Washability Study of Four Pakistani Coals by Float and Sink Technique-I

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(Received 3rd June, 1987; revised 12th March, 1989)

Summary: Washability studies of four coal samples obtained from Makarwal, Sor-Range, Degari and Shahrigh coal fields were made by float and sink technique using media of different specific gravities. The washability results were explained by suggesting that in Makarwal and Sor-Range coals most part of the ash forming materials might occur in close association with the coal structure, which are difficult to be separated by physical method of cleaning. In case of Degari and Shahrigh coals, however significant amounts of their ash forming materials might be present as discrete mineral matter, which could be separated to a considerable extent by physical method of cleaning.

Introduction

Coal which is composed mostly of carbonaceous material, has also variable amounts of ash forming inorganic matter. The inorganic matter in coal is objectionable in several of its applications. It causes slagging, fouling and corrosion of the combustion units. Moreover because of the increased tonnage use of coal for combustion, the presence of trace elements in coal are of great concern, because of their deleterious environmental effects [1]. Beneficial effects of mineral matter in coal liquefaction [2-5] and gasification [6-7] have also been reported.

The inorganic matter in coal is present in the form of discrete minerals, ionexchangeable cations and as chelated organometallic complexes, attached to the organic matrix. The inorganic matter present as discrete minerals can be easily removed by physical method of cleaning, using differences in the physical properties of coal and mineral matter [8]. However little success has been achieved in cases, where the inorganic matter is present either in very close association with the organic structure of coal or as discrete minerals of very small sized particles. Earlier work [9-10] have reported that a significant portion of the ash forming materials in low rank coals is bound directly to the organic matrix, rather than as discrete mineral phase.

The present investigation is an attempt to know whether Pakistani coals, which are of low rank would also have considerable amounts of their

ash forming matter as directly bound to the organic structure of coal, where separation by physical means will be impracticable or significant amount is present as discrete minerals as well.

Experimental

Sample preparation

Four Pakistani coal samples, obtained through PMDC from Makarwal, Sor-range, Degaria nd Shahrigh coal fields, were investigated in the current project. The coal samples were crushed in a porcelain pestle and mortar and were screened through 0.6 mm and 0.3 mm screens. The products, which passed through 0.6 mm screen and retained on 0.3 mm screen were dried at 110°C in an oven and used for ash analysis and washability studies.

Coal Fractionation by Specific Gravity Separation Method

Two grams portions from each of the coal samples were added to each of five separating funnels containing 50 ml baths of different specific gravities. The baths choosen were ethylene dichloride (Sp.G.1.282), chloroform (SP. G. 1.489) carbon tetrachloride (Sp. G. 1.632) and a mixture of 50% chloroform and 50% ethylene dichloride (Sp.G.1.385) and a mixture of 40% chloroform and 60% ethylene dichloride (Sp. G.1.365). The separating funnels were shaken several times carefully and were allowed to settle. The coal, distributed in float and sink fraction, was separated and filtered through dried and weighed whatman filter papers. The float and sink fractions, alongwith the filter papers, were dried at 110°C in an oven; cooled in a dessicator and weighed.

Ashing of coal

The float and sink fractions as well as whole coal samples were ashed at 750°C in a muffle furnace, until ashing was completed as indicated by the complete absence of coal particles, which took 2-4 hours depending on the amount of coal fractions.

Results and Discussion

The washability characteristics of four Pakistani coal samples are given in Table-1. In the case of Makarwal coal, increase in float fractions and decrease in sink fractions are quite significant with increase in specific gravity of the medium. With ethylene dichloride, the amount of float fraction is quite low, whereas the sink fraction is quite high. In case of carbon tetrachloride, most of the coal comes as float product and very negligible fraction comes as sink product. The % ash contents of the various float and sink fractions and the ratio between the % ash contents of float fractions and the whole coal (R) show that considerable amounts of the ash forming material comes into the float fractions with a resultant less enrichment in the sink products. This shows that nearly all of the ash forming material in Makarwal coal, eventhough low, might be present in close association with the coal structure [9,10] and is difficult to be separated by physical methods of cleaning. The ash contents of the float fraction in the case of ethylene dichloride and the sink fractions in the case of chloroform and carbon tetrachloride were not determined because of very small amounts of the fractions.

The washability characteristics of Sor-range coal show that similar to Makarwal coal, most of the coal comes as sink fractions with medium of lowest specific gravity (ethylene dichloride) and as float fraction with medium of highest specific gravity (carbon tetrachloride). The results also show that most of the ash forming material comes into the float fractions and less enrichment occur in the sink product. This indicates that Sor-range coal might also have most of its ash forming material in close association with the organic structure of coal, where separation by physical means is impracticable.

The washability characteristics of Degari coal show that unlike Makarwal and Sor-range coal, a considerable amount of coal fraction comes as sink product with medium of highest specific gravity (carbon tetrachloride). The % ash in the float and sink products and the ratio R show that unlike Makarwal and Sor-range coals, considerable enrichment of ash forming material occur in the sink products in case of Degari coal. This shows that in the case of Degari coal, most of the ash forming material might be present as discrete mineral matter, which are easy to be separated to a considerable extent with the specific gravity method of separation.

