

RESEARCH LABORATORY

RESEARCH & DEVELOPMENT DEPT.

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INVESTIGATION OF THE EFFECT OF K-389 ADDITIVE ON THE COMBUSTION  
ZONE TEMPERATURE OF A PLAIN END EXPERIMENTAL CIGARETTE AND ON THE  
WEIGHTS OF WHOLE TAR AND NICOTINE DETECTED IN THE MAINSTREAM  
SMOKE THEREFROM

Reference:- Memorandum to Research and Development Department  
dated March 4, 1959.

Analysis No. A-191

SMOKE ANALYSIS

Whole tar and nicotine determinations have recently been completed on the smoke from an experimental type of cigarette containing K-389 additive and designated as PC-2A. Control cigarettes coded PC-2 were tested simultaneously to provide reference levels for tar and nicotine.

The PC-2 control cigarettes were made with regular "Player's Mild" blend. The blend employed for the PC-2A type was made by allowing one pound of the aforementioned tobacco to tumble slowly in the laboratory casing cylinder while the K-389 additive was dusted on to the extent of 4% by weight.

Cigarette samples were made by hand with the V-Master Cigarette Maker at a target weight of 1160 mg. Approximately 150 of each type measuring  $70 \pm 1$  mm. in length were made with Vogue cigarette paper in this manner.

The cigarettes were weighed individually on the torsion balance with the weights being recorded in frequency distribution form in order that a minimum range (centre at the average weight) could be arrived at to provide 100 cigarettes for the smoke analysis and combustion zone temperature measurements. Exceedingly wide weight ranges had to be tolerated in this study because of the weight variation inherent in hand made cigarettes. Average weights of 1105 mg. and 1145 mg. were obtained for the PC-2 and PC-2A types respectively. The cigarettes were reweighed individually and selected within ranges of 210 mg. and 230 mg. respectively for the aforementioned types to provide a sufficient number for the tests and even then only three nicotine determinations were made on the smoke from the control PC-2 type instead of the usual four.

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Prior to smoking the cigarettes were pressure dropped. In view of the extreme variation in these results they have been recorded in Table II.

The cigarettes were smoked to 23 mm. butt lengths under standard conditions--i.e. employing one 35 ml. puff of 2 seconds duration per minute. The smoke was collected and analysed according to the Modified Foster D. Snell Procedure dated January 14, 1959.

Results:- Please refer to the attached tables.

Remarks:-

The addition of small amounts of K-389 (4% in this case) to a tobacco blend appears to effect a tremendous reduction in the amounts of whole tar and nicotine found in the mainstream smoke. A 51.4% reduction in whole tar and a 64.4% reduction in nicotine is apparent from a comparison of the data in Table I (percentages employed for calculation rather than weights) for the PC-2 and PC-2A cigarettes. Since the gravimetric procedure which was employed for the nicotine analyses becomes less accurate as the weight of nicotine decreases and also the technician or analytical error has the tendency to become proportionately larger, the whole tar reduction figure is probably a more reliable estimate of the effectiveness of the K-389 additive. By correcting the nicotine data for solubility losses the nicotine reduction figure becomes 61.8%.

There appears to be no significant difference in either the average number of puffs or time required to smoke the PC-2 and PC-2A cigarettes although quite possibly the excessive variation in the observed numbers of puffs and time data (Table III) might tend to obscure any potential difference in these characteristics.

The cigarettes were far too variable in weight and pressure drop to enable the laboratory to obtain precise results. However, it is quite apparent that the K-389 additive is far superior to alumina and/or aluminized paper (Memorandum to Research and Development Department dated March 4, 1959) in effecting a reduction in the concentrations of whole tar and nicotine in cigarette smoke.

A more extensive study of the effect of K-389 on tar and nicotine reduction has been proposed for the near future at which time machine-made quality controlled cigarettes shall be tested. It is hoped that the forthcoming project will enlighten us as to the mechanism of the 'reduction' process and the amounts of K-389 (percentages) to be applied to tobacco blends to achieve a desired reduction.

COMBUSTION ZONE TEMPERATURES

Determinations of combustion zone temperature have been made on the two cigarette samples described above. The method of

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measurement was very similar to that described by Touey and Mumpower (Tobacco Science 1, 33, 1957). Thermocouple wires of 0.002" diameter and of platinum v platinum 87% - rhodium 13% composition were inserted through the cigarette perpendicular to the long axis and at a distance of 15 mm. from the lighted end, with the junction positioned axially in the cigarette. The cigarettes were smoked by machine at the rate of one two-second puff of 35 ml. volume per minute, and the temperature recorded was the peak temperature occurring during a puff. The signal from the thermocouple was recorded by means of a Leeds and Northrup "Speedomax" potentiometric recorder.

