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THERMAL ANALYSES OF WASHED, MICROWAVE TREATED AND MAGNETICALLY SEPARATED COALS OF SOUTH-EASTERN COALFIELDS, INDIA

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Abstract

The effects of beneficiation by washing and selective demineralisation based on the magnetic separation of microwave pre-treated samples, on the spontaneous heating tendency and thermal description of coals of South Eastern Coalfields, India using crossing point temperature and thermal analysis technique are presented.

Keywords: coals, magnetic separation, microwave treatment

Introduction

Coal is once again, gaining importance as the major source of energy and chemicals. It is, therefore, essential to focus attention to the mining, transportation and storage problems. The increase in production from the present rate of about 230 MT/annum to 400 MT/annum planned by 2000 AD will naturally result in considerable increase in the mineral contents of coal, as extraneous shale and other overburden mixing, will be unavoidable. Some of the catalytic effect in the oxidation of coal leading to spontaneous heating in large scale stacks. Therefore, it is very essential to determine the spontaneous heating tendency of coals with varying mineral contents so that the coal could be beneficiated to the specified level of mineral matter for its safe storage and processing economically. Selective demineralisation would be the right approach in this direction facilitating beneficiation through the removal of adverse mineral components. Microwave (MW) pretreatment has been found to selectively convert pyrite to highly magnetically susceptible pyrrhotite in coal without affecting the organic matrix [1, 2]. In addition, the size distribution and surface characteristics of ground material has been found to be favourable for beneficiation [3]. Furthermore, high magnetic susceptibility of MW treated material will help in dry beneficiation,

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thereby eliminating the loss of enriched fines in the effluent water. An attempt has, therefore, been made in the present work to determine the effect of beneficiation on the spontaneous heating tendency and thermal decomposition of washed, MW treated and magnetically separated coals using crossing point temperatures and thermal analyses technique.

Experimental

Seven coal samples of Chirimiri and Talcher coalfields which are known for their susceptibility to spontaneous heating, have been used. These coals are mostly high moisture (7 to 10%), high volatile (30 to 35%) and medium to high ash (20 to 30%) ones. The as-received coals were washed by modified float and sink method [4] to various density fractions and their respective crossing point temperature and thermal analyses were determined under static and dynamic air-flow conditions. The original samples were also microwave treated and magnetically separated, and their ignition temperatures and thermal analyses have also been determined. The crossing point temperature set-up essentially consists of a tubular furnace into which 4 g of –100 +200 ASTM mesh size sample is heated at an uniform heating rate of $1^{\circ}C\ min^{-1}$ using a constant air-flow rate of $80\ ml\ min^{-1}$ through it. The temperature at which the sample crosses over that of the furnace due to its exothermic oxidation reaction is taken as the crossing point temperature. Thermal analysis was carried out in a STANTON 625 instrument using a sample size of 10–15 mg of –100 +200 ASTM mesh at a heating rate of $10^{\circ}C\ min^{-1}$ in static and dynamic air-flow ($50\ ml\ min^{-1}$) conditions.

Results and discussion

The detailed experimental data is presented in Table 1. The effect of dynamic air-flow compared to static one, clearly shows a rapid rate of heat release as indicated by a very sharp exothermic rise (Figs 1a and b). But the thermal analysis under static air condition clearly show the resolution of endothermic peak which could possibly be due to the decomposition of carbonate and pyrite minerals [5, 6]. Furthermore, the peak maxima of higher density fractions having higher ash contents shifts towards the right. It is further interesting to note that the higher density fractions show endothermic peak between 400 to 500°C which is predominant in the case of MW treated samples compared to that of the lightest or the heaviest fractions. The CPT is found to increase up to a specific gravity of 1.5 to 1.6 and then it decreases (Fig. 2a). The lower CPT at higher specific gravities could, possibly, be due to the predominant presence or absence of carbonate minerals which is reflected also in the X-ray pattern. In addition, MW treated samples show higher heat release compared to the as-received and washed fractions. The thermal analysis of the magnetically separated as-received and MW treated samples are akin to the washed fractions, the non-magnetic portion being

