UPGRADING OF PAKISTAN COALS BY DE-ASHING

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Pakistan coals, high in ash, were subjected to dense-medium separation at the specific gravities in the range of 1.30 to 1.50. Due to the concentration of pyrites and sulphates in the sinks, the lighter fractions were found to have been reduced in ash as well as in sulphur. The calorific value of the clean coal was found to have been improved.

Introduction

Most of the coals occurring in different areas of West Pakistan belong to the Tertiary Age and have high ash, sulphur and volatile matter and low calorific value. Their utilization in industry or for domestic purposes is, therefore, limited. Studies carried out in the laboratories of the Council on the desulphurisation[1] and carbonisation[2] of these coals have already been reported. Earlier, in 1950, while surveying the coal deposits of Pakistan, Powell Duffryn Technical Services Ltd. had reported[3] that some of the high ash content coals are amenable to washing with no appreciable reduction in the sulphur content. Due to higher ash content in the fresh samples, washability tests have been carried out again. It is found that partial desulphurisation does take place, most probably due to the concentration of pyrites and sulphates in the heavier fractions, which are ultimately eliminated as sinks.

In our investigations five different coals, representing high ash were taken for dense-medium separation. The proximate analysis of these coals is given in Table 1. Except the coal from Jhimpir, all other samples were found amenable to washing with respect to the yield of clean coal and ash content as shown in Fig. 1. As a result

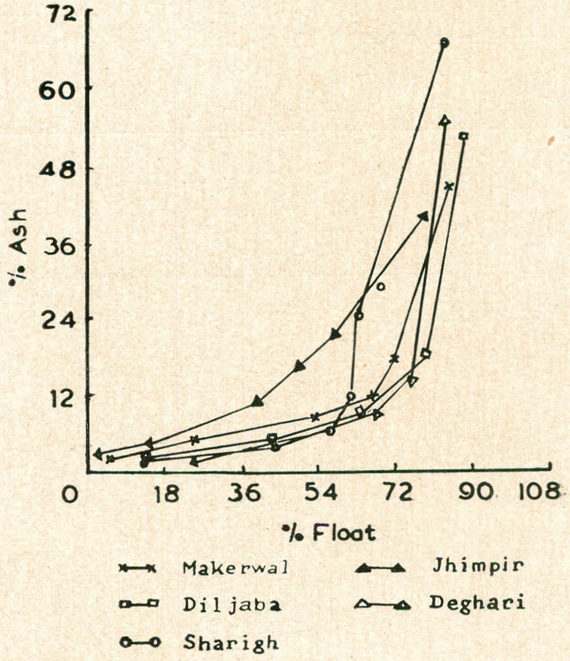

Fig. 1.

TABLE 1.

Coal	Yield %	Moisture %	Ash %	Volatile matter %	Fixed carbon %	Total S %	Gross calorific value K. cal./g.	Sink Actual wt.	Eq. to original coal in heat
Makerwal (Original)	—	4.30	16.70	45.65	33.35	5.40	5950	—	—
Makerwal (Clean)	74.45	2.62	7.30	46.30	43.72	3.74	6780	24.00	15.10
Diljaba (Original)	—	3.90	22.64	34.46	39.00	3.20	5480	—	—
Diljaba (Clean)	78.44	6.40	5.97	40.90	46.73	2.37	6140	21.56	12.60
Sharigh (Original)	—	3.80	27.60	36.90	33.20	5.45	5500	—	—
Sharigh (Clean)	67.10	3.21	4.00	44.70	48.08	3.03	6240	32.90	24.00
Deghari (Original)	—	5.41	34.68	31.68	28.28	3.64	5050	—	—
Deghari (Clean)	77.70	4.20	4.92	44.02	46.86	2.84	6352	22.30	6.90

of the experiments carried out, optimum conditions were obtained at a specific gravity of 1.45 and the maximum yield of floats was found to be around 75% with a minimum ash content in the range of 5-7% except in the case of Sharigh coal.

Experimental

The separation was effected by means of a mixture of carbon tetrachloride and benzene in suitable proportions to obtain the required specific gravity, ranging from 1.30 to 1.50. About 100 g. of air-dried coal (-12+25) mesh B.S.S., were stirred with a glass rod in a tall cylinder of 500 ml. capacity, containing a mixture of carbon tetrachloride and benzene.[4] The contents were allowed to stand for five minutes. The lighter fractions of coal were then skimmed off with a perforated spoon and dried in oven at 80°C. at atmospheric pressure. The heavier fractions were obtained by filtration through a filter paper (Whatman No. 1), and dried likewise. The ash content of fractions obtained at different specific gravities were determined and are tabulated with yield in Table 2.

At the optimum specific gravity a bulk separation was made and relevant analysis carried out

TABLE 2.

