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Volatile displacement of Burnt Coals

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Abstract

The volatile displacement of burnt coals has been compared with that of carbonized coals. A relation has been found between volatile displacement of burnt coals and its chemical composition, i.e., carbon and hydrogen contents.

Introduction

Seyler (1938) originally showed that volatile displacement, i.e., the difference between the experimentally determined and calculated volatile matter in coal is related to petrological composition. Chandra and Gupta (1976) observed that the volatile displacement is also dependent on weathering of coal. Since no results were available on the volatile displacements of burnt coals, an investigation was undertaken to study the same. The purpose of this note is to describe the results of this study.

Experimental Procedure

For the purpose of this investigation samples of burnt coals were collected from the different seams of the Jharia coalfield which were found to be burnt. The proximate and ultimate analyses of the collected samples were determined experimentally.

The volatile matter of the burnt coals was calculated from the equation:

$$\text{V.M. (calculated)} = 10.61\text{H} - 1.24\text{C} + 84.15$$

(In our calculation the values for C and H were taken on dry ash free basis)

The difference between the experimental and calculated matter is equal to the volatile displacement, or in other words:

$$\text{Volatile displacement} = \text{V.M. (experimental)} - \text{V.M. (calculated)}$$

Results and Discussion

The variation of experimental and calculated volatile matter of burnt coals is shown in Fig. 1. For comparison the same parameters for the coals carbonized in the laboratory under controlled conditions have been included in the figure. The volatile displacements of carbonized coals shown in figure 1 were calculated from the chemical composition of carbonized coals reported by Chandra (1957).

It will be seen from Fig. 1 that plots of experimental and calculated volatile matter of the burnt coals (i.e., coals heated in the presence of oxygen) and carbonized coals (i.e., coals heated in the absence of oxygen) follow almost the same trend. Burnt coals having up to 10% of experimental volatile matter show negative values of calculated volatile matter. Coals carbonized in the laboratory beyond 500°C also show negative calculated volatile matter. In this connection it may be mentioned that negative values for calculated volatile matter have not been obtained previously either by Seyler (1938) on raw coals or by Chandra and Gupta (1976) on weathered coals. Therefore, negative calculated volatile matter values of any unknown coal can be taken as indicative of heat effect either in the presence of oxygen (as in case of burnt coals) or in the absence of oxygen (as in the case of carbonized coals). It will be seen that above 20% of experimental volatile matter there is a separate relation between the calculated and experimental volatile matter of burnt coals (Fig. 1).

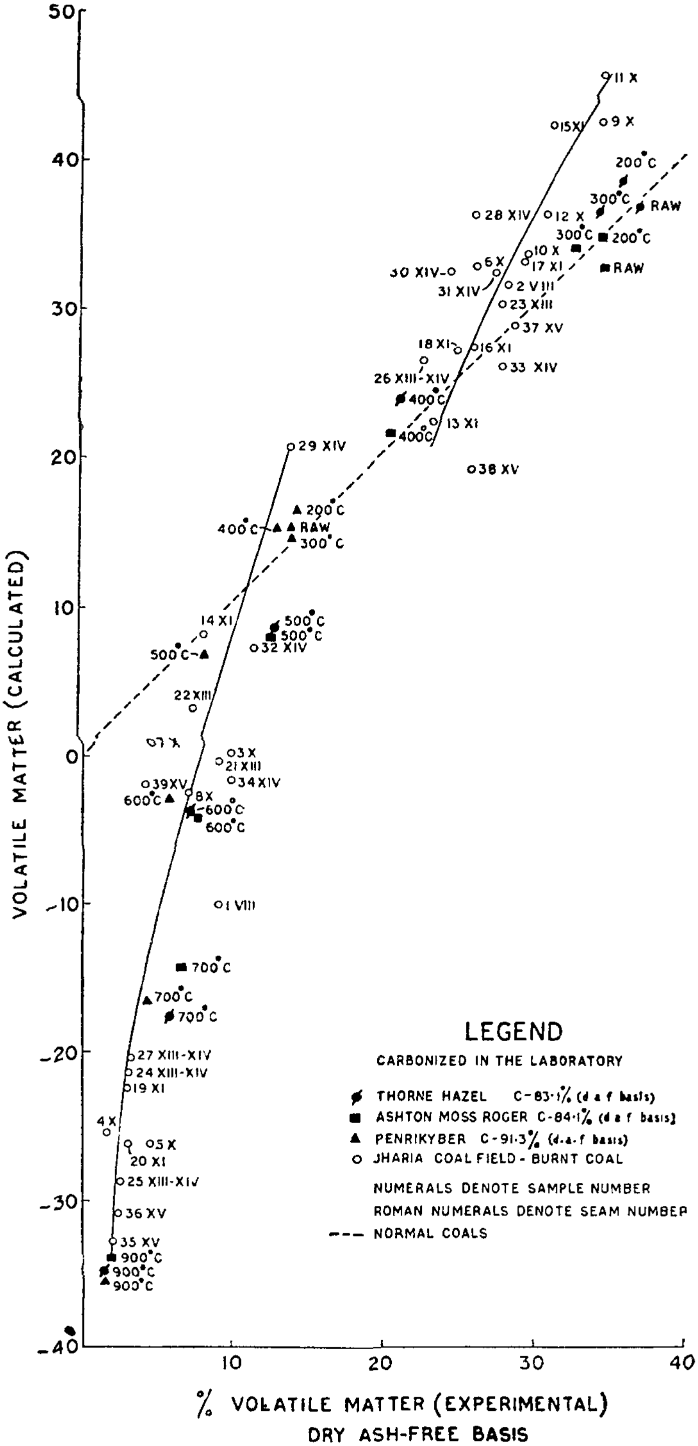
VOLATILE MATTER (CALCULATED)
% VOLATILE MATTER (EXPERIMENTAL)
DRY ASH-FREE BASIS
LEGEND
CARBONIZED IN THE LABORATORY
THORNE HAZEL C-83·1% (d a f basis)
ASHTON MOSS ROGER C-84·1% (d a f basis)
PENRIKYBER C-91·3% (d.a.f basis)
JHARIA COAL FIELD - BURNT COAL
NUMERALS DENOTE SAMPLE NUMBER
ROMAN NUMERALS DENOTE SEAM NUMBER
NORMAL COALS

