapor Pressure >20 mmHg @ 200° C.,
- a difference between boiling point and melting point of at least 50° C., and a boiling point greater than 160° C., and a melting point less than 160° C.,
- a difference between boiling point and melting point of at least 50° C., and a boiling point greater than 160° C., and a melting point less than 160° C.,
- a difference between boiling point and melting point of at least 50° C., and a boiling point at most 40° C. less than operating temperature, and a melting point at least 40° C. lower than operating temperature, or
- a combination thereof produce one or more of the following effects:

T_{max}—Time to maximum blood concentration: Based on the results established herein, a user of an e-cigarette comprising the nicotine salt formulation will experience a comparable rate of physical and emotional satisfaction from using a formulation comprising a mixture of nicotine salts prepared with an appropriate acid at least 1.2× to 3× faster than using a formulation comprising a freebase nicotine. As illustrated in FIG. 1: Nicotine from a nicotine salts formulation appears to generate a heartbeat that is nearly 1.2 times that of a normal heart rate for an individual approximately 40 seconds after the commencement of puffing; whereas the nicotine from a nicotine freebase formulation appears to generate a heartbeat that is nearly 1.2 times that of a normal heart rate for an individual approximately 110 seconds after the commencement of puffing; a 2.75× difference in time to achieve a comparable initial satisfaction level.

Again this would not be inconsistent with the data from FIG. **2**, where the data illustrated that at approximately 120 seconds (2 minutes), the heart rate of test participants reached a maximum of 105-110 bpm with either a regular cigarette or a nicotine salt formulation (TF1); whereas those same participants heart rates only reached a maximum of approximately 86 bpm at approximately 7 minutes with a nicotine freebase formulation (TF2); also a difference in effect of 1.2 times greater with nicotine salts (and regular cigarettes) versus freebase nicotine.

Further, when considering peak satisfaction levels (achieved at approximately 120 seconds from the initiation of puffing (time=0) and looking at the slope of the line for a normalized heart rate, the approximate slope of those nicotine salt formulations that exceeded the freebase nicotine formulation range between 0.0054 hr_n/sec and 0.0025 hr_n/sec. By comparison, the slope of the line for the freebase nicotine formulation is about 0.002. This would suggest that the concentration of available nicotine will be delivered to the user at a rate that is between 1.25 and 2.7 times faster than a freebase formulation.

In another measure of performance; C_{max}—Maximum blood nicotine concentration; it is anticipated that similar rates of increase will be measured in blood nicotine concentration, as those illustrated above. That is, it was anticipated based on the findings herein, and unexpected based on the art known to date, that there would be comparable C_{max} between the common cigarette and certain nicotine salt formulations, but with a lower C_{max} in a freebase nicotine solution.

Similarly, anticipated based on the findings herein, and unexpected based on the art known to date, that certain nicotine salt formulations would have higher rate of nicotine uptake levels in the blood at early time periods. Indeed, Example 8 presents data for multiple salt formulations consistent with these predictions which were made based on the findings and tests noted herein, and unexpected compared to the art available to date.

Example 7: Heart Rate Study of Nicotine Solutions Via e-Cigarette

Exemplary formulations of nicotine levulinate, nicotine benzoate, nicotine succinate, nicotine salicylate, nicotine malate, nicotine pyruvate, nicotine citrate, nicotine sorbate, nicotine laurate, nicotine freebase, and a control of propylene glycol are prepared as noted in Example 1 and are administered in the same fashion by an electronic cigarette to the same human subject. About 0.5 mL of each solution is loaded into an "eRoll" cartridge atomizer (joyetech.com) to be used in the study. The atomizer is then attached to an "eRoll" e-cigarette (same manufacturer). The operating temperature of the e-cigarette is from about 150° C. to about 250° C., or from about 180° C. to about 220° C.

Heart rate measurements are taken for 6 minutes; from 1 minute before start of puffing, for 3 minutes during puffing, and continuing until 2 minutes after end of puffing. The test participant takes 10 puffs over 3 minutes in each case. The base heart rate is the average heart rate over the first 1 minute before start of puffing. Heart rate after puffing started is averaged over 20-second intervals. Normalized heart rate is defined as the ratio between individual heart rate data point and the base heart rate. Final results are presented as normalized heart rate.

Example 8: Blood Plasma Testing

Blood plasma testing was conducted on three subjects (n=3). Eight test articles were used in this study: one reference cigarette and seven blends used in an e-cigarette device having an operating temperature of the e-cigarette from about 150° C. to about 250° C., or from about 180° C. to about 220° C. The reference cigarette was Pall Mall (New Zealand). Seven blends were tested in the e-cigarette: 2% free base, 2% benzoate, 4% benzoate, 2% citrate, 2% malate, 2% salicylate, and 2% succinate. Except for 2% succinate (n=1), all other blends have n=3. The seven blends were liquid formulations prepared as described in Example 1.

The concentration of nicotine in each of the formulations was confirmed using UV spectrophotometer (Cary 60, manufactured by Agilent). The sample solutions for UV analysis were made by dissolving 20 mg of each of the formulations in 20 mL 0.3% HCl in water. The sample solutions were then scanned in UV spectrophotometer and the characteristic nicotine peak at 259 nm was used to quantify nicotine in the sample against a standard solution of 19.8 μg/mL nicotine in the same diluent. The standard solution was prepared by first dissolving 19.8 mg nicotine in 10 mL 0.3% HCl in water followed by a 1:100 dilution with 0.3% HCl in water. Nicotine concentrations reported for all formulations were within the range of 95%-105% of the claimed concentrations

All subjects were able to consume 30-55 mg of the liquid formulation of each tested blend using the e-cigarette.

Literature results: C. Bullen et al, Tobacco Control 2010, 19:98-103 Cigarette (5 min adlib, n=9): T_{max}=14.3 (8.8-19.9), C_{max}=13.4 (6.5-20.3) 1.4% E-cig (5 min adlib, n=8): T_{max}=19.6 (4.9-34.2), C_{max}=1.3 (0.0-2.6) Nicorette Inhalator (20 mg/20 min, n=10): T_{max}=32.0 (18.7-45.3), C_{max}=2.1 (1.0-3.1)

Estimated C_{max} of 2% nicotine blends:

$$C_{max}\text{=Mass consumed*Strength*Bioavailability/(Vol of Distribution*Body Weight)=40 mg*2\%*80\%/(2.6 L/kg*75 kg)=3.3 ng/mL}$$

Estimated C_{max} of 4% nicotine blends:

$$C_{max}\text{=Mass consumed*Strength*Bioavailability/(Vol of Distribution*Body Weight)=40 mg*4\%*80\%/(2.6 L/kg*75 kg)=6.6 ng/mL}$$

Pharmacokinetic profiles of the blood plasma testing are shown in FIG. **4**; showing blood nicotine concentrations (ng/mL) over time after the first puff (inhalation) of the aerosol from the e-cigarette or the smoke of the Pall Mall. Ten puffs were taken at 30 sec intervals starting at time=0 and continuing for 4.5 minutes. For ease of reference and review of FIG. **4**, at the 5-minute timepoint, the curves on the graph show from top to bottom (highest average blood nicotine concentration to lowest average blood nicotine concentration) are 4% benzoate, 2% succinate, 2% salicylate, 2% citrate, Pall Mall cigarette, 2% benzoate, 2% malate, and 2% free base blend. Although noted as highest to lowest at this time point, this is not to say that there is a statistically significant difference between any of the salt formulations, or between any of the salt formulations and the Pall Mall cigarette. However, it is possible there may be a statistically significant difference between the C_{max} of particular salt formulations, and it is also likely based on the data shown in FIG. **4** and in other studies herein that the freebase formulation is statistically different from salt formulations and/or the Pall Mall with respect to C_{max}, since it appears lower than others tested at several time points. One of skill in the art, upon review of the disclosure herein could properly power a test to determine actual statistically-based differences between one or more formulations and the cigarette, or between the formulations themselves in an e-cigarette. For ease of reference Tables 1 & 2 present the amount of nicotine detected (as an average of all users) for each formulation and the Pall Mall, presented in ng/mL, along with C_{max} and T_{max} and AUC. Data from these tables, along with the raw data therefore, was used to generate FIGS. **4**, **5**, and **6**.

