LETTERS TO THE EDITORS

PHYSICAL SCIENCES

Smoke Emission of Low-Temperature Chars

It has been accepted in the past that coals are effectively smokeless when they contain less than 20 per cent of volatile matter. Thus the approved smokeless fuels include low-volatile steam coals ranging in volatile content from 9·1 to 19·5 per cent and manufactured fuels of volatile content near or less than the lower limit of this range. Consequently, the assumption is sometimes made that, in order to be smokeless, coal products must have their volatile content reduced to less than 20 per cent.

This assumption is unjustified. Early work by Piersol[1] showed that devolatilization of certain American coals gave chars which were smokeless although their volatile contents exceeded 20 per cent. At the Coal Research Establishment a similar effect has been found for high-volatile British coals which were devolatilized by fluidized carbonization. Briquettes made from a char of 33 per cent volatile content emitted less smoke than a steam coal of 18 per cent volatile content, and when made from a char of about 23 per cent volatile content they were completely smokeless.

The smoke emission of a series of chars of different volatile contents and of coals covering a similar volatile range has been investigated. From both coals and chars, the smoke consisted mainly of tar-like pyrolysis products which had escaped complete combustion. The smoke emission decreased with decreasing volatile content, but was always less for a char than for a coal of the same volatile content. Nevertheless, as shown by Fig. 1, a common relationship for coals and chars was found between the smoke yield on combustion and the tar yield as measured by a Gray–King assay. It is concluded that the smoke emission of coals and chars is mainly determined by the yield of tar on carbonization. A char of 23 per cent volatile content is smokeless because its yield of tar is small. This is mainly due to the fact that during the preparation of the char, a considerable amount of tar has already been evolved from the parent coal.

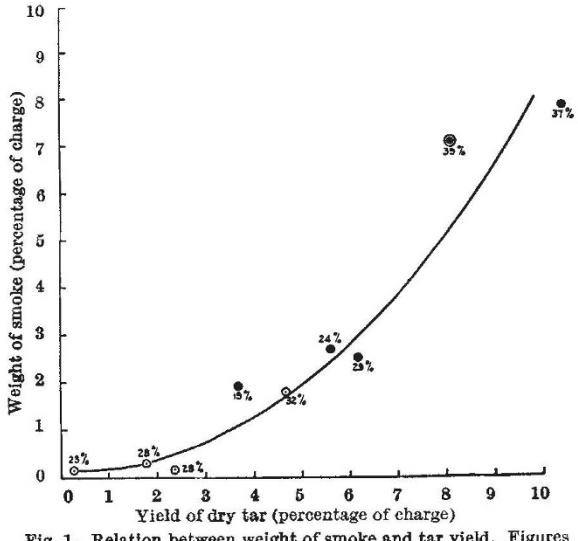

Fig. 1. Relation between weight of smoke and tar yield. Figures adjoining points are volatile matter contents (percentage d.a.f.). ●, Coals; ⊙, chars

Table 1. Yields of Products from the Carbonization of Cannock Wood Coal
(Percentages of dry coal)

Carbonizing conditions	Char	Tar	Liquor	Gas
Coal carbonized to 425° C.	87·7	6·7	3·8	1·4
Char recarbonized to 550° C.	77·8	1·8	4·0	4·0
Total yields from two-stage carbonization	77·8	8·5	7·8	5·4
Coal carbonized directly to 550° C.	76·8	9·8	7·1	6·2

A second factor, however, also contributes to the low yield of tar from a smokeless char. When a high-volatile coal was carbonized at 5 deg. C. per min. to 425° C. to give a smokeless char, the yield of tar was 6·7 per cent by weight. Carbonization of the coal under the same conditions but to 550° C. (a temperature sufficiently high for the maximum yield of tar under these carbonizing conditions) gave 9·8 per cent yield of tar. It might therefore be expected that the yield of tar obtained by carbonizing the smokeless char to 550° C. would equal the difference, namely, 3·1 per cent. The yield obtained (1·8 per cent) was significantly lower. Moreover, as shown in Table 1, the decrease in yield of tar was accompanied by a corresponding increase in the yield of char, the yields of liquor and gas not being significantly affected. These results show that when carbonization is carried out to a fixed upper temperature in two stages, some of the intermediate pyrolysis products, which would have been evolved as tar in a single-stage carbonization to that temperature, are converted into char. This effect is related to the observation of other workers[2–4] who, studying different aspects of coal pyrolysis, have also observed that when the upper temperature limit of carbonization is fixed, the yield of tar or coke depends on the carbonizing conditions. It is concluded that certain pyrolysis products of coal can either be evolved as tar or, if they are left in contact with the heated coal, undergo further reactions—possibly polymerization or condensation—to give a solid product.

Thanks are due to the National Coal Board for permission to publish this communication, a full account of which is being published elsewhere.

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[4] van Krevelen, D. W., Huntjens, F. J., and Dormans, H. N. M., *Fuel*, **35**, 462 (1956).