

Apartment 803,
191 St. George Street,
Toronto 5, Ontario.

Dear Dennis:

I would like to convey my appreciation to Dr. Green for his helpful comments. It is unfortunate that he did not have the second part of the paper which I have just completed as I feel it would have answered in a satisfactory way some of his criticisms. I had also rewritten the first part of the paper in view of the results of the second part. In deference to Dr. Green's suggestions I also made some further recent changes. I am sorry I could not meet Dr. Green myself as I am sure an exchange of views would have been mutually valuable:

1. I changed "coloured hydrocarbon content" to "Optical Tar Density."
2. Page 1, last paragraph. I think Dr. Green will find I have covered this topic in the appendix of the revised text.
3. Page 2. I appreciate that these thermocouples will not give an exact reading of the absolute temperature and have so noted in the revised text. I think Dr. Green will be inclined to agree with me that the rate of heating measured by this size of thermocouple is, however, quite accurate and certainly it is not possible to dispute the large relative differences which occur.
4. Page 2. Text revised - so I still make the desired point but in a more acceptable form.
5. Page 3, paragraph 1. I revised the text to make meaning clearer.
6. Page 4, paragraph 1. Results were actually measured by smoking to an approximately normal butt-length and reported on a "per puff" basis.
- (I) 7. Page 5. With regard to the equations relating coloured hydrocarbon (CH) (now Optical Tar Density - RCTD) with heating rate (HR) and mass per puff (M/P) I agree that there is a filtration problem. It is impossible to avoid some filtration in the tobacco without changing the combustion mode. There should be a filtration factor in the equations. The cigar may filter the smoke just as efficiently as the filters in the cigarettes tested. On the other hand, in the pipes employed in our experiments the filtration of the smoke will be limited. In this respect I would be the first to admit that filtration in the devices concerned could make a difference of 20% or so in the reading; however since the effect of the other variables causes a change up to 2000% (a factor of 20) the effect of filtration is probably of minor importance. Note that the error in the equation is + 10% which would account for some of the filtration differences.

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(II) I think the accuracy of the value of M/P I require is a bit less than that desired by the tobacco industry. I hesitated to put confidence levels on my values as they change with humidity (uncontrolled) and as a function of length etc. Note that I am looking at differences up to a factor of 4 or 400% between the cigarette and pipe. The values I report check very closely with the values calculated from the starting mass minus the ash mass minus the mass burned at idle divided by the number of puffs. When the total burning times during puffing per unit mass for each device is calculated, the times are all proportional to the burning rates found. If a king size cigarette is smoked at 35 ml, 2 sec. puffs, eight times a minute then a 25 mm. butt is reached after 22 puffs. If the tobacco from the same cigarette is placed in a pipe and smoked under the same conditions as the cigarette the number of puffs required is 90. Since 0.1 gms. of tobacco were burned in each case the calculated burning rates would be 0.036 gm/puff (no subtraction for idle time-extremely long hot zone) and 0.009 gm/puff for the pipe at eight puffs per minute. The measured values were 0.024 gm/puff at 2 puffs/min. for the cigarette and 0.009 gm/puff; for the pipe at 3 puffs/min. The above comments may help convince Dr. Green that there is a very real and very large difference in burning rates between pipes and cigarettes and that the quoted, values must be close to the true values.

If Dr. Green would like to see traces of the weight loss as a function of time on our automatic Ainsworth balance I would be happy to provide them.

(III) The mass per puff (M/P) is not primarily a function of the rate of heating (HR). M/P appears to be related to the cross sectional area of the interface which controls the gas velocity over the tobacco and the intimacy of the air-tobacco contact. Note that (M/P) increases over the value in cigarettes for the cigar and the heating rate of the tobacco decreases, while in the pipe both the heating rate and the burning rate are lower than in the cigarette. The rate of heating is a function of the thermal diffusivity of the tobacco agglomerate. While such factors as tobacco density can influence both M/P and HR, they can still be independent.

Page 8 I think Dr. Green's question adequately answered in the new text where this equation is not reported but a comparison of the smoke toxicity and the Optical Tar Density is made.

Page 9 The values for the coloured hydrocarbon content, now called the "Optical Tar Density" for the compressed reconstructed cigarette were shown in Table 2 (Table 1 of new text). The number of puffs of the reconstructed cigarette depends on whether it is made with the same weight of tobacco or the same length. If the same weight were used, the number of puffs would be 21 at 21 puffs per minute compared to 15 for the conventional cigarette. If the same length were used and one-third more tobacco the number of puffs at 2 puffs per minute would be approximately 30.

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The smoulder temperature from our work appears to go through a maximum at densities slightly higher than those of a normal cigarette and then begin to decrease with further increase in tobacco density.

Minor Points

- (1) I did the statistical analysis in this case because somebody always asks for it if you don't do it.
- (2) I think the best answer to this question is to draw Dr. Green's attention to the values of total particulate matter now included in the report and originating in work done at Rothman's in Quebec. The resistance to draw of each cigarette was measured before testing and it was not tested if it did not fall in the same range as the normal cigarette.
- (3) I think this point is well covered (in the manner which Dr. Green suggests) in the new text.

Summary

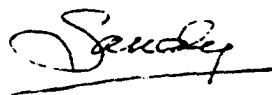
I think from the revised text Dr. Green should be inclined to agree to the following conclusions.

1. The toxicity of pipe and cigar smoke is less than cigarette smoke.
2. Changing the combustion conditions markedly changes the properties of the smoke, i.e. the TPM and the Optical Tar Density.
3. Two of the major parameters controlling or affecting the smoke composition are the burning rate and the heating rate of the tobacco.
4. Since both the combustion variables and the smoke from the reconstructed cigarette are similar, the toxicity of the smoke should be similar. I also feel that while the values of the constants in the equation relating RCTD (relative optical tar density) and heating rate and burning rate may be refined and while a filtration term could be added, that the form of the equation will be preserved and certainly that the essential conclusions, which I have derived, will be substantiated.

I hope that Dr. Green finds the revised text more acceptable and would very much appreciate his further comment in due course.

Hope to see you shortly,

Sincerely,



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