REACTIVITY OF COLOMBIAN COALS TOWARD COMBUSTION

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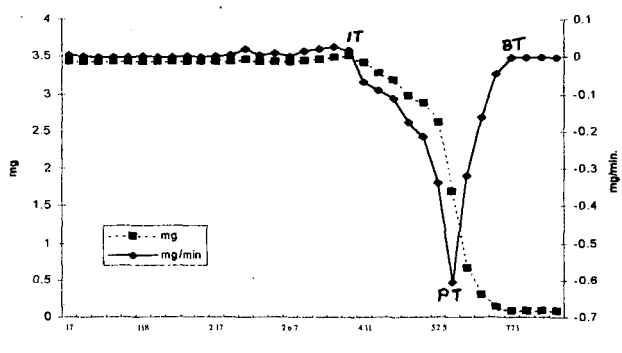
With the new world wide environment regulations, special attention is given to combustion efficiency in the electric utilities. Colombian coals are of cretaceous origen and the behavior towards combustion is different to the European and North American coals. The increase of international coal market has also created new power station operational problems in the areas of ignition, ash properties and residual carbon in ash (1) so the charaterization of coal toward combustion behavior is increasily important.. The study of pulverized coal char reactivity has been done by Drop tube reactor and Wire mesh tests. However these equipments are not common in most laboratories and easier methods must been suitable. Cumming (2) has done burning profile test to assessing the coal reactivity by DTG output from thermobalance system.. This combustion profile test has been subsecuently used by different authors (3)(4)(5)(6) as a method for characterization of coal burning properties. Pisupati (5) has found a good correlation between the Drop tube reactor test and the ignition temperature. Zhan (7) has also found that the reactivity estimated from the burn out measurement on stainless steel plate at 800°C and DTG technique in the higher temperature range match quite well.

The Martin del Corral Power Station localized near to Bogotá, is burning medium to low volatile coal and the fly ash carbon content is surprisingly high between 18-30%. The objective of the present work is to evaluted the reactivty profile of the coals used in the utility and to compare with the industrial test done in a boiler.

Experimental

Fresh samples of coals localized in the zone of influence of the Power Station were characterized and evaluated its combustibility by the combustion profile method using TGA non isotherm method.The differential thermogravimetric (DTG) test were carried out using a Perkin Elmer TGA equipment. About 5mg of pulverized sample, less than 75μm was spread into the crucible and the system was heated at a heating rate of 20 °C min^{-1} until 900 °C. A residence time at 120 °C for 5 minutes was fixed to permit the release of moisture. In the burnig profile, figure 1, three points can be clearly define; the initial temperature (IT) is defined as the temperature at which the rate of weigt loss excess 0.1% after the moisture peak., the peak temperature (TP) is defined as the temperature at which the rate of weight loss was a maximun and the burnout temperature (BP) is the temperature at which the rate loss decreased less than 1.0% min^{-1}.

FIGURE 1. COMBUSTION PROFILE

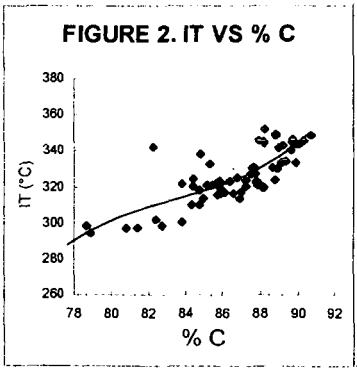


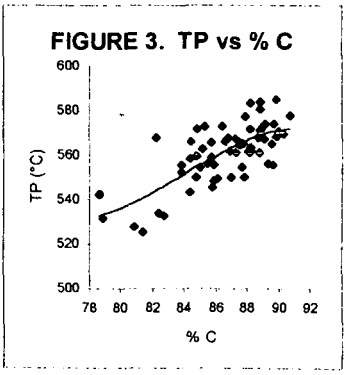
At the thermoelectric plant three coals were fired during the test in a 343.000 lb steam/h boiler. A tipical blend of the medium volatile bituminous coals a single low volatile bituminous coal and a single high volatile bituminous coal.