TABLE 1

Time	Pall Mall	2% Freebase	2% Benzoate	4% Benzoate
−2	0.46	0.03	0.09	0.05
0	−0.46	−0.03	−0.09	−0.05
1.5	1.54	0.08	5.67	6.02
3	9.98	1.19	8.60	11.47
5	11.65	1.70	11.44	15.06
7.5	11.34	3.09	6.43	12.12
10	9.24	3.42	5.03	11.08
12.5	8.85	3.35	4.68	10.10
15	8.40	2.81	4.47	8.57
30	5.51	1.74	2.72	5.56
60	3.39	0.79	1.19	3.60
T_{max} (min)	5.17	10.00	6.67	5.83
C_{max} (ng/mL)	11.65	3.42	11.44	15.06
AUC (ng*min/mL)	367.5	106.2	207.8	400.2

TABLE 2

Time	2% Citrate	2% Malate	2% Salicylate	2% Succinate
−2	0.06	−0.17	−0.19	−0.06
0	−0.06	0.17	0.19	0.06
1.5	4.80	1.09	6.14	2.10
3	8.33	5.30	12.04	10.81
5	12.09	10.02	13.46	13.81
7.5	6.93	5.93	5.21	5.15
10	6.01	4.85	4.60	5.18
12.5	5.34	4.17	3.83	4.17
15	4.72	3.79	3.52	3.41
30	3.40	1.56	2.19	2.01
60	1.70	0.46	0.55	1.00
T_{max} (min)	5.83	5.00	4.33	5.00
C_{max} (ng/mL)	12.09	10.02	13.46	13.81
AUC (ng*min/mL)	238.0	146.1	182.9	179.5

Comparison of T_{max} and C_{max} of the seven blends and reference cigarette are shown in FIG. **5**. Comparison of C_{max} and AUC of the seven blends and reference cigarette are shown in FIG. **6**. Due to the time limit of the wash-period, baseline blood nicotine concentration (at t=−2 and t=0 min) was higher for samples consumed at a later time on the test day. The data in FIGS. **4-6** show corrected blood nicotine concentration values (i.e. apparent blood nicotine concentration at each time point minus baseline nicotine concentration of the same sample).

Rates of nicotine uptake in the blood of the users of each sample within the first 90 seconds are shown in Table 3.

TABLE 3

Sample	Rate of nicotine uptake (ng/mL/min)
2% Salicylate	4.09
2% Benzoate	3.78
2% Citrate	3.20
2% Succinate	1.40
Pall Mall (reference)	1.03
2% Malate	0.73
2% Freebase	0.05
4% Benzoate	4.01

Although the T_{max} and C_{max} values are comparable between the tested blends and the reference cigarette (with the exception of the 2% free base blend), the rates of nicotine absorption within the first 90 seconds differed among the test articles. In particular, four blends (2% salicylate, 2% benzoate, 4% benzoate, and 2% citrate) showed markedly higher rates of absorption within the first 90 seconds compared to the other blends and with the reference cigarette. These four blends contain salts (salicylate, benzoate, and citrate) which performed well in the Satisfaction Study of Example 3. Moreover, 2% benzoate and 4% benzoate had comparable rates of absorption, suggesting that a lower concentration of nicotinic salt may not adversely impact the rate of absorption.

Example 9: Blood Plasma Testing

Blood plasma testing is conducted on 24 subjects (n=24). Eight test articles are used in this study: one reference cigarette and seven blends delivered to a user in an e-cigarette as an aerosol. The operating temperature of the e-cigarette is from about 150° C. to about 250° C., or from about 180° C. to about 220° C. The reference cigarette is Pall Mall (New Zealand). Seven blends are tested: 2% free base, 2% benzoate, 4% benzoate, 2% citrate, 2% malate, 2% salicylate, and 2% succinate. The seven blends are liquid formulations prepared according to protocols similar to that described infra and in Example 1.

All subjects are to consume 30-55 mg of the liquid formulation of each tested blend. Ten puffs are to be taken at 30 sec intervals starting at time=0 and continuing for 4.5 minutes. Blood plasma testing is to occur for at least 60 minutes from the first puff (t=0) Pharmacokinetic data (e.g., C_{max}, T_{max}, AUC) for nicotine in the plasma of users are obtained at various time periods during those 60 minutes, along with rates of nicotine absorption within the first 90 seconds for each test article.

Example 10: Blood Plasma Testing

Blood plasma testing is conducted on twenty-four subjects (n=24). Eleven test articles are used in this study: one reference cigarette and ten blends delivered to a user in an e-cigarette as an aerosol. The reference cigarette is Pall Mall (New Zealand). The operating temperature of the e-cigarette is from about 150° C. to about 250° C., or from about 180° C. to about 220° C. Ten blends are tested: 2% free base, 2% benzoate, 2% sorbate, 2% pyruvate, 2% laurate, 2% levulinate, 2% citrate, 2% malate, 2% salicylate, and 2% succinate. The ten blends are liquid formulations prepared according to protocols similar to that described infra and in Example 1.

All subjects are to consume 30-55 mg of the liquid formulation of each tested blend. Ten puffs are to be taken at 30 sec intervals starting at time=0 and continuing for 4.5 minutes. Blood plasma testing is to occur for at least 60 minutes from the first puff (t=0). Pharmacokinetic data (e.g., C_{max}, T_{max}, AUC) for nicotine in the plasma of users are obtained at various time periods during those 60 minutes, along with rates of nicotine absorption within the first 90 seconds for each test article.

Example 11: Blood Plasma Testing

Blood plasma testing is conducted on twenty-four subjects (n=24). Twenty-one test articles are used in this study: one reference cigarette and twenty blends delivered to a user in an e-cigarette as an aerosol. The reference cigarette is Pall Mall (New Zealand). The operating temperature of the e-cigarette is from about 150° C. to about 250° C., or from about 180° C. to about 220° C. Twenty blends are tested: 2% free base, 4% free base, 2% benzoate, 4% benzoate, 2% sorbate, 4% sorbate, 2% pyruvate, 4% pyruvate, 2% laurate, 4% laurate, 2% levulinate, 4% levulinate, 2% citrate, 4% citrate, 2% malate, 4% malate, 2% salicylate, 4% salicylate, 2% succinate, and 4% succinate. The twenty blends are liquid formulations prepared according to protocols similar to that described infra and in Example 1.

All subjects are to consume 30-55 mg of the liquid formulation of each tested blend. Ten puffs are to be taken at 30 sec intervals starting at time=0 and continuing for 4.5 minutes. Blood plasma testing is to occur for at least 60 minutes from the first puff (t=0). Pharmacokinetic data (e.g., C_{max}, T_{max}, AUC) for nicotine in the plasma of users are obtained at various time periods during those 60 minutes, along with rates of nicotine absorption within the first 90 seconds for each test article.

Example 12: Blood Plasma Testing

Blood plasma testing is conducted on twenty-four subjects (n=24). Twenty-one test articles are used in this study: one reference cigarette and twenty blends delivered to a user in an e-cigarette as an aerosol. The reference cigarette is Pall Mall (New Zealand). The operating temperature of the e-cigarette is from about 150° C. to about 250° C., or from about 180° C. to about 220° C. Twenty blends are tested: 2% free base, 1% free base, 2% benzoate, 1% benzoate, 2% sorbate, 1% sorbate, 2% pyruvate, 1% pyruvate, 2% laurate, 1% laurate, 2% levulinate, 1% levulinate, 2% citrate, 1% citrate, 2% malate, 1% malate, 2% salicylate, 1% salicylate, 2% succinate, and 1% succinate. The twenty blends are liquid formulations prepared according to protocols similar to that described infra and in Example 1.

All subjects are to consume 30-55 mg of the liquid formulation of each tested blend. Ten puffs are to be taken at 30 sec intervals starting at time=0 and continuing for 4.5 minutes. Blood plasma testing is to occur for at least 60 minutes from the first puff (t=0). Pharmacokinetic data (e.g., C_{max}, T_{max}, AUC) for nicotine in the plasma of users are obtained at various time periods during those 60 minutes, along with rates of nicotine absorption within the first 90 seconds for each test article.

Further understanding may be gained through contemplation of the numbered embodiments below.

