POSTER

INFLUENCE OF COAL RANK AND AIR PREOXIDATION UPON CHAR REACTIVITY

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INTRODUCTION

Oxidation during natural weathering, transport, stockpiling and other operations previous to utilization can markedly alter some properties of coals [1-5]. The oxidative mechanism and process by which coal properties are affected are discussed at length in the literature [6-7]. Nevertheless, the effect of oxidation on the combustion behaviour of coals has not yet been clearly elucidated [8,9]. Char combustion is a crucial step in the overal coal combustion process. A study was carried out in order to contribute to the understanding of the effect of coal preoxidation on the reactivity of the chars produced.

EXPERIMENTAL

Five coals of different rank (from a High A Bituminous coal to a semianthracite) and origin (USA, Australia, Spain) were used in this work. Table 1 shows the most important analytical characteristics of the coals.

Table 1. Characteristics of the coals used.

Coal	Proximate analysis (% wt)		
	Moisture	Ash (db)	V.M. (daf)
Va	0.9	18.0	13.0
Sa	0.9	26.0	20.8
Im	2.7	14.4	27.3
Tu	1.0	7.4	26.0
Pu	1.7	21.8	39.1

Air pre-oxidation of coals was performed at 200 °C during different periods of time, from 0 to 120 hours, in an oven with forced circulation of air.

Reactivity measurements were carried out in a TGA apparatus (Setaran TAG 24). The technique involves two steps: char preparation and reactivity measurement. The TGA apparatus enables continuous weight measurements to be made on a sample whilst it undergoes thermal treatment in a flowing controlled atmosphere. Specifically, the preparation technique involves heating about 15 mg (<0.212 mm in diameter size) of coal in a stream of nitrogen (50 cm^3 min^{-1}) to a maximum temperature of 850 °C, at a constant heating rate of 50 K min^{-1}. It is then held at that temperature for about 1 h, or until no further weight loss is observed. Aftherwards, the sample is cooled to 500 °C. After a period of time of about 15 min (thus ensuring thermal stability) a stream of dry air (50 cm^3 min^{-1}) is admitted to the apparatus. The weight of the sample is then continuously recorded. In addition, it was possible to record simultaneously the first derivative of weigth change with time (dw/dt).

The instantaneous reactivity is calculated by the following equation:

$$R_i = -\frac{1}{w}\frac{dw}{dt}$$

where R_i is the instantaneous reactivity (mg s^{-1} mg^{-1}), w is the weight (mg) of char (on an ash-free basis) unreacted at time t, and (dw/dt) is the weight loss rate (mg h^{-1}), calculated as the slope of the weight-loss versus time curve at time t.

RESULTS AND DISCUSSION

Char combustion is the slowest step in the combustion of a coal particle and hence char reactivity is important in determining the burn-out time. A reactivity test was performed to evaluate the relative reactivities of the chars. The chars were produced "in situ" in the TGA apparatus at 850 °C as indicated.

Plots of instantaneous reactivity -R_i- against percentage of burn-of indicated that R_i increased rapidily up to a determined value of burn-of and then decreased. A significant difference in the evolution of R_i versus time of reaction can be observed in relation with coal rank in Figure 1. This figure shows the evolution of instantaneous reactivity for the five coals studied. As can be seen, significant differences in the reactivity of the parent coals were observed.

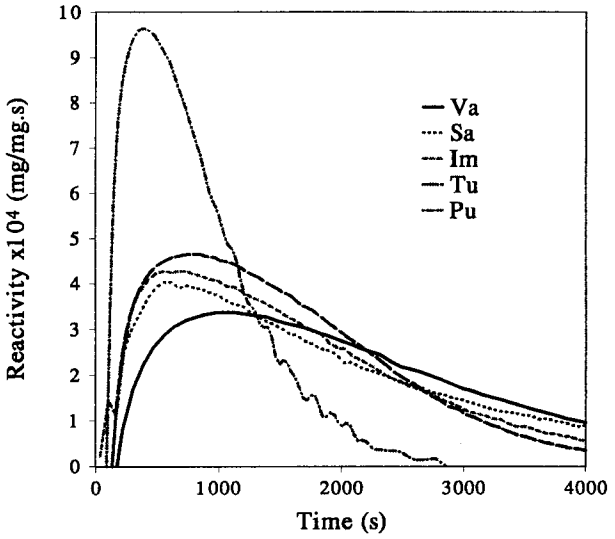

Figure 1.Evolution of instantaneous reactivity, R_i, for the coals studied.

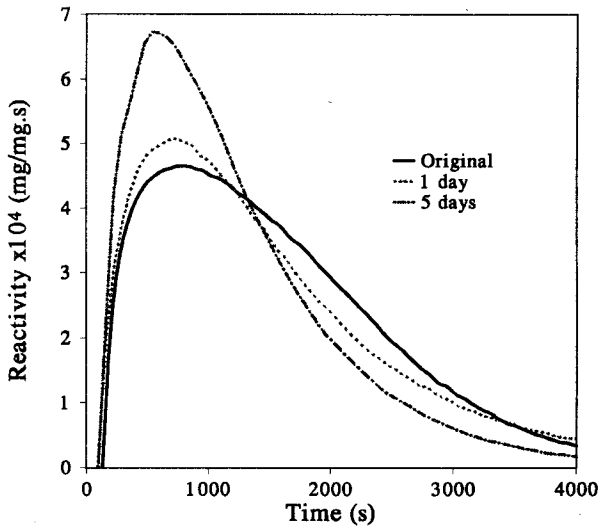

Figure 2. Evolution of the instantaneous reactivity for fresh and oxidized Tu coal.

For high rank coals such as Va semianthracite a slow decrease of R_i was observed after reaching the maximum value. On the other hand, high bituminous coals, such as Pu coal, exhibit a rapid decrease in instantaneous reactivity after the maximun value. In Figure 1 it can be observed that Pu coal exhibits the highest reactivity. This coal also presents the highest content in volatile matter.

The weight losses during the char oxidation period in TGA are higher for char samples from oxidized coals than those from the fresh coals, indicating higher reactivities in the chars produced from the oxidized coals. Figure 2 shows the weight-loss rate change during char combustion for fresh and oxidized Tu coal. Air oxidation produces an increase in the reactivity of the subsequent chars obtained for all the coals studied.

CONCLUSIONS

Air pre-oxidation of coal produced an increase in the reactivity of all the chars studied. Significant differences in the reactivity of the chars obtained from the parent coals were observed. Important modifications in their behaviour towards oxidation were also observed. Chars obtained from coals of the highest volatile matter content exhibit the highest reactivity.

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