Results and discussion.

Table 1 shows the analytical data of the coal used. The rank of coal goes from low volatile to high volatiles bituminous C. Figure 1 shows a tipical burning profile of the coal used. The region of weight gains between 200-300°C indicates chemisorption of oxygen. Some peaks and shoulders observed before TP are believed to be due to quick release of volatile matter or to the evolution of trapped material into the macromolecular structure of coal.

In the burning profile, IT indicates the temperature at which start the evolution of small moities of organic matter and can be related with the rank of the coal used. Figure 2, shows that there is an increase of the IT as the rank of coal increases. The related curve has two breaks at 80%C and 87%C which correspond to the coalification jumps of the bituminous coals. Similar tendency can be observed for PT, figure 3. Not correlation was found for the BP. It is well known that the volatile matter content [VMC] is an indicative of the rank of coal and as expected a good linear relation with a 0.83 correlation factor, was found for the IT, as shown in the figure 4. The lower IT (297.10 °C) was found for the higest VMC (46.39%) while a IT of 348 °C was found for the lowest one (20.23%).





Pisupati (5) has found a good correlation betwen IT and the combustion efficience in an industrial scale demostration boiler. In this work a good correlation was found between IT and the VMC, indicating that it is a good index for study the behavior of coal during combustion and this criteria was used for the selection of the industrial test. Table 2 shows the analytical data of the coal used in the industrial scale test. The boiler efficience the three coals were: 80.89 for the coal with the lower VMC; 84.74 for the coal with the highest VMC and 83.70 for the industrial blend.

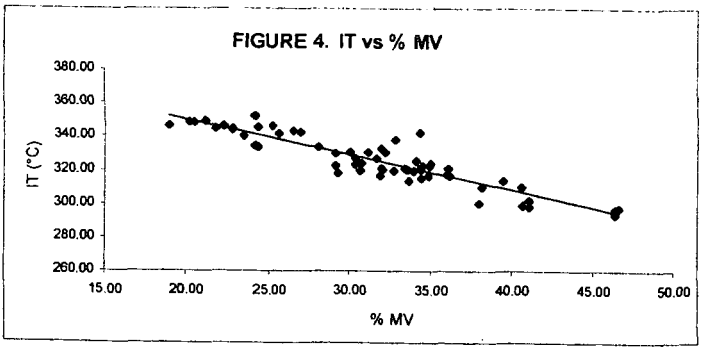


Table 1. Analytical data of the coal used.