Ten determinations were made on each sample (previously selected in the same way as for whole tar determinations) and the average peak temperature has been recorded in Table I. The uncertainty in each mean is thought to be approximately 15°C.

It is seen from the table that the temperature recorded for cigarettes made with treated tobacco is approximately 17° lower than that of the control. This difference is well within the experimental error, however, and it is concluded that no significant difference in combustion temperature is observed between the two samples.

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TABLE I

Brand or Type	Average Weight in mg.	Weight Range for Selection in mg.	SMOKE ANALYSIS DATA						Combustion zone Temperatures Degrees C.
			WHOLE TAIL			NICOTINE			
			Wt. of Tobacco Smoked/Cigt. in mg. (moisture free basis)	Mg./Cigt.	%	Wt. of Tobacco Smoked/Cigt. in mg. (moisture free basis)	Mg./Cigt.	%	
Experimental Type PC-2 Rec'd April 24/59	1105	1105 ± 105	577.0	25.2	4.21	560.4	1.04	.317	857
			583.0	22.7	3.89	591.0	1.35	.330	
			604.4	20.7	3.42	594.5	1.86	.313	
			607.3	2.4	4.15	588.6	1.86	.320	
			590.0	23.5	3.93		*(1.97)	**(.335)	
Experimental Type PC-2A Rec'd April 24/59	1145	1145 ± 115	621.5	11.8	1.90	624.0	0.84	.135	640
			657.2	11.8	1.60	638.7	0.77	.121	
			642.7	12.7	1.98	656.1	0.68	.103	
			640.0	12.7	1.96	632.3	0.61	.096	
			642.0	12.3	1.91	638.3	0.73	.114	
					*(0.82)	**(.126)			

\* Nicotine results corrected for solubility loss - 0.09 mg./cigt./500 ml. of distillate.

\*\* Based on corrected weights of nicotine.

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TABLE II

PRESSURE DROP DATA ON CIGARETTES SELECTED FOR SMOKING

PC-2 Type		PC-2A Type	
Pressure Drop (inches of water)	Frequency	Pressure Drop (inches of water)	Frequency
1.4	1	1.0	1
1.8	2	2.7	1
1.9	2	2.9	1
2.0	2	3.0	1
2.1	4	3.1	2
2.2	5	3.2	1
2.3	2	3.3	1
2.4	6	3.5	1
2.5	5	3.6	1
2.6	3	4.0	1
2.7	2	4.3	2
2.8	1	4.4	2
2.9	1	4.6	1
3.0	2	4.7	1
3.1	5	4.8	3
3.2	2	5.0	1
3.3	5	5.1	2
3.4	1	5.2	1
3.5	3	5.3	2
3.7	2	5.4	1
3.8	3	5.6	1
3.9	3	5.7	1
4.0	1	6.0	1
4.1	2	5.1	1
4.2	1	6.2	2
5.8	1	6.4	2
6.9	1	6.5	2
		6.6	1
		6.9	2
		7.0	2
		7.1	1
		7.2	1
		7.3	2
		7.5	5
		7.6	1
		8.1	1
		8.4	1
		8.5	4
		8.7	4
		9.1	3
		9.5	1
		9.7	1
		10.0	1
		10.2	1
		10.9	1
		11.1	1
		11.2	1
		11.5	2
		11.7	1
		12.5	1
		13.8	1
<b>Total</b>	<b>70</b>		<b>80</b>
<b>Average 2.9</b>		<b>6.9</b>	

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TABLE III - SUPPLEMENTARY DATA

Type of Brand	Pressure Drop Data on Selected Cigarettes			No. of Measurements	Average Number of puffs Required to Smoke 47 mm. in Length	Average Time Taken to Smoke 47 mm. (in minutes)
	Average (in. of water)	Range (in. of water)				
Experimental Type PC-2	2.9.	1.4 - 6.9	70	11.9 (11.3 11.0 12.5 12.8)	11 (10:21 10:11 11:46 11:56)	
Experimental Type PC-2A	6.9	1.0 - 13.8	80	11.6 (10.6 11.4 12.2 12.2)	10 3/4 ( 9:42 10:30 11:14 11:17)	

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