

COMPARISON OF NICOTINE EMISSIONS RATE, “NICOTINE FLUX”, FROM HEATED, ELECTRONIC, AND COMBUSTIBLE TOBACCO PRODUCTS: DATA, TRENDS, AND RECOMMENDATIONS FOR REGULATION

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SUPPLEMENTAL MATERIAL

Table S1. Summary of the nicotine yield and flux of various tobacco products and the corresponding puffing topography parameters.

* Average puff number under ISO smoking regime was used.

<i>Tobacco Product</i>	<i>Brand</i>	<i>Puff Number</i>	<i>Puff duration (s)</i>	<i>Nicotine Yield (mg/unit)</i>	<i>Nicotine Flux (µg/s)</i>	<i>Reference</i>	<i>Year of Publication</i>
Cigarettes	Maintained nicotine cigarette	15	2	2.7	90.0	[1]	1988
	Middle tar cigarette	15	2	2.9	96.7		
	Low tar cigarette	14	2.5	1.8	51.4		
	Regular-yield brands (9-15 mg ISO tar)	11.5	1.4	2	124.2	[2]	2006
	Matinee extra mild (4 mg ISO tar)	13.4	1.6	1.5	70.0		
	Own brand (female smokers)	13.5	1.33	1.92	106.9	[3]	2007
	Own brand (male smokers)	12	1.48	2.2	123.9		
	Kent (non-menthol cigarette)	14.4	1.17	0.9	53.4	[4]	2017
	Benson & Hedges Light (menthol cigarette)	15.1	1.23	1.05	56.5		
	Marlboro red	12.2	1.68	2.54	123.9	[5]	2020
	Lucky Strike	10.7	1.8	1.3	67.5	[6]	2018
	Lucky Strike Menthol	10	2	1.3	65.0		
	Lucky Strike	16.6	1.6	1.5	56.5	[7]	2020
	Low-yield cigarettes (<=0.8 mg of nicotine/cigarette)	12.7	1.5	1.7	89.2	[8]	2000
	Medium-yield cigarettes (0.9–1.2 mg of nicotine/cigarette)	12.1	1.5	2.39	131.7		
	2R4F	9.5	2	0.829	43.6	[9]	2014
	1R6F	8.0	2	0.73	45.6	[10]	2018
	1R6F	8.4	2	2.34	139.3		
	3R4F	9.0	2	0.74	41.1		
	3R4F	10.7	2	2.38	111.2		
	Regular-yield brands (9-15 mg ISO tar)	9	2	1.1	61.1	[2]	2006
		12.1	2	2.4	99.2		
	Low-yield cigarettes (<=0.8 mg of nicotine/cigarette)	9	2	0.7	38.9	[8]	2000
Medium-yield cigarettes (0.9–1.2 mg of nicotine/cigarette)	9	2	1.11	61.7			
Marlboro Ultra Smooth	7.2	2	0.42	29.2	[11]	2006	
	6.9	2	1.09	79.0			
Marlboro Regular	12	2	1.99	82.9	[12]	2018	
VLNC	VLN King	9*	2	0.03	1.7	[13]	2019
Roll Your Own Cigarettes	Average of 13 brands	12.4	2	1.3	52.4	[14]	1985
	Average of 11 brands	9.42	2	1.90	100.8	[15]	2014
	Average of 517 cigarettes made by 26 regular users	12.3	2	1.30	52.8	[16]	1998
Tobacco Heating Products	glo with Bright Tobacco Kent Neostiks	11.6	1.8	0.3	14.4	[6]	2018
	glo with mentholated Intensely Fresh Kent Neostiks	10	1.8	0.3	16.7		
	iQOS with Essence tobacco HeatStick	10.55	1.8	0.9	47.4		
	glo with Bright Tobacco Kent Neostiks	15.4	1.6	0.34	13.8	[7]	2020
	iQOS with Essence tobacco HeatStick	15	1.4	0.98	46.7		