1. A method of delivering nicotine to a user comprising operating an electronic cigarette to a user wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C., and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

2. A method of delivering nicotine to a user comprising operating an electronic cigarette to a user wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C., and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

3. A method of delivering nicotine to a user comprising operating an electronic cigarette wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point, and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

4. A method of delivering nicotine to a user comprising providing an electronic cigarette to a user wherein the electronic cigarette comprises a nicotine salt formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point, and inhaling an aerosol generated from the nicotine salt formulation heated by the electronic cigarette.

5. The method of any one of embodiments 1-3, wherein an operating temperature is from 150° C. to 250° C.

6. The method of any one of embodiments 1-3, wherein an operating temperature is from 180° C. to 220° C.

7. The method any one of embodiments 1-3, wherein an operating temperature is about 200° C.

8. The method of embodiment 4, wherein the operating temperature is from 150° C. to 250° C.

9. The method of embodiment 4, wherein the operating temperature is from 180° C. to 220° C.

10. The method of embodiment 4, wherein the operating temperature is about 200° C.

11. The method any one of embodiments 1-10, wherein the aerosol comprises condensate of the nicotine salt.

12. The method any one of embodiments 1-10, wherein the aerosol comprises condensate of freebase nicotine.

13. The method any one of embodiments 1-10, wherein the aerosol comprises condensate of freebase nicotine and condensate of the carrier.

14. The method any one of embodiments 1-10, wherein the aerosol comprises condensate of freebase nicotine and condensate of the acid.

15. The method any one of embodiments 1-14, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 5 microns.

16. The method any one of embodiments 1-14, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 1 or 2 microns.

17. The method any one of embodiments 1-14, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 0.7 microns.

18. The method any one of embodiments 1-14, wherein the aerosol comprises condensate in particle sizes from about 0.3 microns to about 0.4 microns.

19. The method any one of embodiments 1-18, wherein the acid is a carboxylic acid.

20. The method of any one of embodiments 1-18, wherein the acid used to form said nicotine salt is an organic acid.

21. The method of embodiment 20, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

22. The method of embodiment 20, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

23. The method of any one of embodiments 1-18, wherein the acid used to form the nicotine salt is salicylic acid.

24. The method of any one of embodiments 1-18, wherein the acid used to form the nicotine salt is benzoic acid.

25. The method of any one of embodiments 1-18, wherein the acid used to form the nicotine salt is pyruvic acid.

26. The method of any one of embodiments 1-18, wherein the acid used to form the nicotine salt is sorbic acid.

27. The method of any one of embodiments 1-18, wherein the acid used to form the nicotine salt is lauric acid.

28. The method of any one of embodiments 1-18, wherein the acid used to form the nicotine salt is levulinic acid.

29. The method of any one of embodiments 1-18, wherein said nicotine salt comprises nicotine pyruvate.

30. The method of any one of embodiments 1-18, wherein said nicotine salt comprises nicotine salicylate.

31. The method of any one of embodiments 1-18, wherein said nicotine salt comprises nicotine sorbate.

32. The method of any one of embodiments 1-18, wherein said nicotine salt comprises nicotine laurate.

33. The method of any one of embodiments 1-18, wherein said nicotine salt comprises nicotine levulinate.

34. The method of any one of embodiments 1-18, wherein said nicotine salt comprises nicotine benzoate.

35. The method of any one of embodiments 1-34, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

36. The method of any one of embodiments 1-34, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

37. The method of any one of embodiments 1-34, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

38. The method of any one of embodiments 1-34, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

39. The method of any one of embodiments 1-38, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

40. The method of any one of embodiments 1-38, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

41. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

42. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

43. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

44. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

45. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

46. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

47. The method of any one of embodiments 1-40, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

48. The method of any one of embodiments 1-47, wherein the formulation further comprises a flavorant.

49. The method of any one of embodiments 1-48, wherein the formulation is non-corrosive to an electronic cigarette.

50. The method of any one of embodiments 1-49, wherein the acid is stable at and below operating temperature or about 200° C.

51. The method of any one of embodiments 1-50, wherein the acid does not decompose at and below operating temperature or about 200° C.

52. The method of any one of embodiments 1-51, wherein the acid does not oxidize at and below operating temperature or about 200° C.

53. The method of any one of embodiments 1-52, wherein the formulation is non-corrosive to the electronic cigarette.

54. The method of any one of embodiments 1-53, wherein the formulation is non-toxic to a user of the electronic cigarette.

55. The method of any one of embodiments 1-54, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

56. The method of embodiment 55, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

57. A method of delivering nicotine to the blood of a user, said method comprising providing an aerosol that is inhaled by the user from an electronic cigarette that comprises a nicotine salt formulation wherein providing the aerosol comprises the electronic cigarette heating the formulation thereby generating the aerosol, wherein the aerosol is effective in delivering a level of nicotine in the blood of the user that is at least 5 ng/mL at about 1.5 minutes after a first puff of ten puffs of the aerosol, each puff taken at 30 second intervals.

58. The method of embodiment 54, wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

59. The method of embodiment 54, wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

60. The method of embodiment 54, wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

61. The method of any one of embodiments 57-60, wherein the heating of the formulation is at a temperature from 150° C. to 250° C.

62. The method of any one of embodiments 57-60, wherein the heating of the formulation is at a temperature from 180° C. to 220° C.

63. The method of any one of embodiments 57-60, wherein the heating of the formulation is at a temperature of about 200° C.

64. The method of embodiment 54, wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than the operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point; and the operating temperature is 200° C.

65. The method of any one of embodiments 57-64, wherein the Cmax is over 10 ng/mL on average.

66. The method of any one of embodiments 57-64, wherein the Cmax is over 11 ng/mL on average.

67. The method of any one of embodiments 57-64, wherein the Cmax is between 10 ng/mL and 16 ng/mL on average.

68. The method of any one of embodiments 57-64, wherein the Cmax is between 11 ng/mL and 15 ng/mL on average.

69. The method of any one of embodiments 57-64, wherein the Cmax is between 11 ng/mL and 14 ng/mL on average.

70. The method of any one of embodiments 57-69, wherein the Tmax under 10 minutes on average.

71. The method of any one of embodiments 57-69, wherein the Tmax is under 9 minutes on average.

72. The method of any one of embodiments 57-69, wherein the Tmax is under 8 minutes on average.

73. The method of any one of embodiments 57-69, wherein the Tmax is under 7 minutes on average.

74. The method of any one of embodiments 54-63, wherein the Tmax is from 3 minutes to 10 minutes on average.

75. The method of any one of embodiments 57-69, wherein the Tmax is from 3 minutes to 7.5 minutes on average.

76. The method of any one of embodiments 57-75, wherein the aerosol comprises condensate of the nicotine salt.

77. The method of any one of embodiments 57-75, wherein the aerosol comprises condensate of freebase nicotine.

78. The method of any one of embodiments 57-75, wherein the aerosol comprises condensate of freebase nicotine and condensate of the carrier.

79. The method of any one of embodiments 57-75, wherein the aerosol comprises condensate of freebase nicotine and condensate of the acid.

80. The method of any one of embodiments 57-79, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 5 microns.

81. The method of any one of embodiments 57-79, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 1 or 2 microns.

82. The method of any one of embodiments 57-79, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 0.7 microns.

83. The method of any one of embodiments 57-79, wherein the aerosol comprises condensate in particle sizes from about 0.3 microns to about 0.4 microns.

84. The method of any one of embodiments 57-83, wherein the acid is a carboxylic acid.

85. The method of any one of embodiments 57-83, wherein the acid used to form said nicotine salt is an organic acid.

86. The method of embodiment 85, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

87. The method of embodiment 85, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

88. The method of any one of embodiments 57-83, wherein the acid used to form the nicotine salt is salicylic acid.

89. The method of any one of embodiments 57-83, wherein the acid used to form the nicotine salt is benzoic acid.

90. The method of any one of embodiments 57-83, wherein the acid used to form the nicotine salt is pyruvic acid.

91. The method of any one of embodiments 57-83, wherein the acid used to form the nicotine salt is sorbic acid.

92. The method of any one of embodiments 57-83, wherein the acid used to form the nicotine salt is lauric acid.

93. The method of any one of embodiments 57-83, wherein the acid used to form the nicotine salt is levulinic acid.

94. The method of any one of embodiments 57-83, wherein said nicotine salt comprises nicotine pyruvate.

95. The method of any one of embodiments 57-83, wherein said nicotine salt comprises nicotine salicylate.

96. The method of any one of embodiments 57-83, wherein said nicotine salt comprises nicotine sorbate.

97. The method of any one of embodiments 57-83, wherein said nicotine salt comprises nicotine laurate.

98. The method of any one of embodiments 57-83, wherein said nicotine salt comprises nicotine levulinate.

99. The method of any one of embodiments 57-83, wherein said nicotine salt comprises nicotine benzoate.

100. The method of any one of embodiments 57-99, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

101. The method of any one of embodiments 57-99, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

102. The method of any one of embodiments 57-99, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

103. The method of any one of embodiments 57-99, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

104. The method of any one of embodiments 57-103, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

105. The method of any one of embodiments 57-103, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

106. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

107. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

108. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

109. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

110. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

111. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

112. The method of any one of embodiments 57-105, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

113. The method of any one of embodiments 57-112, wherein the formulation further comprises a flavorant.

114. The method of any one of embodiments 57-113, wherein the formulation is non-corrosive to an electronic cigarette.

115. The method of any one of embodiments 57-114, wherein the acid is stable at and below operating temperature or about 200° C.