Coal	Sp. gr.	Float by wt. %	Cumulative wt.	Cumulative % by wt. to the middle of fraction	Ash on fraction %	True average ash %
Makerwal	1.30	7.65	7.65	3.82	2.70	2.70
	1.35	35.80	43.45	25.55	4.52	5.06
	1.40	19.20	62.65	53.05	8.68	6.17
	1.45	8.42	71.07	66.86	11.85	6.80
	1.50	3.38	74.45	72.76	17.90	7.30
	Sink	24.00	98.45	86.45	44.72	16.40
Diljaba	1.30	26.00	26.00	13.00	3.19	3.19
	1.35	33.00	59.00	62.50	4.97	4.20
	1.40	11.80	70.80	64.90	9.40	5.07
	1.45	7.64	78.44	74.57	14.40	5.97
	1.50	4.90	80.34	79.39	84.00	9.40
	Sink	19.10	99.44	89.89	70.00	21.40
Sharigh	1.30	50.50	50.50	25.25	2.60	2.60
	1.35	12.80	63.30	56.90	6.40	3.55
	1.40	3.80	67.10	65.20	11.52	4.00
	1.45	1.40	68.50	67.80	24.60	8.95
	1.50	1.20	69.70	69.10	29.50	9.34
	Sink	29.20	98.90	84.30	66.60	26.30
Deghari	1.30	22.00	22.00	11.00	2.50	2.50
	1.35	41.90	63.90	42.95	4.08	3.53
	1.40	8.80	72.70	68.30	9.90	4.30
	1.45	5.00	77.70	75.20	14.72	4.92
	1.50	2.80	80.50	79.10	29.60	5.78
	Sink	19.30	99.80	85.15	56.20	34.70
Jhimpir	1.30	5.26	5.26	2.63	3.27	3.27
	1.35	18.60	23.86	40.56	4.70	4.38
	1.40	22.55	46.41	40.13	11.60	7.87
	1.45	8.32	54.73	50.53	17.40	9.35
	1.50	3.27	58.00	56.36	21.96	10.07
	Sink	42.00	100.00	79.00	40.00	22.70

TABLE 3.—DISTRIBUTION OF SULPHUR.

Coal	Total sulphur %	Pyritic sulphur %	Sulphate sulphur %	Organic sulphur (by diff.) %	Total sulphur reduced %
Makerwal (Original)	4.50	2.80	1.11	2.01	—
Makerwal (Clean)	3.74	0.44	0.65	2.65	30.70
Sink	11.76	9.65	1.56	0.55	—
Diljaba (Original)	3.20	1.28	0.22	1.70	—
Diljaba (Clean)	2.37	0.34	0.20	1.83	25.00
Sink	6.30	4.80	0.29	1.20	—
Deghari (Original)	3.64	1.47	0.95	1.22	—
Deghari (Clean)	3.03	0.97	0.43	1.81	16.40
Sink	5.85	4.68	0.82	0.35	—
Sharigh (Original)	4.45	1.58	1.41	2.46	—
Sharigh (Clean)	2.84	0.42	0.50	1.92	47.90
Sink	11.80	7.71	1.73	1.36	—

in the washed and the rejected coals shown in Table 3.

Results and Discussion

As would appear from Table 2, the yield of clean coal at a suitable specific gravity of 1.4-1.45 is in the range of 62-78% except for the Sharigh coal which gives a comparatively lower yield. It may also be noted that the amount of sinks reduced in terms of original coal with respect to available calorfic value, further compensates for the lower yield of clean coal in all the cases as may be seen in Table 3. The higher ash content of sinks necessitates their removal.

The distribution of sulphur in various forms in the original, washed and rejected portions of coals is shown in Table 3, wherefrom it may be seen that it is mostly inorganic sulphur that is contributory towards the removal of ash from the clean coal. It is also clear that the total sulphur content in the sinks has increased mostly due to pyrites and sulphates, which being heavier, settle with the sinks.

Conclusion

The washed coal serves as a good starting material for carbonisation. After carbonisation the ash content is increased in the semi-coke or coke obtained as residue depending on the temperature applied. Reduction of the inorganic sulphur takes place with no appreciable increase in the volatile matter, whereas in the process of superheated steam treatment with the reduction in total sulphur, the carbon content is fixed in such a way that the percentage of the volatile matter is very much reduced. The elimination of a major portion of pyrites and iron from the clean coal should decrease the sulphur-retaining tendency[5] of the residue at the time of carbonisation and superheated steam treatment. The clean coal, which is low in ash and sulphur, may be used in suitable mixture with imported coking coal for use in locomotives. The separating medium used in the laboratory investigations is a mixture of carbon tetrachloride and benzene but on an industrial scale cheaper media will be used.

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