Figure 1.

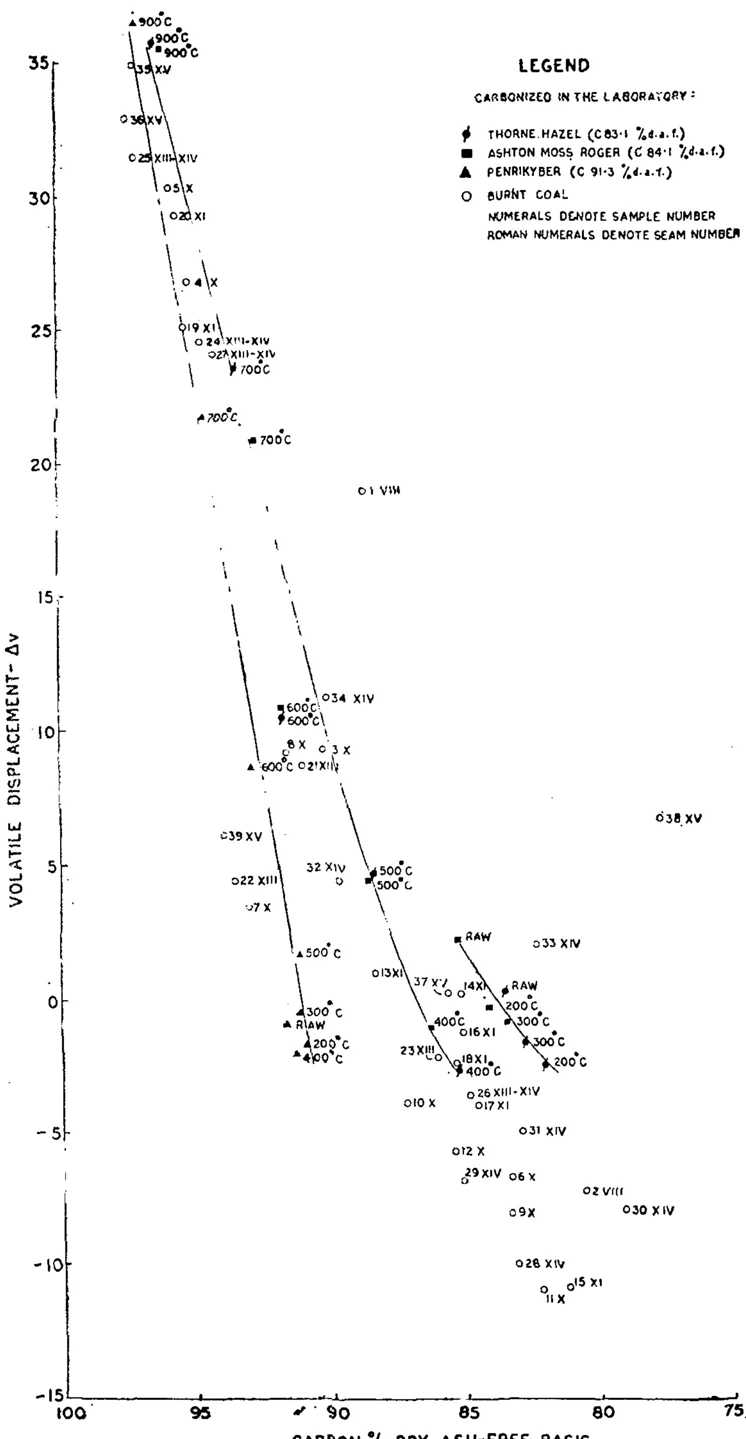
LEGEND
CARBONIZED IN THE LABORATORY:
THORNE HAZEL (C 83·1 %d.a.f.)
ASHTON MOSS ROGER (C 84·1 %d.a.f.)
PENRIKYBER (C 91·3 %d.a.f.)
BURNT COAL
NUMERALS DENOTE SAMPLE NUMBER
ROMAN NUMERALS DENOTE SEAM NUMBER
VOLATILE DISPLACEMENT - Δv
CARBON % DRY ASH-FREE BASIS

Figure 2.