116. The method of any one of embodiments 57-115, wherein the acid does not decompose at and below operating temperature or about 200° C.

117. The method of any one of embodiments 57-116, wherein the acid does not oxidize at and below operating temperature or about 200° C.

118. The method of any one of embodiments 57-117, wherein the formulation is non-corrosive to the electronic cigarette.

119. The method of any one of embodiments 57-118, wherein the formulation is non-toxic to a user of the electronic cigarette.

120. The method of any one of embodiments 57-119, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

121. The method of embodiment 120, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

122. A nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

123. A nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

124. A nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

125. A nicotine salt liquid formulation in an electronic cigarette for generating an inhalable aerosol upon heating in the electronic cigarette, the formulation in the cigarette comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

126. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-124, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 150° C. to 250° C.

127. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-124, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 180° C. to 220° C.

128. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-124, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature of about 200° C.

129. The nicotine salt liquid formulation in the electronic cigarette of embodiment 125, wherein the operating temperature is from 150° C. to 250° C.

130. The nicotine salt liquid formulation in the electronic cigarette of embodiment 125, wherein the operating temperature is from 180° C. to 220° C.

131. The nicotine salt liquid formulation in the electronic cigarette of embodiment 125, wherein the operating temperature is about 200° C.

132. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid is a carboxylic acid.

133. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form said nicotine salt is an organic acid.

134. The nicotine salt liquid formulation in the electronic cigarette of embodiment 133, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

135. The nicotine salt liquid formulation in the electronic cigarette of embodiment 133, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

136. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form the nicotine salt is salicylic acid.

137. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form the nicotine salt is benzoic acid.

138. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form the nicotine salt is pyruvic acid.

139. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form the nicotine salt is sorbic acid.

140. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form the nicotine salt is lauric acid.

141. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein the acid used to form the nicotine salt is levulinic acid.

142. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein said nicotine salt comprises nicotine pyruvate.

143. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein said nicotine salt comprises nicotine salicylate.

144. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein said nicotine salt comprises nicotine sorbate.

145. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein said nicotine salt comprises nicotine laurate.

146. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein said nicotine salt comprises nicotine levulinate.

147. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-131, wherein said nicotine salt comprises nicotine benzoate.

148. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-147, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

149. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-147, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

150. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-147, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

151. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-147, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

152. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-151, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

153. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-151, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

154. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

155. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

156. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

157. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

158. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

159. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

160. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-153, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

161. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-160, wherein the formulation further comprises a flavorant.

162. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-161, wherein the formulation is non-corrosive to an electronic cigarette.

163. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-162, wherein the acid is stable at and below operating temperature or about 200° C.

164. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-163, wherein the acid does not decompose at and below operating temperature or about 200° C.

165. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-164, wherein the acid does not oxidize at and below operating temperature or about 200° C.

166. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-165, wherein the formulation is non-corrosive to the electronic cigarette.

167. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-166, wherein the formulation is non-toxic to a user of the electronic cigarette.

168. The nicotine salt liquid formulation in the electronic cigarette of any one of embodiments 122-167 further comprising one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

169. The nicotine salt liquid formulation in the electronic cigarette of embodiment 168, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

170. A nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

171. A nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

172. A nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

173. A nicotine salt liquid formulation for generating an inhalable aerosol upon heating in the electronic cigarette, the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

174. The nicotine salt liquid formulation of any one of embodiments 170-172, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 150° C. to 250° C.

175. The nicotine salt liquid formulation of any one of embodiments 170-172, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 180° C. to 220° C.

176. The nicotine salt liquid formulation of any one of embodiments 170-172, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature of about 200° C.

177. The nicotine salt liquid formulation of embodiment 173, wherein the operating temperature is from 150° C. to 250° C.

178. The nicotine salt liquid formulation of embodiment 173, wherein the operating temperature is from 180° C. to 220° C.

179. The nicotine salt liquid formulation of embodiment 173, wherein the operating temperature is about 200° C.

180. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid is a carboxylic acid.

181. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid used to form said nicotine salt is an organic acid.

182. The nicotine salt liquid formulation of embodiment 181, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

183. The nicotine salt liquid formulation of embodiment 181, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

184. The liquid formulation of any one of embodiments 170-179, wherein the acid used to form the nicotine salt is salicylic acid.

185. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid used to form the nicotine salt is benzoic acid.

186. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid used to form the nicotine salt is pyruvic acid.

187. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid used to form the nicotine salt is sorbic acid.

188. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid used to form the nicotine salt is lauric acid.

189. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein the acid used to form the nicotine salt is levulinic acid.

190. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein said nicotine salt comprises nicotine pyruvate.

191. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein said nicotine salt comprises nicotine salicylate.

192. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein said nicotine salt comprises nicotine sorbate.

193. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein said nicotine salt comprises nicotine laurate.

194. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein said nicotine salt comprises nicotine levulinate.

195. The nicotine salt liquid formulation of any one of embodiments 170-179, wherein said nicotine salt comprises nicotine benzoate.

196. The nicotine salt liquid formulation of any one of embodiments 170-195, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

197. The nicotine salt liquid formulation of any one of embodiments 170-195, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

198. The nicotine salt liquid formulation of any one of embodiments 170-195, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

199. The nicotine salt liquid formulation of any one of embodiments 170-195, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

200. The nicotine salt liquid formulation of any one of embodiments 170-199, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

201. The nicotine salt liquid formulation of any one of embodiments 170-199, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

202. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

203. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

204. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

205. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

206. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

207. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

208. The nicotine salt liquid formulation of any one of embodiments 170-201, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

209. The nicotine salt liquid formulation of any one of embodiments 170-208, wherein the formulation further comprises a flavorant.

210. The nicotine salt liquid formulation of any one of embodiments 170-209, wherein the formulation is non-corrosive to an electronic cigarette.

211. The nicotine salt liquid formulation of any one of embodiments 170-210, wherein the acid is stable at and below operating temperature or about 200° C.

212. The nicotine salt liquid formulation of any one of embodiments 170-211, wherein the acid does not decompose at and below operating temperature or about 200° C.

213. The nicotine salt liquid formulation of any one of embodiments 170-212, wherein the acid does not oxidize at and below operating temperature or about 200° C.

214. The nicotine salt liquid formulation of any one of embodiments 170-213, wherein the formulation is non-corrosive to the electronic cigarette.

215. The nicotine salt liquid formulation of any one of embodiments 170-214, wherein the formulation is non-toxic to a user of the electronic cigarette.

216. The nicotine salt liquid formulation of any one of embodiments 170-215, further comprising one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

217. The nicotine salt liquid formulation of embodiment 216, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

218. A nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

219. A nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

220. A nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

221. A nicotine salt liquid formulation for use in an electronic cigarette the nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

222. The nicotine salt liquid formulation of any one of embodiments 218-220, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 150° C. to 250° C.

223. The nicotine salt liquid formulation of any one of embodiments 218-220, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 180° C. to 220° C.

224. The nicotine salt liquid formulation of any one of embodiments 218-220, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature of about 200° C.

225. The nicotine salt liquid formulation of embodiment 221, wherein the operating temperature is from 150° C. to 250° C.

226. The nicotine salt liquid formulation of embodiment 221, wherein the operating temperature is from 180° C. to 220° C.

