

VALIDATION OF CIGARETTE FILTER ANALYSIS METHODOLOGIES USED FOR THE ESTIMATION OF CIGARETTE SMOKE YIELDS TO SMOKERS

Mike Dixon, Jim Shepperd & Kelley St. Charles British American Tobacco, Southampton, UK,

INTRODUCTION

Standardised methods for the measurement of tar and nicotine yields from cigarettes such as the Federal Trade Commission (FTC) and the International Organisation for Standardisation (ISO) have been in use for the past 4 decades. These methods were adopted to provide consumers with information on the ranking of cigarettes in terms of tar and nicotine yields rather than purporting to represent the absolute amounts of tar and nicotine smokers would receive from cigarettes (FTC Press Release 1967, ISCSH 4th Report 1988). Recently it has been claimed that FTC/ISO methods fail to provide consumers with reliable information on the yield ranking of cigarettes and should be abandoned (Bates et al 1999, Wilkenfeld 2001, WHO 2001). Consequently, it would be desirable to have methods of determining the tar and nicotine yields from cigarettes when smoked under normal conditions by consumers. This would help to a) establish whether the FTC/ISO ranking of cigarettes is maintained across groups of consumers and b) whether alternatives to the FTC/ISO methods provide a better correlation with the yields obtained by groups of smokers. This presentation describes a study aimed at validating 'whole filter' (Shepperd et al 2001) and 'part filter' (St Charles et al 2002) methods for determining tar and nicotine yields obtained during normal human smoking conditions.

METHODOLOGY

1. Record Human Smoking Behavior (Smoking Analyzer)
2. Duplicate Smoking Records and...
 - a. Determine Mainstream (MS) nicotine & NFDPM delivery
 - b. Filter Analysis on filters ex duplication:
 - i.e. Calibration Smoking plus filter analysis → Delivery Estimation
3. Statistical comparison of MS delivery a) and delivery estimate b)
4. Conduct for both 'whole' and 'part' filter Methods = **Filter Analysis Methodology Comparison**

Brands

Product	Source Market	Blend	ISO Pack Yield (mg/cig)	
			Nicotine	NFDPM
1	Germany	Blended	0.1	1
2	UK	Flue Cured	0.1	1
3	UK	Flue Cured	0.3	3
4	Germany	Blended	0.4	4
5	Germany	Blended	0.5	6
6	Germany	Blended	0.8	11

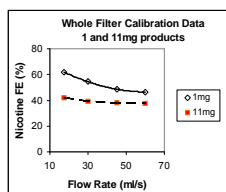
CALIBRATION METHODS AND RESULTS

WHOLE FILTER METHOD:

Average FE used to estimate Delivery:

$$\text{Estimated Delivery} = ((\text{Filter nic}/\text{FE}) \times 100) - \text{Filter nic}$$

Greater flow dependency for low delivery/high vent products

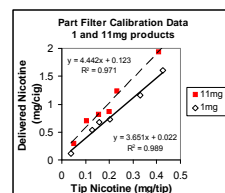


PART FILTER METHOD:

Linear Regression used to estimate delivery:

$$\text{Estimated Delivery} = (\text{Tip nicotine} \times \text{slope}) + \text{intercept}$$

Slope product dependent. Less flow dependency than Whole Filter Method... removes ventilation influences

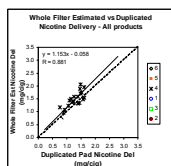


RESULTS

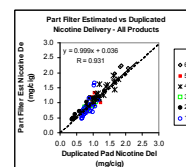
Example plots for Nicotine; Filter Analysis Estimates vs Duplicated MS Pad values.

Individual product nicotine and NFDPM data tabulated below for Whole and Part Filter methods:

PRODUCT	NICOTINE (mg/cig)			NFDPM (mg/cig)		
	Duplicated MS Yield	Estimated Delivery	p value	Duplicated MS Yield	Estimated Delivery	p value
1	0.08	0.83	NS	9.4	7.9	< 0.001
2	0.03	0.26	NS	8.1	7.1	0.035
3	1.16	1.30	0.004	12.8	14.3	0.004
4	1.27	1.48	< 0.001	15.0	16.7	< 0.001
5	1.34	1.71	< 0.001	17.4	21.4	< 0.001
6	1.57	1.63	NS	25.4	24.4	0.014



PRODUCT	NICOTINE (mg/cig)			NFDPM (mg/cig)		
	Duplicated MS Yield	Estimated Delivery	p value	Duplicated MS Yield	Estimated Delivery	p value
1	0.05	0.84	NS	9.3	8.5	NS
2	0.16	0.32	0.007	8.2	8.3	< 0.001
3	1.16	1.16	NS	12.8	12.8	NS
4	1.27	1.27	0.014	15.0	15.0	NS
5	1.34	1.34	NS	17.4	17.4	NS
6	1.57	1.57	NS	25.4	25.4	0.022



CONCLUSIONS

- The Whole Filter method gave good estimation of duplicated yields from 1 and 11mg cigarettes, but overestimated the duplicated yields from the 3 – 6mg products
- This problem was not apparent with the Part Filter method which provided good estimates of duplicated yields across the delivery range tested
- Both methods gave respectable correlations between estimated deliveries and pad yields across the range of behavior patterns measured, thus demonstrating that either method will predict differences in relative deliveries produced by changes in behavior patterns.
- The Part Filter method shows reduced flow dependency effects
- Nicotine condensation into the filter appears to be a problem with some brands when using the Whole Filter method, i.e. particularly seen with long filter products smoked to short butt lengths
- Nicotine condensation is much less of a problem with the Part Filter method – extended 'safety zone'
- **The Part Filter method is the method of choice for all future filter analysis based dosimetry studies.**

ABSTRACT

Methods based on the analyses of cigarette filters have been used to estimate tar and nicotine yields to smokers. These methods rely on the measurement of filtration efficiencies (FEs). However FEs may be influenced by both cigarette design features e.g., type of filter and levels of filter ventilation, and human smoking behaviour factors such as puff flow-rates and cigarette butt lengths. Two filter analysis methods are considered in our study. One is based on the analysis of whole filters using average values of FEs obtained from a range of machine smoke puffing regimes. The other, a 'part filter' method, analyses a 10mm section from the mouth end of the filter where the FE is less susceptible to the effects of puff flow rates and butt lengths. Human puffing behaviour records were obtained from 10 smokers each smoking 6 commercial cigarettes ranging from 1mg to 12mg tar yields (ISO values). These records were used to drive a human smoke duplicator and the resulting tar and nicotine yields obtained from duplication were compared with the estimates obtained from 'whole' and 'part filter' analysis. The results indicated that whilst both filter methods gave good correlations with nicotine and tar yields obtained from smoke duplication, the 'part filter' method was less susceptible to the effect of nicotine condensation and gave a more accurate assessment of yields than the 'whole filter' method.

REFERENCES

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