	carbon-based Eclipse	25	2	2.36	47.2	[17]	2019
	Glo with Bright Tobacco Kent Neostiks	8	2	0.462	28.9	[18]	2018
	Glo with mentholated Intensely Fresh Kent Neostiks	8	2	0.365	22.8		
	Unspecified Heat not Burn Device	12	2	1.4	58.3	[12]	2018
	Unspecified Heat not Burn Device with Mentholated flavor	12	2	1.38	57.5		
	Unspecified Heat not Burn Device	12	4	1.41	29.4		
	Unspecified Heat not Burn Device with Mentholated flavor	12	4	1.43	29.8		
	Carbon-based Eclipse	12	2	0.14	5.8	[17]	2019
Carbon-based Eclipse	18.3	2	0.56	15.3			
Electronic Nicotine Delivery Systems	<i>Volish, eGo-3 (nicotine concentration 18 mg/ml; liquid composition: Propylene glycol, nicotine, vanillin, linalool, flavorings)</i>	15	2.8	1.06	25.2	[19]	2015
	<i>Volish, eGo-3 (nicotine concentration 18 mg/ml; liquid composition: Propylene glycol, glycerin, nicotine, ethanol, flavorings)</i>	15	2.8	1.15	27.4		
	<i>Volish, eGo-3 (nicotine concentration 24 mg/ml; liquid composition: Glycerin, nicotine, propylene glycol, linalool, vanillin, flavorings)</i>	15	2.8	1.05	25.0		
	<i>Volish, eGo-3 (nicotine concentration 22 mg/ml; liquid composition: Glycerin, propylene glycol, nicotine, flavorings)</i>	15	2.8	1.43	34.0		
	<i>Volish, eGo-3 (nicotine concentration 12 mg/ml; liquid composition: Glycerin, propylene glycol, nicotine, flavorings)</i>	15	2.8	0.88	21.0		
	<i>Volish, eGo-3 (nicotine concentration 16 mg/ml; liquid composition: Glycerin, propylene glycol, nicotine, flavorings)</i>	15	2.8	1.02	24.3		
	<i>Volish, eGo-3 (nicotine concentration 25 mg/ml; liquid composition: Glycerin, propylene glycol, nicotine, ethanol, flavorings)</i>	15	2.8	1.36	32.4		
	<i>Volish, eGo-3 (nicotine concentration 28 mg/ml; liquid composition: Glycerin, propylene glycol, nicotine, ethanol, malic acid, flavorings)</i>	15	2.8	1.49	35.5		
	<i>Volish, eGo-3 (nicotine concentration 11 mg/ml; liquid composition: Glycerin, nicotine, menthol, vanillin, aromatic oils, vanilla)</i>	15	2.8	0.77	18.3		
	<i>Blu Cigs (Tobacco-flavored cartomizers with nicotine concentration of 16 mg/ml)</i>	33	2.75	1.2	13.2	[20]	2015
	<i>V2 Cigs (Tobacco-flavored cartomizers with nicotine concentration of 18 mg/ml)</i>	31	2.54	1.4	17.8		
	<i>Lab Assembled ECIG 6 W (E-liquid concentration range 6-18 mg/ml)</i>	57	4.6	3.5	13.3	[21]	2018
	<i>Lab Assembled ECIG 10 W (E-liquid concentration range 6-18 mg/ml)</i>	46	3.8	4.2	24.0		
	<i>KangerTech Mini ProTank with own flavor (E-liquid nicotine concentration range 1.6-16.7 mg/ml and PG/VG ratio range of 69/31-5/95)</i>	106	4.3	3.4	7.5	[22]	2018
	<i>KangerTech Mini ProTank with strawberry flavored e-liquid (E-liquid nicotine concentration 19.9 mg/ml and PG/VG ratio of 40/60)</i>	73	3.2	5.4	23.1		
	<i>KangerTech Mini ProTank with Tobacco flavored e-liquid (E-liquid nicotine concentration 19.3 mg/ml and PG/VG ratio of 44/56)</i>	69	2.8	4.1	21.2		
	<i>Vype with 'Twilight Tobacco' flavored e-liquid (E-liquid nicotine concentration 5 mg/ml and PG/VG ratio of 40/60)</i>	61.1	1.45	0.75	8.5	[7]	2020
	Vapour 2 cigs (E-liquid nicotine concentration 20 mg/ml and PG/VG ratio of 50/50)	12	2	0.46	19.2	[12]	2018
		12	4	0.86	17.9		
	eGo style, Epsilon (E-liquid nicotine concentration 20 mg/ml and PG/VG ratio of 50/50)	12	2	0.51	21.3		
	12	4	1.73	36.0			