227. The nicotine salt liquid formulation of embodiment 221, wherein the operating temperature is about 200° C.

228. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid is a carboxylic acid.

229. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid used to form said nicotine salt is an organic acid.

230. The nicotine salt liquid formulation of embodiment 229, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

231. The nicotine salt liquid formulation of embodiment 229, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

232. The liquid formulation of any one of embodiments 218-227, wherein the acid used to form the nicotine salt is salicylic acid.

233. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid used to form the nicotine salt is benzoic acid.

234. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid used to form the nicotine salt is pyruvic acid.

235. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid used to form the nicotine salt is sorbic acid.

236. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid used to form the nicotine salt is lauric acid.

237. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein the acid used to form the nicotine salt is levulinic acid.

238. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein said nicotine salt comprises nicotine pyruvate.

239. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein said nicotine salt comprises nicotine salicylate.

240. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein said nicotine salt comprises nicotine sorbate.

241. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein said nicotine salt comprises nicotine laurate.

242. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein said nicotine salt comprises nicotine levulinate.

243. The nicotine salt liquid formulation of any one of embodiments 218-227, wherein said nicotine salt comprises nicotine benzoate.

244. The nicotine salt liquid formulation of any one of embodiments 218-243, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

245. The nicotine salt liquid formulation of any one of embodiments 218-243, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

246. The nicotine salt liquid formulation of any one of embodiments 218-243, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

247. The nicotine salt liquid formulation of any one of embodiments 218-243, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

248. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

249. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

250. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

251. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

252. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

253. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

254. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

255. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

256. The nicotine salt liquid formulation of any one of embodiments 218-247, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

257. The nicotine salt liquid formulation of any one of embodiments 218-256, wherein the formulation further comprises a flavorant.

258. The nicotine salt liquid formulation of any one of embodiments 218-257, wherein the formulation is non-corrosive to an electronic cigarette.

259. The nicotine salt liquid formulation of any one of embodiments 218-258, wherein the acid is stable at and below operating temperature or about 200° C.

260. The nicotine salt liquid formulation of any one of embodiments 218-259, wherein the acid does not decompose at and below operating temperature or about 200° C.

261. The nicotine salt liquid formulation of any one of embodiments 218-260, wherein the acid does not oxidize at and below operating temperature or about 200° C.

262. The nicotine salt liquid formulation of any one of embodiments 218-261, wherein the formulation is non-corrosive to the electronic cigarette.

263. The nicotine salt liquid formulation of any one of embodiments 218-262, wherein the formulation is non-toxic to a user of the electronic cigarette.

264. The nicotine salt liquid formulation of any one of embodiments 218-263, further comprising one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

265. The nicotine salt liquid formulation of embodiment 264, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

266. Use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C., and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

267. Use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C., and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

268. Use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point, and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

269. Use of a nicotine salt formulation for delivery of nicotine to the blood of a user from an electronic cigarette, wherein the nicotine salt formulation in the electronic cigarette is heated to form an aerosol which delivers a level of nicotine in the blood of the user that is at least 5 ng/mL at about 1.5 minutes after a first puff of ten puffs of the aerosol, each puff taken at 30 second intervals.

270. Use of a nicotine salt formulation for delivery of nicotine to a user from an electronic cigarette wherein the nicotine salt formulation comprises a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point, and the nicotine salt formulation is heated by the electronic cigarette to generate an aerosol inhalable by the user.

271. The use of any one of embodiments 266-269, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature is from 150° C. to 250° C.

272. The use of any one of embodiments 266-269, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature is from 180° C. to 220° C.

273. The use of any one of embodiments 266-269, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature is about 200° C.

274. The use of embodiment 270, wherein the operating temperature is from 150° C. to 250° C.

275. The use of embodiment 270, wherein the operating temperature is from 180° C. to 220° C.

276. The use of embodiment 270, wherein the operating temperature is about 200° C.

277. The use of any one of embodiments 266-276, wherein the aerosol comprises condensate of the nicotine salt.

278. The use of any one of embodiments 266-276, wherein the aerosol comprises condensate of freebase nicotine.

279. The use of any one of embodiments 266-276, wherein the aerosol comprises condensate of freebase nicotine and condensate of the carrier.

280. The use of any one of embodiments 266-276, wherein the aerosol comprises condensate of freebase nicotine and condensate of the acid.

281. The use of any one of embodiments 266-280, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 5 microns.

282. The use of any one of embodiments 266-280, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 1 or 2 microns.

283. The use of any one of embodiments 266-280, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 0.7 microns.

284. The use of any one of embodiments 266-280, wherein the aerosol comprises condensate in particle sizes from about 0.3 microns to about 0.4 microns.

285. The use of any one of embodiments 266-284, wherein the acid is a carboxylic acid.

286. The use of any one of embodiments 266-284, wherein the acid used to form said nicotine salt is an organic acid.

287. The use of embodiment 286, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

288. The use of embodiment 286, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

289. The use of any one of embodiments 266-284, wherein the acid used to form the nicotine salt is salicylic acid.

290. The use of any one of embodiments 266-284, wherein the acid used to form the nicotine salt is benzoic acid.

291. The use of any one of embodiments 266-284, wherein the acid used to form the nicotine salt is pyruvic acid.

292. The use of any one of embodiments 266-284, wherein the acid used to form the nicotine salt is sorbic acid.

293. The use of any one of embodiments 266-284, wherein the acid used to form the nicotine salt is lauric acid.

294. The use of any one of embodiments 266-284, wherein the acid used to form the nicotine salt is levulinic acid.

295. The use of any one of embodiments 266-284, wherein said nicotine salt comprises nicotine pyruvate.

296. The use of any one of embodiments 266-284, wherein said nicotine salt comprises nicotine salicylate.

297. The use of any one of embodiments 266-284, wherein said nicotine salt comprises nicotine sorbate.

298. The use of any one of embodiments 266-284, wherein said nicotine salt comprises nicotine laurate.

299. The use of any one of embodiments 266-284, wherein said nicotine salt comprises nicotine levulinate.

300. The use of any one of embodiments 266-284, wherein said nicotine salt comprises nicotine benzoate.

301. The use of any one of embodiments 266-300, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

302. The use of any one of embodiments 266-300, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

303. The use of any one of embodiments 266-300, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

304. The use of any one of embodiments 266-300, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

305. The use of any one of embodiments 266-304, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

306. The use of any one of embodiments 266-304, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

307. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

308. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

309. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

310. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

311. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

312. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

313. The use of any one of embodiments 266-306, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

314. The use of any one of embodiments 266-313, wherein the formulation further comprises a flavorant.

315. The use of any one of embodiments 266-314, wherein the formulation is non-corrosive to an electronic cigarette.

316. The use of any one of embodiments 266-315, wherein the acid is stable at and below operating temperature or about 200° C.

317. The use of any one of embodiments 266-316, wherein the acid does not decompose at and below operating temperature or about 200° C.

318. The use of any one of embodiments 266-317, wherein the acid does not oxidize at and below operating temperature or about 200° C.

319. The use of any one of embodiments 266-318, wherein the formulation is non-corrosive to the electronic cigarette.

320. The use of any one of embodiments 266-319, wherein the formulation is non-toxic to a user of the electronic cigarette.

321. The use of any one of embodiments 266-320, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

322. The use of embodiment 321, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid

323. A cartomizer for an electronic cigarette comprising:

a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.;

an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and

a fluid storage compartment that stores the nicotine salt liquid formulation.

324. A cartomizer for an electronic cigarette comprising:

a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.;

an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and

a fluid storage compartment that stores the nicotine salt liquid formulation.

325. A cartomizer for an electronic cigarette comprising:

a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point;

an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and

a fluid storage compartment that stores the nicotine salt liquid formulation.

326. A cartomizer for an electronic cigarette comprising:

a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point;

an atomizer comprising a heating element in fluid communication with the nicotine salt liquid formulation; and

a fluid storage compartment that stores the nicotine salt liquid formulation.

327. The cartomizer of any one of embodiments 323-325, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 150° C. to 250° C.

328. The cartomizer of any one of embodiments 323-325, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 180° C. to 220° C.

329. The cartomizer of any one of embodiments 323-325, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature of about 200° C.

