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MICROBIAL DESULPHURIZATION OF LAKHRA COAL IN ETHANOL AMINO OLEATE SOLUTION

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Studies on microbial desulphurization of Lakhra coal (less than 100 mesh size) were conducted, with mixed culture, by continuous agitation and under pH value of 1.8, in 0.004% ethanol amino oleate solution, resulting in 92.4% pyrite removal.

Key words: Coal, Desulphurization and Microbial technique.

Introduction

Pakistani coal is lignite to sub-bituminous having high ash and high sulphur. Especially in Lakhra coal (which are the second largest deposits of Pakistan), the sulphur contents varies from 2.2 to 9.6% [1] because of the expected environmental drawbacks. Attention has also been paid to technologies for cleaning coal before combustion. One of the option is the removal of finely dispersed sulphidic minerals from coal by means of microbial technique. So keeping in view the high sulphur content, microbial technique was applied for Lakhra coal.

Chemical engineering principles of the microbial desulphurization were discussed by T. F. Huber *et al.* [2]. A kinetic model for bacterial growth, pyrite oxidation and scale-up of a reactor for microbial desulphurization of coal was designed resulting in 90% pyrite removal [3]. Smaller particles size resulted in increased pyrite removal [4]. Pilot scale experiments were carried out by shaking powdered coal with bacterial suspension yielding 51.8% S-removal [5]. Dugan has reported that mixed bacterial culture reduce S-from coal in a more effective manner than pure culture, the rate of reduction can reach upto 65-70 gm/L [6]. Mixed culture with pH 2.5 and ambient temperature, with less than 100 mesh particle size, shows 90% removal of pyritic sulphur, in a period of two weeks [7].

Materials and Methods

Incubator of "Karl Kolb" was used for maintaining the temperature. Total sulphur was determined according to ASTM D-3177-75 by "Herous" tube furnace [8]. Pyritic sulphur was determined by ASTM D-2492 [9].

In this study the mixed bacterial culture, originally obtained from an odoriferous canal behind N.E.D. University Campus, was used. Various concentrations of bacterial samples were prepared according to the method reported by D. J. Merchant *et al.* [10]. A starter culture was prepared on an artificial medium [11]. This culture was maintained on Lakhra coal (of less than 100 mesh size), by transferring each to 5 weeks time, in 20% (w/v) slurry with 0.004% ethanol amino oleate solution, instead of mineral salt solution [12]. The pH was adjusted to 1.8 by the addition of 18 M H_2SO_4 [3], at temperature 20, 30 and 35°. Proximate analysis and sulphur contents (total and forms) in this coal are presented in Table 1.

Different quantity of bacteria i.e. inoculation of 1075, 2100, 4100 and 6300 per ml with agitation and without agitation were carried out. Stock culture was prepared approximately twelve days prior to the inoculation of the coal suspension.

Results and Dicussion

Three batches of experiments were performed on coal samples, containing 4.57% total sulphur, including 1.57% pyritic sulphur. The data for Lakhra coal have been recorded in Table 1.

Table 2 shows the results of experiments, at temperature 20, 30 and 35°, with different quantity of bacteria i.e. 1075, 2100, 4200 and 6300 bacteria per ml and the analysis of leached samples for pyritic sulphur.

Time plays an important role in sulphur reduction, specially upto the regime change i.e. as the contact time is increased, the sulphur reduction is also increased and the explanation for that is the more availability of pyritic sulphur surface area. After 168 hrs. time the regime change is complete. During this period no significant reduction in sulphur was found. The reason for this seems to be non-availability of pyritic sulphur on the surface of the coal, that means time is an

TABLE 1. PROXIMATE AND SULPHUR (TOTAL AND FORMS) ANALYSIS.

