

"COPY" 22.12.59.

Copy No.....

Research & Development Establishment
British-American Tobacco Co.Ltd.
Southampton.

Report No. RD.14 - R

Title: SMOKE GROUP
Programme for coming 12-16 week period.

Author: D.G.Felton

Issued by: H.D.Anderson

Date of Issue: 1.3.57.

Original distribution: D.S.F.Hobson Esq.,
Sir Charles Ellis
File 36D
T.M.Wade Jnr., Esq.,

Copy No.6 Master
7 L.Hinshelwood Esq.,
8 Library
9
10
11
12
13

105471399

"COPY" 22.12.59.

SMOKE GROUP

Programme for coming 12-16 week period

1. INTRODUCTION

As a result of several statistical surveys, the idea has arisen that there is a causal relationship between ZEPHYR and tobacco smoking, particularly cigarette smoking. Various hypotheses have been propounded, from time to time, as explanations of this conception. The two which seem most important at present are:-

(i) Tobacco smoke contains a substance or substances which may cause ZEPHYR

(ii) Substances which can cause ZEPHYR are inhaled from the atmosphere, e.g. in the form of soot. Because of the way in which these causative agents are bound to the soot, they are in an inactive form; but the inhalation of compounds with solvent properties leads to the elution of the agents and their subsequent activation into a form which readily causes ZEPHYR. This "Elution Hypothesis" may account in part for a subsidiary relationship claimed between ZEPHYR and the level of urbanisation (and consequently of atmospheric pollution).

The second hypothesis is one which is not easily amenable to experimental study, since in some of its ramifications it enters the field of biology. It is known that cigarette smoke contains certain compounds, especially in the basic fraction, which possess powerful solvent properties. But further than this it is not possible to go at present.

105471401

The first hypothesis is being actively investigated by groups of workers around the world. Until very recently the most suspected compound was BORSTAL. Most values for BORSTAL content of cigarette smoke are held to be too low to reach a biological threshold value for ZEPHYR causation, even on a basis of continued dosage; this conclusion was published by one who is, nevertheless, one of the strongest proponents of the hypothesis under discussion. Very recently, a second compound has been claimed to have been detected in cigarette smoke and this has been stated, independently, to be twenty times as active as BORSTAL. It is 3,4,9,10-DBP. This work still requires confirmation and meanwhile BORSTAL remains as the most widely suspected component in smoke and atmospheric pollution.

It was in view of the foregoing that the Smoke Group embarked on a study of the neutral fraction of smoke, and, in particular, the condensed aromatic polycyclic hydrocarbons (APH). Although this type of work had already been undertaken by other groups of workers, it was felt that duplication was essential. Some of the work already published was of rather doubtful reliability and the values found for BORSTAL content or reported failures to find this compound made it of prime importance to establish our own assay for this. Later publications have only served to emphasise the correctness of this conclusion.

2. DISCUSSION OF BASIC PROGRAMME

At the outset, it was felt that, with the limited resources in personnel, equipment and especially time available, the programme of work undertaken should be flexible and yet be designed in such a way as to yield the maximum of information. Accordingly, the chemical programme chosen was -

105471403

- (a) Qualitative analysis of APH fraction
- (b) Quantitative analysis for BORSTAL

But to give point to this, it was decided to seek experimental variations such as might reveal gross qualitative or quantitative changes in the smoke. It was thought that should any differences be found, it might be possible to deduce from the experimental variations introduced an idea of the cause of formation of, or course of the formative reactions yielding, APH's. Such knowledge would greatly assist the direction of research into prophylaxis.

Possible experimental variations which have been suggested include -

- (i) Variation in puff parameters
- (ii) Comparison of smoke from front and back halves of cigarettes
- (iii) Comparison of smoke from cigarettes made exclusively from lamina or CRS of the same basic blend
- (iv) Variation in casing materials
- (v) Mainstream smoke and smoke condensed in the butts
- (vi) APH Composition of fresh and "aged" tar

A Physics programme was closely integrated with the Chemistry programme with the idea that this would yield results to help in determining the combustion conditions under which the APH's were produced and the physical nature of the smoke. Initially this meant accurate measurements of temperature along the cigarette and in the combustion zone, especially. It is assumed that two identical cigarettes on combustion at identical combustion temperatures will yield smoke mixtures very closely similar in composition.

105471405

It is thus seen that the experimental variations itemised above may be divided broadly into those in which the material combusted is different and those in which differences are due to other factors. Thus smoke from the front half of a cigarette is filtered through the rest of the cigarette, certain materials being deposited on the tobacco remaining. This material then undergoes a second distillation or pyrolysis and may be changed further in the process. In that respect, variation (ii) is a variation in material combusted. However, certain of the more highly condensed APH's may still be deposited in the butt and hence the APH content of the butt may still differ from that of the smoke from the latter half of the cigarette.

It would seem that the broad strategy of the programme is correct, especially as regards the known constituents of the APH fraction. Thus, as regards the newly discovered 3,4,9,10-DBP, the qualitative analysis for APH should enable the position of this compound in the fractional chromatographic sequence to be located and a suitable assay procedure can then be sought and applied. It might be arguable that a qualitative analysis for hitherto unknown compounds in the APH fraction is desirable to provide prior knowledge, but this would involve us in long and probably tedious identification procedures, and, in the absence of the necessary biological results, would be valueless.

