

PUFF BY PUFF TAR, NICOTINE AND CARBONYL PUFF PROFILES UNDER DIFFERENT SMOKING REGIMENS OF COMMERCIAL CIGARETTES WITH VARIOUS CARBON FILTER TECHNOLOGIES

R.M. Robertson, K. R. Norfleet, W. B. Canterbury



Introduction

Puff by puff smoke analysis has shown that the CelFX™ carbon filter technology has similar nicotine and tar smoke delivery profiles as mono-acetate filtered cigarettes. However, carbonyls are significantly reduced by the CelFX™ technology, particularly in the first 6 puffs, as compared to a cellulose acetate filter.

This work investigates the differences in puff-by-puff results between various commercial cigarettes containing different filter configurations including the novel CelFX® carbon filter, carbon-on-tow filters and cellulose acetate filters. Evaluations were conducted using both Health Canada Intense smoking protocol and the ISO 3308 smoking protocol. Prior work presented in 2015 used 3R4F cigarettes hand assembled with different filters but with no ventilation. This study seeks to assess performance in commercial products as originally designed. All cigarettes are American blend but significant differences in the tobacco columns do still exist.

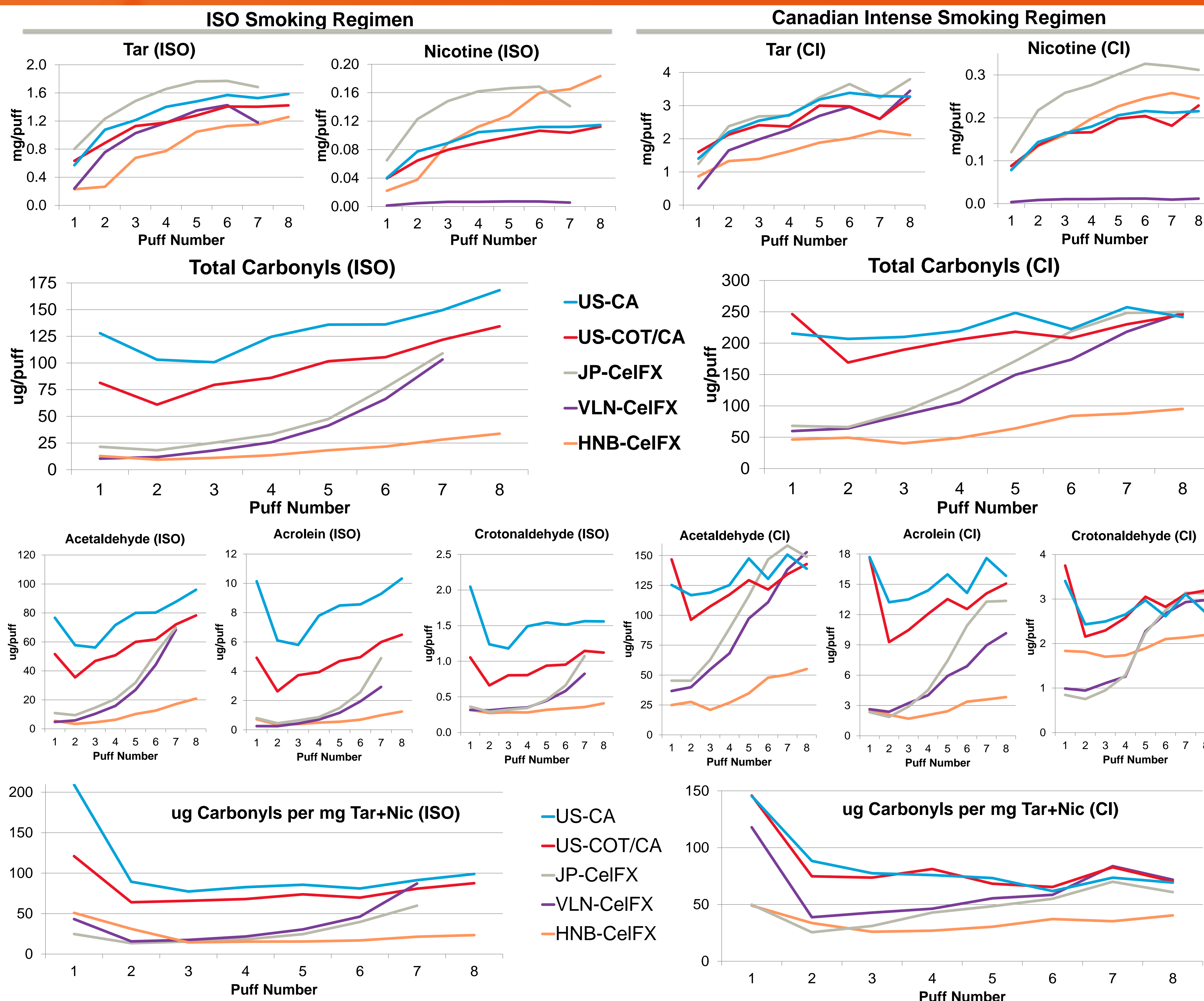
Of additional note is the inclusion of two modified nicotine cigarettes made by 22nd Century Group, Inc., using the CelFX carbon filter technology: one with very low nicotine (Magic 0) and one with a tobacco blend enabling normal nicotine delivery with lower tar.

Experimental

The Cerulean CR20i smoking machine was used to determine the smoking puff profile of five commercial cigarettes. The puff profiles were determined using ISO 3308 and the Health Canada Intense smoking protocols. Tar, nicotine water and carbonyls were determined for each cigarettes. Total carbonyls consists of formaldehyde, acetaldehyde, acetone, acrolein, propionaldehyde, crotonaldehyde, methyl-ethyl-ketone and butyraldehyde. Puff volume adjustments were done to correct the higher resistance caused by the carbonyl collection impingers. All smoking analysis was done in duplicate.

Code	Description	Filter type	Country	Carbon Segment (mm)	Acetate Segment (mm)
US – CA	American Blend	Mono-acetate	USA	-	27
US – COT/CA	American Blend	Carbon-on-Tow/Acetate	USA	10	15
JP – CelFX	American Blend	CelFX®/Acetate	Japan	10	17
HNB – CelFX	22nd Century Group High Nicotine Blend	CelFX® / Acetate	Export	10	15
VLN – CelFX	22nd Century Group Very Low Nicotine	CelFX® / Acetate	Export	10	15

Code	ISO Protocol			CI Protocol		
	Tar (mg)	Nic (mg)	Carbonyls (ug)	Tar (mg)	Nic (mg)	Carbonyls (ug)
US – CA	10.4	0.76	1,046	22.0	1.41	1,821
US – COT/CA	9.3	0.69	771	20.4	1.37	1,713
JP – CelFX	10.4	0.97	331	22.9	2.13	1,241
HNB – CelFX	6.5	0.90	149	13.5	1.55	516
VLN – CelFX	7.2	0.039	277	18.1	0.078	1,104



Conclusions

As this evaluation sought to use commercial cigarettes specific conclusions on reductions or effects related to the filter cannot be drawn due to significant variability in cigarette design and tobacco blends.

In general, however, commercial cigarettes with CelFX carbon filter segments consistently show significantly reduced deliveries of carbonyl compounds under both routine and intense smoking regimens compared to acetate or carbon-on-tow filters.

Reductions are generally most significant in early puffs followed by a lessening of the reduction in later puffs. Even normalized for differences in tar and nicotine, the CelFX filter still appears to offer significantly less carbonyl delivery.