	EVIC VTC Mini battery with Nautilus Mini atomizer (E-liquid nicotine concentration 20 mg/ml and PG/VG ratio of 50/50)	12	2	0.82	34.2			
		12	4	1.84	38.3			
Electronic Nicotine Delivery Systems	Vype Disposable Regular	1	3	0.04	13.3	[17]	2019	
		1	5	0.06	12.0			
	Intellicig XL	1	3	0.03	10.0	[23]	2015	
		1	5	0.07	14.0			
	V4L CoolCart cartomizers (8.53 mg/ml nicotine concentration)		2	15	0.11			3.7
			4	15	0.30			5.0
			4	15	0.29			4.8
			8	15	0.72			6.0
			8	15	0.68			5.7
			2	15	0.64			21.3
			4	15	1.18			19.7
			4	15	1.50			25.0
		8	15	3.23	26.9			
		8	15	3.09	25.8			
	V4L CoolCart cartomizers (15.73 mg/ml nicotine concentration)	4	15	0.48	8.0	[23]	2015	
		8	15	4.7	39.2			
	JUUL US - Tobacco flavor (65 mg/ml nicotine concentration)	15	4	1.3	21.7	[24]	2020	
	JUUL UK - Tobacco flavor (19 mg/ml nicotine concentration)	15	4	0.4	6.7			
	JUUL US - Tobacco flavor (69 mg/ml nicotine concentration)	15	4	2.07	34.5	[25]	2019	
	JUUL US - Tobacco flavor	1	2.5	0.157	62.8	[26]	2019	
JUUL US – Crème brulee flavor	1	2.5	0.170	68.0				
JUUL US – Fruit punch flavor	1	2.5	0.154	61.6				
JUUL US - Mint flavor	1	2.5	0.188	75.2				
JUUL US – Tobacco flavor (69.8 mg/ml nicotine concentration)	15	4	1.67	27.8	[27]	2021		
Ezzy Oval – Berry Cool flavor (53.8 mg/m nicotine concentration)	15	4	4.07	67.8				
Ezzy Oval – Mango Lychee flavor (75.4 mg/m nicotine concentration)	15	4	5.44	90.7				
Hyde – Cherry lemonade flavor (86.9 mg/m nicotine concentration)	15	4	3.15	52.5				
Puff Bar – Banana ice flavor (83.4 mg/m nicotine concentration)	15	4	6.72	112.0				
SEA – Mint flavor (54.3 mg/m nicotine concentration)	15	4	1.67	27.8				
Waterpipes	-	77.7	3.6	1.6	5.8	[28]	2016	
	-	290	2.9	5	5.9	[29]	2018	
	-	220	2.8	4.8	7.8	[30]	2010	
	-	105	2.6	5.4	19.8	[31]	2019	
	-	171	2.6	2.96	6.7	[32]	2005	
	-	100	3.0	2.25	7.5	[33]	2003	
	-	171	2.6	6.06	13.6	[34]	2008	
	-	171	2.6	7.75	17.4	[35]	2011	
Cigarillos	<i>Black & Mild</i>	23.1	2.8	2.3	35.6	[36]	2018	
	<i>Winchester</i>	9.8	2	1.8	91.8	[36]	2018	
Small Cigars	Average values of 8 commercially available small cigars in the US	16.6	2	1.24	37.3	[10]	2018	
		16.5	2	3.49	105.8			

	Little cigars with cigar wrapper (average of 5 brands)	8.5	2	1.60	94.1	[37]	1976
	Little cigars with paper wrapper (average of 5 brands)	9.4	2	1.60	85.1		
	Average of 10 brands	14.4	2	2.1	72.9	[14]	1985
Large Cigars	Average of 5 brands	70.3	1.5	2.4	22.8	[37]	1976
	Average of 6 brands	108	1.5	1.9	11.7	[14]	1985
Kretek	Sampoerna	12.6	2	0.74	29.4	[9]	2014
	Garam	17.3	2	1.78	51.4		
	Kretek-R	14.4	2	1.72	59.7		
Bidi	Average of 21 brands	21	2	2.70	64.3	[38]	2003
	Average of 24 brands	17	2	1.86	54.7	[39]	1998
Nicotine Patch	NiQuitin Clear 7 mg	-	24 hrs	7	0.08	[40]	2019
	NiQuitin Clear 14 mg		24 hrs	14	0.16		
	NiQuitin Clear 21 mg		24 hrs	21	0.24		
Nicotine Gum	Zonnic 2mg	-	30 min	2	1.11	[41, 42]	2018/2020

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