330. The cartomizer of embodiment 326, wherein the operating temperature is from 150° C. to 250° C.

331. The cartomizer of embodiment 326, wherein the operating temperature is from 180° C. to 220° C.

332. The cartomizer of embodiment 326, wherein the operating temperature is about 200° C.

333. The cartomizer of any one of embodiments 323-332, wherein the cartomizer further comprises a mouthpiece.

334. The cartomizer of any one of embodiments 323-333, wherein the acid is a carboxylic acid.

335. The cartomizer of any one of embodiments 323-333, wherein the acid used to form said nicotine salt is an organic acid.

336. The cartomizer of embodiment 335, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

337. The cartomizer of embodiment 335, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

338. The cartomizer of any one of embodiments 323-333, wherein the acid used to form the nicotine salt is salicylic acid.

339. The cartomizer of any one of embodiments 323-333, wherein the acid used to form the nicotine salt is benzoic acid.

340. The cartomizer of any one of embodiments 323-333, wherein the acid used to form the nicotine salt is pyruvic acid.

341. The cartomizer of any one of embodiments 323-333, wherein the acid used to form the nicotine salt is sorbic acid.

342. The cartomizer of any one of embodiments 323-333, wherein the acid used to form the nicotine salt is lauric acid.

343. The cartomizer of any one of embodiments 323-333, wherein the acid used to form the nicotine salt is levulinic acid.

344. The cartomizer of any one of embodiments 323-333, wherein said nicotine salt comprises nicotine pyruvate.

345. The cartomizer of any one of embodiments 323-333, wherein said nicotine salt comprises nicotine salicylate.

346. The cartomizer of any one of embodiments 323-333, wherein said nicotine salt comprises nicotine sorbate.

347. The cartomizer of any one of embodiments 323-333, wherein said nicotine salt comprises nicotine laurate.

348. The cartomizer of any one of embodiments 323-333, wherein said nicotine salt comprises nicotine levulinate.

349. The cartomizer of any one of embodiments 323-333, wherein said nicotine salt comprises nicotine benzoate.

350. The cartomizer of any one of embodiments 323-349, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

351. The cartomizer of any one of embodiments 323-349, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

352. The cartomizer of any one of embodiments 323-349, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

353. The cartomizer of any one of embodiments 323-349, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

354. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

355. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

356. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

357. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

358. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

359. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

360. The cartomizer of any one of embodiments 323-353, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

361. The cartomizer of any one of embodiments 323-360, wherein the electronic cigarette is configured to generate an aerosol inhalable by a user.

362. The cartomizer of embodiment 361, wherein the aerosol comprises condensate of the nicotine salt.

363. The cartomizer of embodiment 361, wherein the aerosol comprises condensate of freebase nicotine.

364. The cartomizer of embodiment 361, wherein the aerosol comprises condensate of freebase nicotine and condensate of the carrier.

365. The cartomizer of embodiment 361, wherein the aerosol comprises condensate of freebase nicotine and condensate of the acid.

366. The cartomizer of any one of embodiments 361-365, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 5 microns.

367. The cartomizer of any one of embodiments 361-365, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 1 or 2 microns.

368. The cartomizer of any one of embodiments 361-365, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 0.7 microns.

369. The cartomizer of any one of embodiments 361-365, wherein the aerosol comprises condensate in particle sizes from about 0.3 microns to about 0.4 microns.

370. The cartomizer of any one of embodiments 361-369, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

371. The cartomizer of any one of embodiments 361-369, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

372. The cartomizer of any one of embodiments 323-371, wherein the formulation further comprises a flavorant.

373. The cartomizer of any one of embodiments 323-372, wherein the formulation is non-corrosive to an electronic cigarette.

374. The cartomizer of any one of embodiments 323-373, wherein the acid is stable at and below operating temperature or about 200° C.

375. The cartomizer of any one of embodiments 323-374, wherein the acid does not decompose at and below operating temperature or about 200° C.

376. The cartomizer of any one of embodiments 323-375, wherein the acid does not oxidize at and below operating temperature or about 200° C.

377. The cartomizer of any one of embodiments 323-376, wherein the formulation is non-corrosive to the electronic cigarette.

378. The cartomizer of any one of embodiments 323-377, wherein the formulation is non-toxic to a user of the electronic cigarette.

379. The cartomizer of any one of embodiments 323-378, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

380. The cartomizer of embodiment 379, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

381. An electronic cigarette for generating an inhalable aerosol comprising

a fluid storage compartment;

a heater; and

a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.;

a battery; and

a mouthpiece.

382. An electronic cigarette for generating an inhalable aerosol comprising

a fluid storage compartment;

a heater; and

a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.;

a battery; and

a mouthpiece.

383. An electronic cigarette for generating an inhalable aerosol comprising

a fluid storage compartment;

a heater; and

a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point;

a battery; and

a mouthpiece.

384. An electronic cigarette for generating an inhalable aerosol comprising

a fluid storage compartment;

a heater; and

a nicotine salt liquid formulation in the fluid storage compartment, the liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point;

a battery; and

a mouthpiece.

385. The electronic cigarette of any one of embodiments 381-384, wherein the heater comprises a heater chamber, a fluid wick, and a resistive heating element in contact with the fluid wick.

386. The electronic cigarette of any one of embodiments 381-384, wherein the mouthpiece, the heater and the fluid storage compartment form a cartomizer separable from the battery.

387. The electronic cigarette of any one of embodiments 381-384, wherein the heater and the fluid storage compartment form a cartomizer separable from the battery and the mouthpiece.

388. The electronic cigarette of any one of embodiments 381-384, wherein the fluid storage compartment is separable from the heater, the battery and the mouthpiece.

389. The electronic cigarette of any one of embodiments 381-383, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 150° C. to 250° C.

390. The electronic cigarette of any one of embodiments 381-383, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature from 180° C. to 220° C.

391. The electronic cigarette of any one of embodiments 381-383, wherein the electronic cigarette heats the nicotine salt formulation to an operating temperature of about 200° C.

392. The electronic cigarette of embodiment 384, wherein the operating temperature is from 150° C. to 250° C.

393. The electronic cigarette of embodiment 384, wherein the operating temperature is from 180° C. to 220° C.

394. The electronic cigarette of embodiment 384, wherein the operating temperature is about 200° C.

395. The electronic cigarette of any one of embodiments 381-394, wherein the aerosol comprises condensate of the nicotine salt.

396. The electronic cigarette of any one of embodiments 381-394, wherein the aerosol comprises condensate of free-base nicotine.

397. The electronic cigarette of any one of embodiments 381-394, wherein the aerosol comprises condensate of free-base nicotine and condensate of the carrier.

398. The electronic cigarette of any one of embodiments 381-394, wherein the aerosol comprises condensate of free-base nicotine and condensate of the acid.

399. The electronic cigarette of any one of embodiments 381-398, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 5 microns.

400. The electronic cigarette of any one of embodiments 381-398, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 1 or 2 microns.

401. The electronic cigarette of any one of embodiments 381-398, wherein the aerosol comprises condensate in particle sizes from about 0.1 microns to about 0.7 microns.

402. The electronic cigarette of any one of embodiments 381-398, wherein the aerosol comprises condensate in particle sizes from about 0.3 microns to about 0.4 microns.

403. The electronic cigarette of any one of embodiments 381-402, wherein the acid is a carboxylic acid.

404. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form said nicotine salt is an organic acid.

405. The electronic cigarette of embodiment 404, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

406. The electronic cigarette of embodiment 404, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

407. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form the nicotine salt is salicylic acid.

408. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form the nicotine salt is benzoic acid.

409. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form the nicotine salt is pyruvic acid.

410. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form the nicotine salt is sorbic acid.

411. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form the nicotine salt is lauric acid.

412. The electronic cigarette of any one of embodiments 381-402, wherein the acid used to form the nicotine salt is levulinic acid.

413. The electronic cigarette of any one of embodiments 381-402, wherein said nicotine salt comprises nicotine pyruvate.

414. The electronic cigarette of any one of embodiments 381-402, wherein said nicotine salt comprises nicotine salicylate.

415. The electronic cigarette of any one of embodiments 381-402, wherein said nicotine salt comprises nicotine sorbate.

416. The electronic cigarette of any one of embodiments 381-402, wherein said nicotine salt comprises nicotine laurate.

417. The electronic cigarette of any one of embodiments 381-402, wherein said nicotine salt comprises nicotine levulinate.