The washability results of Shahrigh coal show that similar to Degari coal, a significant amount of

Table 1: Washibility characteristics of Four Pakistani Coal samples with media of Different specific Grevities

S.No.	Solvent	% Float Product				% Sink Product				% Ash in Float Product				% Ash in Sink Product				% Ash in Float Product / % Ash in whole coal x 100			
		Maker wal	Sor-range	Deg-ari	Shah righ	Maker wal	Sor-range	Deg-ari	Shah righ	Maker wal	Sor-range	Deg-ari	Shah righ	Maker wal	Sor-range	Deg-ari	Shah righ	Maker wal	Sor-range	Deg-ari	Shah righ
1.	Ethylene dichloride (SP.G. 1.282)	0.50	2.00	0.51	10.05	95.70	97.82	100.0	92.60	-	-	-	1.69	2.29	5.58	8.21	15.58	-	-	-	12.71
2.	60% Ethylene dichloride 40% Chloroform (SP.G.1.365)	52.92	23.30	66.82	68.26	44.63	76.42	35.05	32.17	0.96	4.19	3.33	2.89	3.18	6.01	23.25	42.90	49.23	78.02	34.61	21.75
3.	50% Ethylene Dichloride 50% Chloroform (SP.G.1.385)	69.26	43.00	74.20	72.11	30.43	58.50	27.20	29.92	1.21	3.65	3.53	3.56	3.68	6.98	31.03	44.60	62.05	67.97	36.69	26.82
4.	Chloroform (SP.G.1.489)	98.48	97.57	86.92	79.71	2.30	4.95	13.33	21.86	1.53	4.10	3.74	4.46	-	-	50.23	61.05	78.46	76.35	38.87	34.36
5.	Carbon tetrachloride (SP.G.1.632)	99.65	99.40	88.80	84.03	0.20	2.17	10.23	15.72	1.83	4.47	4.49	5.08	-	-	60.31	60.80	93.84	83.24	46.67	38.28

Ash of whole Coal; Makerwal - 1.95%; Sor-range - 5.37%; Degari - 9.62%; Shahrigh - 13.27%.

coal comes as sink product with medium of highest specific gravity (carbon tetrachloride). The % ash contents of the various fractions and the ratio R shows that considerable enrichment of the ash forming materials have occurred in the sink fractions especially with medium of the highest specific gravity. The washability studies of the four coal samples show that Shahrigh and Degari coals, might have highest amount of their ash forming materials present as easily separable discrete mineral matter. Makarwal and Sor-range coals, on the other hand might have most of their ash forming materials as closely associated with the organic structure of the coal, which are difficult to be separated by physical method of cleaning.

The % ash contents of the four coal samples are given as footnote under Table-1. Makarwal and Shahrigh coals have respectively the lowest and highest ash contents of the four coal samples. The ash contents of all the four coal samples, determined in the present investigation, are quite low compared to those determined in our earlier unpublished studies and also to the reported literature values for the same coals [11]. The obvious reason is that in our earlier work, analysis were made on the R.O.M. samples, which contained large visible lumps of inorganic matter. Whereas selected coal samples free from visible lumps of inorganic matter were used in the present investigation. The R.O.M. samples would have maximum amounts of their ash forming material derived from mineral matter of roofs and floors of coal mines. The ash content of coal can thus be significantly reduced by improved methods of mining, which avoids, to a greater extent, the inclusion of extraneous mineral matter into the coal sample.

References

1. Ahmad N. and Simon F.O., Ist Pakistan National Coal Conference p. 187, February, 22-26, (1986).
2. Zubovic, Peter, Hatch. Jr., and Medlin J.H., United Nations Symposium on World Coal Prospects, Katowice, Vol. 3, 67- 91, October, 15-23 (1979).
3. Tarrer A.R., Guin J.A., Pitts W.S., Henley, J.P., Prather J.W. and Styles G.A. In "Liquid Fuels from Coal" (R.T. Ellington, ed.) p. 45 (1977). Academic Press New York.
4. Given P.H., Cronauer D.C., Spackman W., Lovell H.L., Davis A., and Biswas B., *Fuel* **54,** *34 (1975).*
5. Mukherjee D. and Chowdhary P.B. *Fuel* **55,** *4 (1976).*
6. Gray D., *Fuel* **57,** *213 (1978).*
7. Walker P.L. Jr., Rusinko F. Jr., and Austin L.G. *Adv. Catal.,* **11,** *134 (1959).*
8. Walker P.L. Jr., Shelef M., and Anderson R.A., In "Chemistry and Physics of Carbon" (P.L.Walker, Jr., ed.) Vol. 4, 287 (1968), Dekker, New York.
9. Durie R.A., *Fuel,* **40,** *407 (1961).*
10. Kiss M.T. and King G.N., *Fuel,* **56,** *340 (1977).*
11. Qureshi G.A., 1st Pakistan National Coal Conference, p 397, February 22-26 (1986).