The Physics programme has yielded several valuable results already. Preliminary measurements in which the temperature of combustion of cigarettes was measured under variable puff conditions indicated that no remarkable differences in temperature were to be expected by variation in the puff parameters. Accordingly this experimental variation of smoking conditions

105471407

has not been studied from the chemical analytical side. Using more accurate methods of temperature recording it has been possible to measure combustion temperatures and obtain what is perhaps the upper limit. By making certain assumptions, it is possible to deduce the distribution of temperature along the cigarette at any instant and thus gain a possible insight into the type of reactions occurring in the tobacco as it is heated.

Progress to date

This is outlined in "Smoke Group - Progress Report No.1".

Programme Proposed (March - June inclusive - 16 weeks)

1. BORSTAL Assays

Although a single analysis of BORSTAL in smoke from "fronts" and "backs" of cigarettes will be completed shortly, one analysis is not sufficient. In order to gain a knowledge of the degree of replication attainable, at least three such analyses are required. Each analysis will occupy 4-5 weeks, including cigarette standardisation, smoking, fractionation and refractionation and assay. As mentioned in the Progress Report, the first "fronts" and "backs" analysis may have been vitiated by the gap in time owing to the transition period when the laboratory was moved to "A" Factory. During this period, the two neutral fractions were stored in the dark at 0°C in a refrigerator but nevertheless marked changes may have occurred during this "aging". So that three more "fronts" and "backs" analyses will be necessary.

The remainder of the period should be spent on analyses of cigarettes made from -

1. Lamina
2. CRS

105471409

as used in the Player's Medium (CQ86) blend. This experiment raises an important point. Since CRS is cut at 200 cuts/inch it will have a different packing density from that of normal cigarettes and hence the draw resistance and weight standardisations used will not apply here. As these are, in any case, atypical cigarettes it is suggested that the standardisation procedures are not applied to this experiment. An indent on the Branch for the production of these experimental cigarettes will need to be placed in advance of requirement. It is suggested that this should be done during the penultimate "fronts" and "backs" assay. Several thousand of each category will be required to permit replication, and other studies if so decided.

With the omission of standardisation, the assay of this nature will occupy approximately 3-4 weeks, and so only one such assay may perhaps be completed if all goes well. Replication of this will follow in the ensuing period.

2. Qualitative Analysis of APH

The initial phase of this analysis is nearing completion and the methods of analysis to be employed have been determined so that the occurrence of the various APH in the chromatographic fractionation sequence is known broadly. This has been done using "aged" tar.

The first phase in this programme will now be a repetition of this analysis using tar collected as freshly as possible and processed without delay. With the knowledge already gained, it will be possible to complete the analysis expeditiously and possible qualitative differences will be revealed. It will be of great interest to learn whether "aging" leads to

105471411

the disappearance of any compound or to the appearance of fresh APH. If the latter case obtains then the formation of APH is not solely a combustion phenomenon.

If time permits in the period under consideration, the next phase to be studied is the APH content of butts as contrasted to that of fresh mainstream smoke. It is conceivable that the more highly condensed APHs will be deposited to a greater extent in the butts than are the simpler ones. This may well be of significance in connection with 3,4,9,10-DBP, a hexacyclic compound.

3. Physical Programme

Now that it has become possible to return to photographic recording of galvanometer traces, made possible by separate dark rooms, it is intended to extend the study of temperature of combustion as a function of puff parameters. The study of temperature distribution along the length of the cigarette has clarified the conception of "phasing" phenomena of puffs relative to thermocouple location, and the effect of conduction along thermocouple leads has been partially evaluated.

It is desirable that the study of this effect of conduction as a function of diameter of the wire used should be completed, by using thermocouples of diameters different from those already used. The requisite materials are already on hand.

Preliminary measurements have suggested that temperature of combustion is not greatly dependent upon puff parameters, but it is very desirable that this should be checked accurately and this phase of the work thereby brought to a conclusion.

105471413

These two problems, if studied thoroughly, should occupy the ensuing three to four months fully. Any time remaining could be devoted to a study of temperatures of combustion for cigarettes of different physical structure, e.g. cigarettes from lamina (60 cuts/inch) and from CRS (200 cuts/inch).

PERSONNEL

1. BORSTAL Assay

Mrs. Flood has been trained to carry out the initial tar separation into neutral fraction and the subsequent chromatographic fractionations. She can also undertake the fluorescence spectrography for detection of BORSTAL but is less fitted for this task. Miss Withington has been trained in fluorescence spectrography and has mastered the technique well. She will be capable of carrying this out with the minimum of supervision. The final assay will need to be done under the supervision of Mr. Cronshaw since it will entail microphotometry and a certain amount of visual photometry in estimating approximate strengths of the final assay solution. Mr. Cronshaw understands this aspect thoroughly.

2. APH Qualitative Analysis

Dr. Hughes has trained Mr. Smith in the requisite chromatographic techniques and also in the determination of ultra-violet absorption spectra. Miss Withington is also an accurate spectrophotometric worker and will be available for this work during periods when BORSTAL is not being determined or assayed.

105471415

3. Physical Programme

Mr. Cronshaw, besides dealing with the temperature measurements, will also supervise the cigarette conditioning and standardisation and the final BORSTAL assays.

Cigarette conditioning, weight selection and draw resistance measurement will be carried out by Gannaway, assisted by Mrs. Flood when she is available. Gannaway is also responsible for solvent purification for the Group and for general laboratory maintenance work.

DGF/LT.

105471417