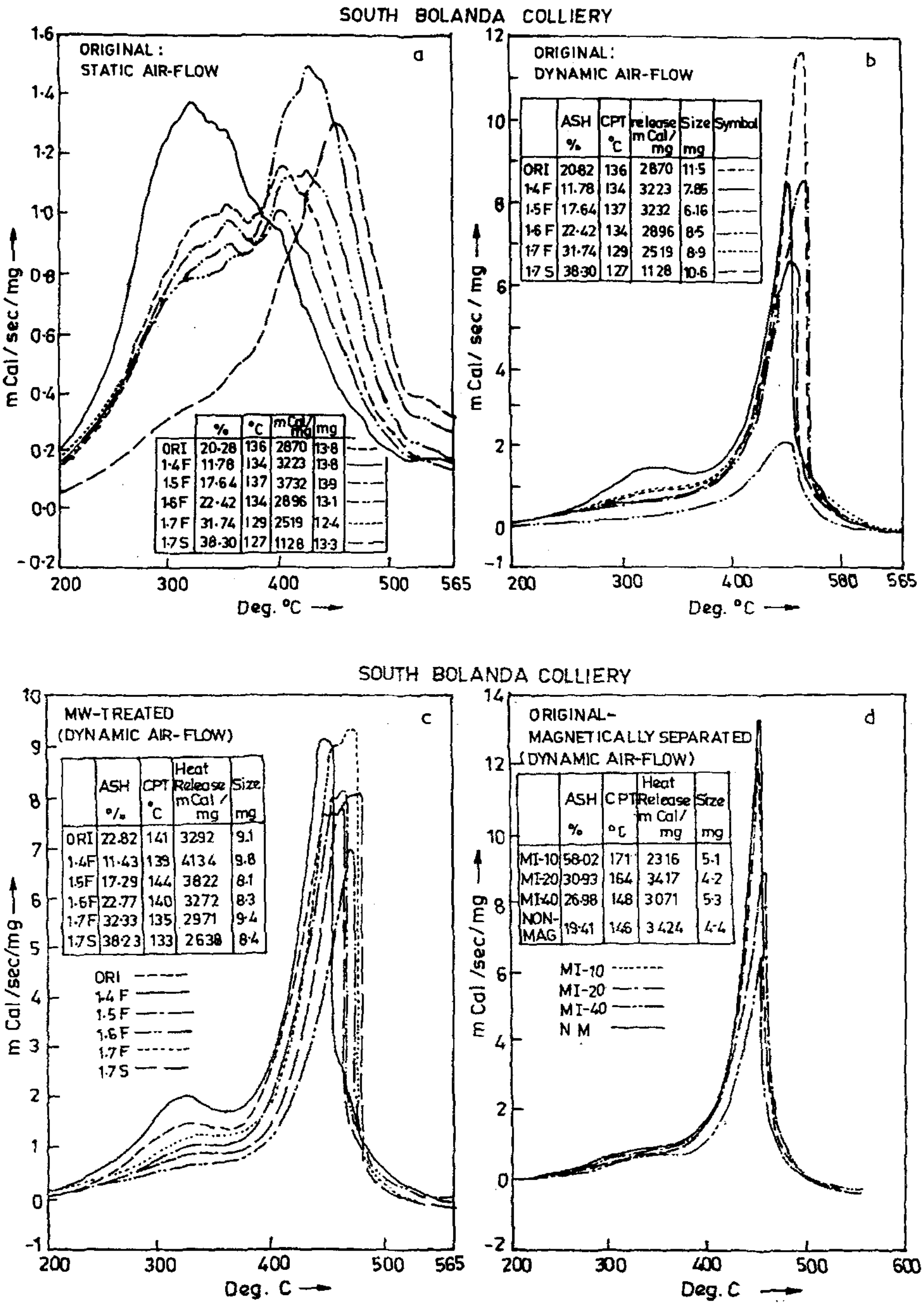

Fig. 1 Thermal analyses of beneficiated coals

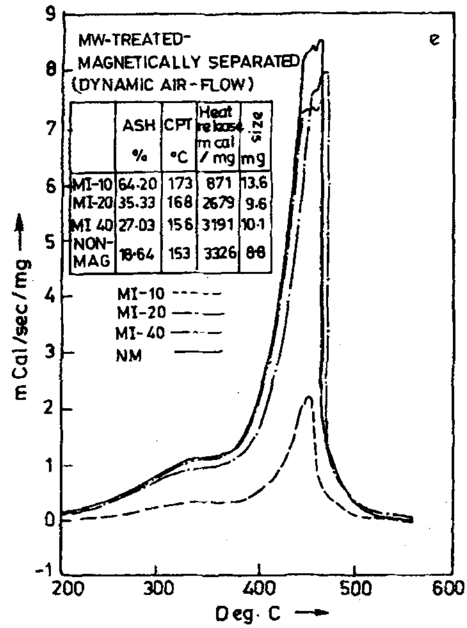

Fig. 1 (Continued) Thermal analyses of beneficiated coals

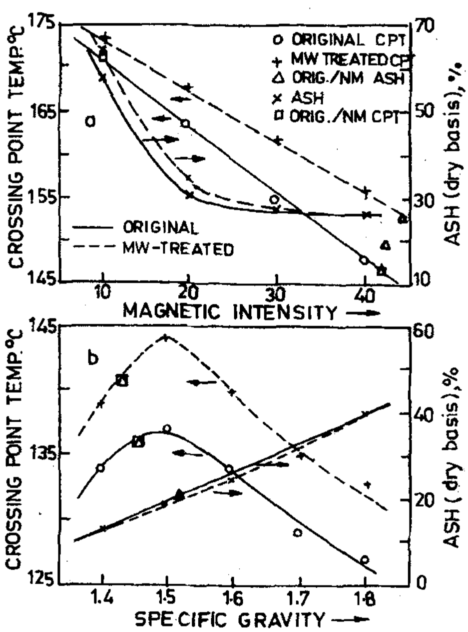

Fig. 2 Effect of beneficiation on crossing point temperature

Table 1 Experimental data of south bolamda colliery

	Without microwave treated				Microwave treated		
	ASH/ %	CPT/ °C	Heat release/ mcal mg^{-1}		ASH/ %	CPT/ °C	Heat release/ mcal mg^{-1}
			Static air	Dianmic air			Dianmic air
Original	20.82	136	1277	2870	22.82	141	3292
1.4 float	11.78	134	1335	3223	11.43	139	4134
1.5 float	17.64	137	1120	3232	17.29	144	3822
1.6 float	22.42	134	1247	2896	22.77	140	3272
1.7 float	31.74	129	1318	2519	32.33	135	2971
1.7 sink	38.30	127	781	1128	38.23	133	2638

	Without microwave treated magnetically separated			Microwave treated magnetically separated		
	ASH/ %	CPT/ °C	Heat release/ mcal mg^{-1}	ASH/ %	CPT/ oC	Heat release/ mcal mg^{-1}
			Dianmic air			Dianmic air
Original	20.82	136	2870	–	–	–
Mag. int. 10	58.02	171	2316	64.20	173	1871
Mag. int. 20	30.93	164	3417	35.33	168	2679
Mag. int. 40	26.98	148	3071	27.03	156	3191
Non-mag.	19.41	146	3424	18.64	153	3326

the lighest and those fractions which have been separated using decreasing magnetic intensity showing higher density and ash contents (Fig. 2b). MW treated and magnetically separated samples rather show very clearly the carbonate endo-peaks and higher CPTs compared to the as-received magnetically separated samples, though they have lower ash contents (Fig. 1c, d, e). This could be attributed to the significant effect of MW treatment on the decomposition of mineral matter.

Conclusion

The fractions obtained by the magnetic separation of microwave pre-treated coals or by microwave treatment alone, show higher CPTs, peak maxima and ash contents, mainly, due to the variation in the segregation of mineral contents in them.

MW pre-treatment of coals followed by either washing or magnetic separation and washing, if necessary, would facilitate effective and economic beneficiation through selective demineralisation.

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