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Short Communication

Effect of Flotation on Coal Combustion

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INTRODUCTION

The selection of coal for use in pulverized coal fired boilers has been based largely on coal rank and proximate analysis. However, Nandi et al. [1] have shown that combustion efficiencies of various coal samples mainly depend on the presence of inert coal macerals, e.g. semifusinite, fusinite and oxidized vitrinite. These inert components are reported to persist through the flame in a partially reacted form and produce higher levels of unburnt carbon in the fly ash. In addition, the reagent used in the cleaning process may affect the combustion of coal by acting as an ignition catalyst or as a retardant. It appears, therefore, that the characterization of ignition and combustion properties of floated fractions of coal which may contain specific maceral components is essential for determining the overall thermal efficiency of the cleaned coal. This note presents data on the viscosity and ignition delay measurements of coal which was cleaned using the froth flotation technique.

EXPERIMENTAL

One hundred grams of −65, +100 mesh coal (8.7% ash) was floated in a Wemco flotation machine using incremental addition of a frother, Aerofroth −73 (American Cyanamid Product). Flotation at 3 wt.% pulp density was carried out until completion in respective stages under natural pH conditions.

Different float fractions were ground to −200 mesh and mixed with water to yield a 30 wt.% slurry before measuring the viscosity at a shear rate of 37.5 s^{-1} using a Brookfield Viscometer.

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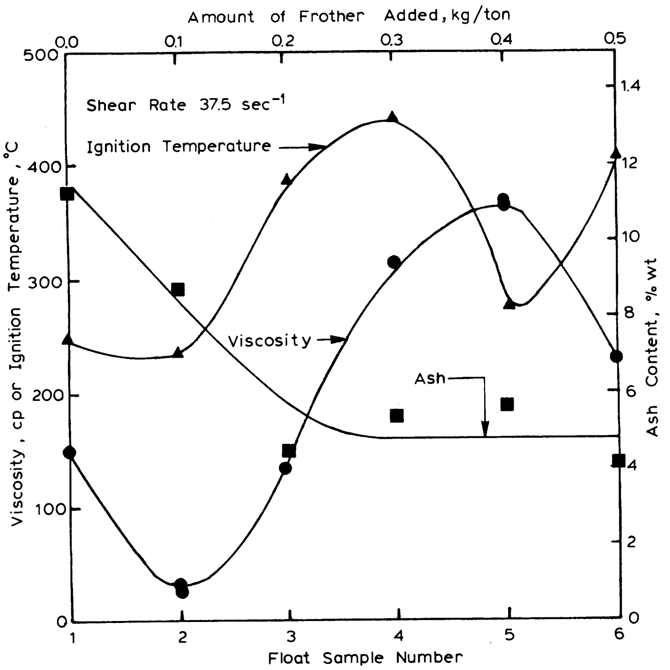

Fig. 1. Viscosity, ignition temperature and ash content of various float samples.

Ignition temperature was measured by a differential thermal analysis (DTA) technique. A DuPont 900 DTA assembly was employed with a heating rate of 100°C/min and 5 mg of sample at 2 cc/h of oxygen flow rate. The particle size was −200 mesh.

Ash content was determined using the standard ASTM procedure.

RESULTS AND DISCUSSION

Coal flotation

The ash content of the different float fractions as a function of the amount of frother added is shown in Fig. 1. The ash content at lower concentrations of frother addition probably is influenced by the higher hydrophobicity of coal particles which are associated with low amounts of mineral matter. It is to be noted that floatability of a coal particle is strongly influenced by its size and nature and amount of the ash-forming mineral constituents. For a given particle size, coal constituents (macerals) will have an effect on the overall floatability of the sample, the presence of a specific maceral, however, does not govern the floatability. High vitrinite content of a coal, for example, does not

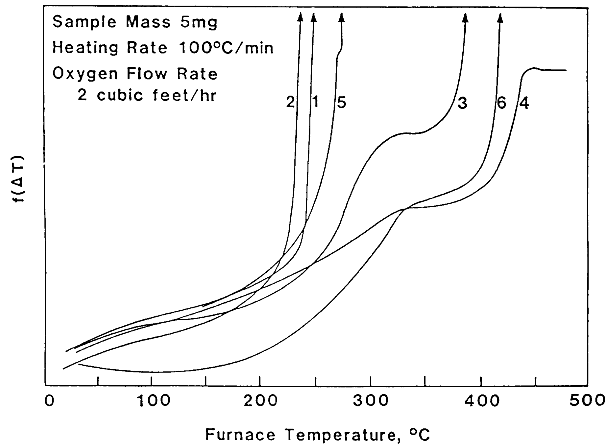

Fig. 2. DTA traces of various float samples showing the ignition behavior; curves 1, 2, 3, 4, 5 and 6 refer to float sample numbers.

ensure better floatability, flotation response of a coal of low reflectance, on the other hand, is generally poor [2].

Viscosity of coal–water mixtures

Viscosity of slurries prepared with floated coal samples are plotted in Fig. 1. It is observed that minimum viscosity is obtained for the fraction recovered with 0.1 kg/t of the frother and the viscosity goes through a maximum with increase in the amount of frother added. Since the viscosity has been known to decrease upon the addition of selected surface active agents, i.e. by making the coal surface hydrophobic, lower viscosity in the initial stages may be indicative of degree of the natural or induced hydrophobicity of the particles collected in different float fractions.

Ignition characteristics

Ignition behavior of float samples are represented by DTA traces in Fig. 2. The complete ignition condition is shown by upward arrows in DTA curves. It is interesting to note that the minimum ignition temperature (enhanced reactivity) is exhibited by the sample floated with 0.1 kg/t of frother. A detailed discussion of analyzing DTA traces for assessing relative reactivity of coal samples has been published elsewhere [3]. A minimum in viscosity of the prepared slurry using this coal fraction is also observed (Fig. 1). The reasons for the second inflection point in coal reactivity as well as in viscosity of coal slurry upon further addition of frother are not yet clear.

The results reported in the literature reveal that the role of macerals and of the mineral matter associated with them, in ignition and combustion characteristics, is quite complex [4–7]. The removal of mineral matter has been reported to alter the coal reactivity either due to changes in the surface area [6,7] or due to the specific catalytic effects of inert material (oxides) [8]. If the mineral content of coal acts as a catalyst then the removal of such material is expected to result in an increase in the ignition time. On the other hand, if it is inert, decrease in the mineral content may or may not have an effect on the ignition characteristics, depending upon other factors such as porosity and packing of the coal particles.

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