418. The electronic cigarette of any one of embodiments 381-402, wherein said nicotine salt comprises nicotine benzoate.

419. The electronic cigarette of any one of embodiments 381-419, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

420. The electronic cigarette of any one of embodiments 381-419, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

421. The electronic cigarette of any one of embodiments 381-419, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

422. The electronic cigarette of any one of embodiments 381-419, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

423. The electronic cigarette of any one of embodiments 381-422, wherein the nicotine salt is in an amount that forms about 0.5% to about 20% nicotine in the inhalable aerosol.

424. The electronic cigarette of any one of embodiments 381-422, wherein the nicotine salt is in an amount that forms about 1% to about 20% nicotine in the inhalable aerosol.

425. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

426. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

427. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

428. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

429. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

430. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

431. The electronic cigarette of any one of embodiments 381-424, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

432. The electronic cigarette of any one of embodiments 381-431, wherein the formulation further comprises a flavorant.

433. The electronic cigarette of any one of embodiments 381-432, wherein the formulation is non-corrosive to an electronic cigarette.

434. The electronic cigarette of any one of embodiments 381-433, wherein the acid is stable at and below operating temperature or about 200° C.

435. The electronic cigarette of any one of embodiments 381-434, wherein the acid does not decompose at and below operating temperature or about 200° C.

436. The electronic cigarette of any one of embodiments 381-435, wherein the acid does not oxidize at and below operating temperature or about 200° C.

437. The electronic cigarette of any one of embodiments 381-436, wherein the formulation is non-corrosive to the electronic cigarette.

438. The electronic cigarette of any one of embodiments 381-437, wherein the formulation is non-toxic to a user of the electronic cigarette.

439. The electronic cigarette of any one of embodiments 381-438, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

440. The electronic cigarette of embodiment 439, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

441. A cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

442. A cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

443. A cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

444. A cartridge in an electronic cigarette comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

445. The cartridge of any one of embodiments 441-444, wherein the cartridge is separable from the electronic cigarette.

446. The cartridge of any one of embodiments 441-445, wherein the acid is a carboxylic acid.

447. The cartridge of any one of embodiments 441-445, wherein the acid used to form said nicotine salt is an organic acid.

448. The cartridge of embodiment 447, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

449. The cartridge of embodiment 447, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

450. The cartridge of any one of embodiments 441-445, wherein the acid used to form the nicotine salt is salicylic acid.

451. The cartridge of any one of embodiments 441-445, wherein the acid used to form the nicotine salt is benzoic acid.

452. The cartridge of any one of embodiments 441-445, wherein the acid used to form the nicotine salt is pyruvic acid.

453. The cartridge of any one of embodiments 441-445, wherein the acid used to form the nicotine salt is sorbic acid.

454. The cartridge of any one of embodiments 441-445, wherein the acid used to form the nicotine salt is lauric acid.

455. The cartridge of any one of embodiments 441-445, wherein the acid used to form the nicotine salt is levulinic acid.

456. The cartridge of any one of embodiments 441-445, wherein said nicotine salt comprises nicotine pyruvate.

457. The cartridge of any one of embodiments 441-445, wherein said nicotine salt comprises nicotine salicylate.

458. The cartridge of any one of embodiments 441-445, wherein said nicotine salt comprises nicotine sorbate.

459. The cartridge of any one of embodiments 441-445, wherein said nicotine salt comprises nicotine laurate.

460. The cartridge of any one of embodiments 441-445, wherein said nicotine salt comprises nicotine levulinate.

461. The cartridge of any one of embodiments 441-445, wherein said nicotine salt comprises nicotine benzoate.

462. The cartridge of any one of embodiments 441-461, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

463. The cartridge of any one of embodiments 441-461, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

464. The cartridge of any one of embodiments 441-461, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

465. The cartridge of any one of embodiments 441-461, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

466. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

467. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

468. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

469. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

470. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

471. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

472. The cartridge of any one of embodiments 441-465, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

473. The cartridge of any one of embodiments 441-472, wherein the formulation further comprises a flavorant.

474. The cartridge of any one of embodiments 441-473, wherein the formulation is non-corrosive to an electronic cigarette.

475. The cartridge of any one of embodiments 441-474, wherein the acid is stable at and below operating temperature or about 200° C.

476. The cartridge of any one of embodiments 441-475, wherein the acid does not decompose at and below operating temperature or about 200° C.

477. The cartridge of any one of embodiments 441-476, wherein the acid does not oxidize at and below operating temperature or about 200° C.

478. The cartridge of any one of embodiments 441-477, wherein the formulation is non-corrosive to the electronic cigarette.

479. The cartridge of any one of embodiments 441-478, wherein the formulation is non-toxic to a user of the electronic cigarette.

480. The cartridge of any one of embodiments 441-479, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

481. The cartridge of embodiment 480, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

482. A kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

483. A kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

484. A kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

485. A kit comprising:

(a) an electronic cigarette for generating an inhalable aerosol comprising
  i. a device body comprising a cartridge receptacle;
  ii. a cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point;
  iii. a heater;
  iv. a battery; and
  v. a mouthpiece; and
(b) instructions for using the electronic cigarette to generate an inhalable aerosol.

486. The kit of any one of embodiments 482-485, wherein the acid is a carboxylic acid.

487. The kit of any one of embodiments 482-485, wherein the acid used to form said nicotine salt is an organic acid.

488. The kit of embodiment 487, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

489. The kit of embodiment 487, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

490. The kit of any one of embodiments 482-485, wherein the acid used to form the nicotine salt is salicylic acid.

491. The kit of any one of embodiments 482-485, wherein the acid used to form the nicotine salt is benzoic acid.

492. The kit of any one of embodiments 482-485, wherein the acid used to form the nicotine salt is pyruvic acid.

493. The kit of any one of embodiments 482-485, wherein the acid used to form the nicotine salt is sorbic acid.

494. The kit of any one of embodiments 482-485, wherein the acid used to form the nicotine salt is lauric acid.

495. The kit of any one of embodiments 482-485, wherein the acid used to form the nicotine salt is levulinic acid.

496. The kit of any one of embodiments 482-485, wherein said nicotine salt comprises nicotine pyruvate.

497. The kit of any one of embodiments 482-485, wherein said nicotine salt comprises nicotine salicylate.

498. The kit of any one of embodiments 482-485, wherein said nicotine salt comprises nicotine sorbate.

499. The kit of any one of embodiments 482-485, wherein said nicotine salt comprises nicotine laurate.

500. The kit of any one of embodiments 482-485, wherein said nicotine salt comprises nicotine levulinate.

501. The kit of any one of embodiments 482-485, wherein said nicotine salt comprises nicotine benzoate.

502. The kit of any one of embodiments 482-501, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

503. The kit of any one of embodiments 482-501, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

504. The kit of any one of embodiments 482-501, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

505. The kit of any one of embodiments 482-501, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

506. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

507. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

508. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

509. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

510. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

511. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

512. The kit of any one of embodiments 482-505, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

513. The kit of any one of embodiments 482-512, wherein the formulation further comprises a flavorant.

514. The kit of any one of embodiments 482-513, wherein the formulation is non-corrosive to an electronic cigarette.

515. The kit of any one of embodiments 482-514, wherein the acid is stable at and below operating temperature or about 200° C.

516. The kit of any one of embodiments 482-515, wherein the acid does not decompose at and below operating temperature or about 200° C.

517. The kit of any one of embodiments 482-516, wherein the acid does not oxidize at and below operating temperature or about 200° C.

518. The kit of any one of embodiments 482-517, wherein the formulation is non-corrosive to the electronic cigarette.

519. The kit of any one of embodiments 482-518, wherein the formulation is non-toxic to a user of the electronic cigarette.

520. The kit of any one of embodiments 482-519, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

521. The kit of embodiment 520, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

522. A cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure >20 mmHg at 200° C.

523. A cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is characterized by vapor pressure of about 20 to 200 mmHg at 200° C.

524. A cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point <160° C., a boiling point >160° C., and at least a 50-degree difference between the melting point and the boiling point.

525. A cartridge comprising a fluid storage compartment, wherein the fluid storage compartment stores a nicotine salt liquid formulation comprising a nicotine salt in a biologically acceptable liquid carrier wherein an acid used to form said nicotine salt is further characterized by a melting point at least 40 degrees lower than an operating temperature of the electronic cigarette, a boiling point no more than 40 degrees lower than the operating temperature of the electronic cigarette, and at least a 50-degree difference between the melting point and the boiling point.