Ash	19.2%	Moisture	9.1%
Volatile matter	39.3	Fixed Carbon	32.4
Calorific value	9,410 Btu/lb	Sulphate sulphur	0.37%
Pyritic sulphur	1.57%	Organic sulphur	2.7%
Total sulphur	4.57%	S-combustible	4.31%
S-Non combustible	0.26%	C	52.1%
H	5.2%	N	0.7%

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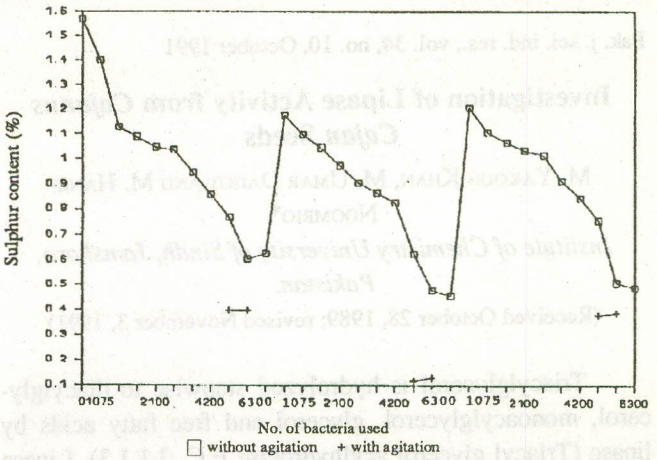
TABLE 2.

S. No.	Quantity of bacteria/ ml	Tempera-ture °C	Time hrs.	% of Pyritic sulphur with/without agitation	
1	1075	120°	120		1.40
2	–	–	144		1.13
3	–	–	168		1.09
4	2100	–	120		1.05
5	–	–	144		1.04
6	–	–	168		0.95
7	4200	–	120		0.86
8	–	–	144		0.77
9	–	–	168	0.40	0.61
10	6300	–	168	0.40	0.63
11	1075	30°	120		1.18
12	–	–	144		1.10
13	–	–	168		1.05
14	2100	–	120		0.98
15	–	–	144		0.91
16	–	–	168		0.87
17	4200	–	120		0.83
18	–	–	144		0.63
19	–	–	168	0.12	0.48
20	6300	–	168	0.13	0.46
21	1075	35°	120		1.21
22	–	–	144		1.11
23	–	–	68		1.07
24	2100	–	10		1.04
25	–	–	144		1.02
26	–	–	168		0.92
27	4200	–	120		0.85
28	–	–	144		0.76
29	–	–	168	0.38	0.51
30	6300	–	168	0.39	0.49

effective factor for removing sulphur from the micro porse of coal particles. The results of the sulphur reduction did not improve by the addition of bacteria exceeding to 4200 per ml (less variation) as is shown in Table 2.

The temperature also showed variation in sulphur reduction, and in order to achieve the optimum activity of the bacteria, tests at different temperature were carried out. Leaching rate at 20° was slow and at 35° it was decreased. From Table 2 it was observed that the optimum temperature for sulphur reduction lies somewhere between 25-34°. The sulphur reduction with 4200 bacteria per ml, in 168 hrs at 20, 30 and 35° (with agitating conditions) was respectively found to be 74.5, 92.4 and 75.9%. reduced from 1.57-0.12% of sulphur.

It is observed from the above discussion, that the time and temperature seems to be the effective factors for removing sulphur from the micropores of the coal particles i.e.the bacteria are penetrating in the micropores with respect to time at reasonable temperature. From the experimental date so obtained, it is concluded that the above said temperature is good for their growth on pyritic sulphur. The above results were achieved at pH 1.8 and with an over-all residence time of



Graph I. Microbial desulphurization

seven days. The above results are comparatively 2.4% higher than the other methods reported in the literature [3].

Graph I shows the behaviour of mixed culture of thiobacilous ferroxidane on Lakhra coal particles. It seems that the mixed culture of thiobacilous ferroxidane with 4200 bacterial concentration per ml, under agitating conditions, in ethanol amino oleate solution (0.004%) is very effective.

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