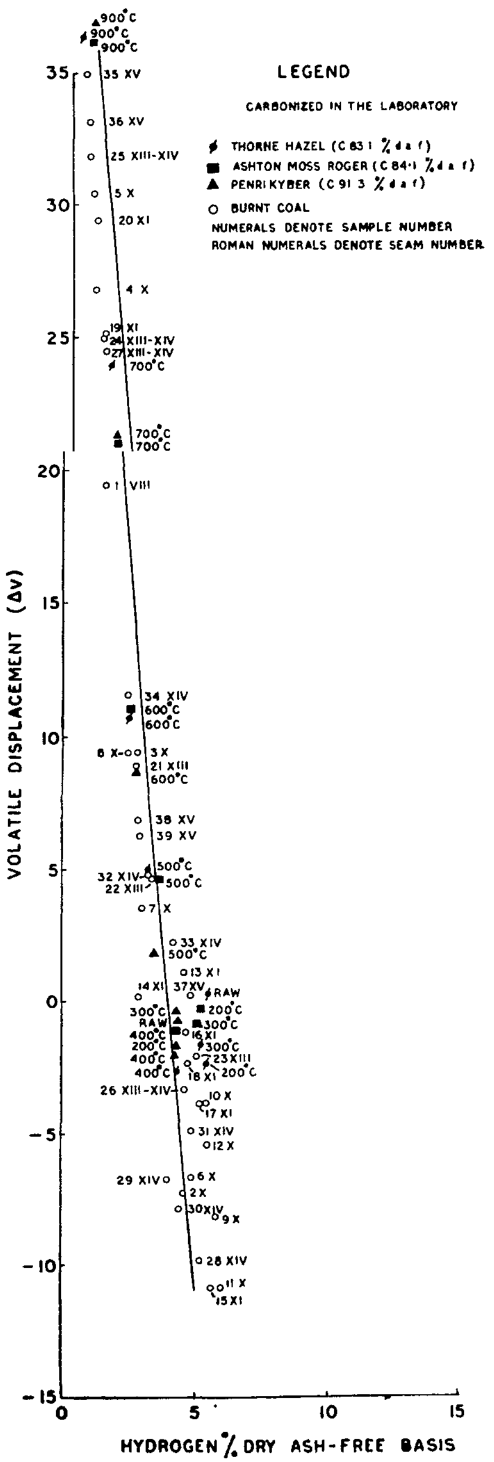

Figure 3.

It has been found that the volatile displacement of burnt coals is also dependent on their chemical composition. When the volatile displacements are plotted against the carbon contents, there appears to be a relation as shown in figure 2. Up to about 87% carbon content the volatile displacements of burnt coals lie between zero and negative values. Beyond 87% carbon content there is a general trend of increase in the volatile displacement with the increase in carbon content (Fig 2). For comparison, the volatile displacement and carbon contents of carbonized coals have been plotted in figure 2. It will be seen that there are three separate curves showing the relation between the volatile displacement and carbon contents depending on the nature of the sample. For example, there are the three curves (1) for the raw coals of the two low rank coals, Thorne Hazel (C – 83.1%) and Ashton Moss Roger (C – 84.1% and their carbonized products heated up to 300°C. This is because the raw low rank coals and their carbonized products heated up to 300°C behave almost the same (Chandra and Bond, 1955); (2) for the two low rank coals mentioned above carbonized beyond 300°C; (3) for the raw high rank coal Penrikyber (C – 91.3%) and all its carbonized products.

It can also be seen that the plots of burnt coals closely follow the curve of the laboratory carbonized coals from about 500°C to 900°C and the volatile displacement increases with the increase in carbon content.

A linear relation has been found to exist between the volatile displacement and the hydrogen content of burnt coals (Fig. 3). For comparison the same parameters for the coals carbonized in the laboratory have been plotted in the same figure. It can be seen that with the decrease in hydrogen content the volatile displacement of burnt and carbonized coals increases.

Although volatile displacement of coals carbonized beyond 500°C is based on imaginary values (i.e. negative calculated volatile matter, there is a systematic variation of volatile displacement with temperature. The volatile displacement increases systematically with the temperature of carbonization (Fig. 2). Therefore the volatile displacement of carbonized coals can be taken as a significant parameter.

Conclusion

From the foregoing studies it would appear that it is possible to differentiate the burnt coals or carbonized coals from the raw coals. The burnt coals and carbonized coals may show negative values for calculated volatiles which are not found in either raw coals or weathered coals.

The results also indicate (Fig. 2) that with the help of volatile displacement, the temperature of carbonization and the rank of the carbonized coals may be predicted. Also a differentiation can be made between the carbonized coals and burnt coals when the burnt coals have volatile displacements less than -3 and also wider scatter (Fig. 2).

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