526. The cartridge of any one of embodiments 523-526, wherein the cartridge can be connected to an electronic cigarette.

527. The cartridge of any one of embodiments 523-527, wherein the acid is a carboxylic acid.

528. The cartridge of any one of embodiments 523-527, wherein the acid used to form said nicotine salt is an organic acid.

529. The cartridge of embodiment 529, wherein the organic acid is monocarboxylic acid, aromatic acid, or keto acid.

530. The cartridge of embodiment 529, wherein the organic acid is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, caprylic acid, capric acid, citric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, phenylacetic acid, benzoic acid, pyruvic acid, levulinic acid, tartaric acid, lactic acid, malonic acid, succinic acid, fumaric acid, finnaric acid, gluconic acid, saccharic acid, salicylic acid, sorbic acid, malonic acid, or malic acid.

531. The cartridge of any one of embodiments 523-527, wherein the acid used to form the nicotine salt is salicylic acid.

532. The cartridge of any one of embodiments 523-527, wherein the acid used to form the nicotine salt is benzoic acid.

533. The cartridge of any one of embodiments 523-527, wherein the acid used to form the nicotine salt is pyruvic acid.

534. The cartridge of any one of embodiments 523-527, wherein the acid used to form the nicotine salt is sorbic acid.

535. The cartridge of any one of embodiments 523-527, wherein the acid used to form the nicotine salt is lauric acid.

536. The cartridge of any one of embodiments 523-527, wherein the acid used to form the nicotine salt is levulinic acid.

537. The cartridge of any one of embodiments 523-527, wherein said nicotine salt comprises nicotine pyruvate.

538. The cartridge of any one of embodiments 523-527, wherein said nicotine salt comprises nicotine salicylate.

539. The cartridge of any one of embodiments 523-527, wherein said nicotine salt comprises nicotine sorbate.

540. The cartridge of any one of embodiments 523-527, wherein said nicotine salt comprises nicotine laurate.

541. The cartridge of any one of embodiments 523-527, wherein said nicotine salt comprises nicotine levulinate.

542. The cartridge of any one of embodiments 523-527, wherein said nicotine salt comprises nicotine benzoate.

543. The cartridge of any one of embodiments 523-543, wherein the liquid carrier comprises glycerol, propylene glycol, trimethylene glycol, water, ethanol or combinations thereof.

544. The cartridge of any one of embodiments 523-543, wherein the liquid carrier comprises propylene glycol and vegetable glycerin.

545. The cartridge of any one of embodiments 523-543, wherein the liquid carrier comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.

546. The cartridge of any one of embodiments 523-543, wherein the liquid carrier comprises 30% propylene glycol and 70% vegetable glycerin.

547. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 25% (w/w).

548. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 20% (w/w).

549. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 18% (w/w).

550. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 1% (w/w) to about 15% (w/w).

551. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 4% (w/w) to about 12% (w/w).

552. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 4% (w/w).

553. The cartridge of any one of embodiments 523-547, wherein the liquid formulation has a nicotine concentration of about 2% (w/w).

554. The cartridge of any one of embodiments 523-553, wherein the formulation further comprises a flavorant.

555. The cartridge of any one of embodiments 523-554, wherein the formulation is non-corrosive to an electronic cigarette.

556. The cartridge of any one of embodiments 523-555, wherein the acid is stable at and below operating temperature or about 200° C.

557. The cartridge of any one of embodiments 523-556, wherein the acid does not decompose at and below operating temperature or about 200° C.

558. The cartridge of any one of embodiments 523-557, wherein the acid does not oxidize at and below operating temperature or about 200° C.

559. The cartridge of any one of embodiments 523-558, wherein the formulation is non-corrosive to the electronic cigarette.

560. The cartridge of any one of embodiments 523-559, wherein the formulation is non-toxic to a user of the electronic cigarette.

561. The cartridge of any one of embodiments 523-560, wherein the formulation further comprises one or more additional nicotine salts in a biologically acceptable liquid carrier suitable for generating the inhalable aerosol upon heating.

562. The cartridge of embodiment 561, wherein a second acid used to form the additional nicotine salt is selected from the group consisting of salicylic acid, sorbic acid, benzoic acid, pyruvic acid, lauric acid, and levulinic acid.

Although preferred embodiments of the present invention have been shown and described herein, it will be obvious to those skilled in the art that such embodiments are provided by way of example only. Numerous variations, changes, and substitutions will now occur to those skilled in the art without departing from the invention. It should be understood that various alternatives to the embodiments of the invention described herein can be employed in practicing the invention. It is intended that the following embodiments define the scope of the invention and that methods and structures within the scope of these embodiments and their equivalents be covered thereby.

What is claimed is:

1. An electronic cigarette comprising a cartridge, wherein the cartridge comprises a nicotine salt liquid formulation, wherein:

(a) the nicotine salt liquid formulation comprises a salt of nicotine and an organic acid in a liquid carrier, wherein the organic acid is benzoic acid or lactic acid;

(b) the salt is present in an amount that forms a nicotine concentration of 0.5% (w/w) to 20% (w/w) in the nicotine salt liquid formulation;

(c) the liquid carrier comprises glycerol and propylene glycol; and

(d) the nicotine salt liquid formulation generates an inhalable aerosol upon heating in the electronic cigarette.

2. The electronic cigarette of claim **1**, wherein the liquid carrier further comprises water.

3. The electronic cigarette of claim **1**, wherein the salt is present in an amount that forms a nicotine concentration of 1% (w/w) to 18% (w/w) in the nicotine salt liquid formulation.

4. The electronic cigarette of claim **1**, wherein the salt is present in an amount that forms a nicotine concentration of 3% (w/w) to 15% (w/w) in the nicotine salt liquid formulation.

5. The electronic cigarette of claim **1**, wherein the salt is present in an amount that forms a nicotine concentration of 4% (w/w) to 12% (w/w) in the nicotine salt liquid formulation.

6. The electronic cigarette of claim **1**, wherein the nicotine salt liquid formulation further comprises a flavorant.

7. The electronic cigarette of claim **1**, wherein the nicotine salt liquid formulation further comprises one or more additional organic acids.

8. The electronic cigarette of claim **1**, wherein the cartridge is configured to serve as a mouthpiece and a reservoir, wherein the reservoir holds the nicotine salt liquid formulation.

9. The electronic cigarette of claim **1**, wherein the organic acid is benzoic acid.

10. The electronic cigarette of claim **1**, wherein the organic acid is lactic acid.

11. A method of providing nicotine to a user, the method comprising:
(a) heating a nicotine salt liquid formulation in an electronic cigarette to produce an inhalable aerosol, and
(b) inhalation of the aerosol by the user;
wherein:
(i) the nicotine salt liquid formulation comprises a salt of nicotine and benzoic acid in a liquid carrier;
(ii) the salt is present in an amount that forms a nicotine concentration of 0.5% (w/w) to 20% (w/w) in the nicotine salt liquid formulation; and
(iii) the liquid carrier comprises glycerol and propylene glycol.

12. The method of claim **11**, wherein the liquid carrier further comprises water.

13. The method of claim **11**, wherein the salt is present in an amount that forms a nicotine concentration of 1% (w/w) to 20% (w/w) in the nicotine salt liquid formulation.

14. The method of claim **11**, wherein the salt is present in an amount that forms a nicotine concentration of 1% (w/w) to 18% (w/w) in the nicotine salt liquid formulation.

15. The method of claim **11**, wherein the salt is present in an amount that forms a nicotine concentration of 3% (w/w) to 15% (w/w) in the nicotine salt liquid formulation.

16. The method of claim **11**, wherein the salt is present in an amount that forms a nicotine concentration of 4% (w/w) to 12% (w/w) in the nicotine salt liquid formulation.

17. The method of claim **11**, wherein the nicotine salt liquid formulation further comprises a flavorant.

18. The method of claim **11**, wherein the nicotine salt liquid formulation further comprises one or more additional organic acids.

19. The method of claim **11**, wherein the electronic cigarette comprises a cartridge, and the cartridge is configured to serve as a mouthpiece and a reservoir, wherein the reservoir holds the nicotine salt liquid formulation.

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