Sample No	%H_2O (a)	%Ash (a)	%V.M (b)	%C (b)	%H (b)	%N (b)	%S (a)
1	0.89	8.05	30.35	86.39	5.49	1.83	0.81
2	1.02	10.03	30.68	87.25	5.60	2.00	0.92
3	0.85	14.12	34.14	86.79	5.63	2.25	0.89
4	1.94	6.90	32.71	88.21	5.71	2.04	1.17
5	1.22	4.55	22.77	89.65	5.00	1.78	0.58
6	0.97	12.82	25.60	89.02	5.31	1.96	0.45
7	1.40	14.48	21.81	88.21	4.97	1.64	0.35
8	1.40	5.15	22.38	89.71	4.62	1.77	0.51
9	0.95	3.64	23.50	89.56	5.08	1.80	0.69
10	0.90	20.51	33.55	84.43	5.92	1.79	0.88
11	1.04	22.61	34.33	82.28	5.53	1.96	7.15
12	1.10	25.87	35.04	84.40	5.86	1.93	1.47
13	0.93	9.64	36.12	85.46	5.83	2.05	1.24
14	0.80	20.67	32.78	84.82	5.65	2.08	4.34
15	1.04	5.96	32.16	88.68	5.63	1.82	1.03
16	2.24	9.30	46.63	80.80	6.31	1.79	1.33
17	0.99	4.76	18.99	90.31	4.71	1.71	0.44
18	1.14	8.37	38.13	84.77	5.89	2.01	0.76
19	1.16	12.84	34.51	85.70	5.67	1.93	1.59
20	0.96	5.53	24.31	89.87	5.19	1.87	0.45
21	0.79	13.24	29.17	88.89	5.64	1.99	0.79
22	0.68	5.70	24.32	88.20	5.27	1.86	0.65
23	1.18	14.92	40.61	84.36	6.05	1.91	0.68
24	1.48	10.86	41.02	82.42	5.85	1.76	1.84
25	1.11	13.14	34.41	83.84	5.71	1.88	2.06
26	1.16	11.10	39.42	84.99	5.82	1.80	0.99
27	2.26	18.52	46.39	81.42	6.46	1.75	1.64
28	2.61	14.09	46.43	78.90	6.31	1.79	2.98
29	1.88	19.72	40.66	78.66	6.02	1.67	0.59
30	0.92	21.57	29.31	84.78	5.86	1.86	1.10
31	1.12	15.81	36.01	86.96	5.93	1.94	0.39
32	2.15	5.54	41.06	82.74	6.03	1.79	0.81
33	0.92	16.24	33.40	85.18	5.79	1.87	0.93
34	0.85	12.18	34.40	85.68	5.70	2.15	1.09
35	0.68	21.23	25.27	87.91	5.17	1.66	2.04
36	2.26	3.33	38.03	83.83	5.79	1.82	0.52
37	1.03	9.03	34.83	86.11	5.71	2.00	1.10
38	1.26	6.06	36.16	85.88	5.76	1.82	0.70
39	0.76	20.50	24.17	88.23	5.17	5.97	1.20
40	0.98	6.33	34.42	87.27	5.55	1.89	0.49
41	1.08	5.48	34.91	85.84	5.66	1.92	1.02
42	1.29	7.82	31.99	87.85	5.55	1.86	0.65
43	0.93	11.52	29.16	87.79	5.60	2.00	2.03
44	1.18	4.77	33.98	85.82	5.70	1.85	0.71
45	1.57	4.70	33.62	86.88	5.54	1.93	0.48
46	1.09	6.08	31.69	87.70	5.59	1.87	1.03
47	1.35	5.45	31.91	86.60	5.52	1.92	0.44
48	0.70	6.42	31.16	87.62	5.52	1.93	0.65
49	0.96	4.86	32.01	88.05	5.65	1.83	0.89
50	1.01	3.75	31.99	85.31	5.38	1.90	0.53
51	1.13	6.18	30.02	87.57	5.47	1.87	1.21
52	0.86	10.13	26.96	89.18	5.46	1.97	1.14
53	0.95	5.14	30.38	87.49	5.61	1.83	0.81
54	0.90	4.72	30.71	88.77	5.46	1.90	0.45
55	1.17	3.96	30.66	88.14	5.41	1.72	0.39
56	0.78	5.09	28.04	89.11	5.45	1.75	0.71
57	0.66	4.28	26.57	90.04	5.31	1.75	0.55
58	0.98	9.96	21.21	88.84	4.93	1.79	0.49
59	0.81	7.78	22.80	89.87	5.11	1.75	0.50
60	0.70	4.18	24.16	89.31	5.08	1.72	0.45
61	0.73	7.68	20.53	88.87	4.83	1.78	0.50
62	0.79	4.69	20.23	90.71	4.73	1.70	0.53

Where:(a), as determined; (b), moisture ash free basis

Table 2. Analytical data of the coal used in the industrial boiler test.

Sample	%H_2O (a)	%V. M (a)	%Ash (b)	%C (b)	%H (b)	%N (b)	%S (a)
003	2.04	30.03	19.38	84.63	4.20	1.65	1.48
163	1.37	26.65	16.91	87.78	4.06	1.95	0.96
mixture	1.53	27.89	20.12	85.55	4.08	1.70	1.57

Where:(a), as determined; (b), moisture ash free basis

This results shows that when working with bituminous coal the VMC is a good approach for the design of the burning coal blend. To have high volatile coal in the blend is important since its ignition temperature is lower and it will be the first ones in burning, given full speed in the burning of the other coals.

Acknowledgments

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