International Journal of Research in Engineering, Science and Management
Volume-2, Issue-2, February-2019
www.ijresm.com | ISSN (Online): 2581-5792

Bioleaching of Ledo Coal (Assam)

Birendra Kumar Yadav
Assistant Professor, Shekhawati Institute of Engineering and Technology, Sikar, India

***Abstract*: In the present study an effort has been made to carry out bioleaching of high sulphur coal. For this purpose, coal form Ledo Assam has obtained which contain high sulphur. Proximate and ultimate analysis of received material has been done to obtain characteristics behavior of coal in term of moisture contain, ash percentage, percentage of Carbon, Nitrogen and sulphur. Further the sample is subjected to petrographical analysis of coal. The Result obtain by above analysis shows that there is presence of high sulphur in Assam Coal. During the studies of time interval it is observed that that maximum 63.91 % ash, 30.7 % sulphur is reduced over a period of 30 days with initial pH 2.5 in laboratory pachuka type column.**

***Keywords*: Bioleaching, coal, proximate analysis**

1. Introduction

Bioleaching is a process based on the ability of microorganism to transform solid compounds into soluble and extractable elements, which can be recovered [4]. It represents a 'clean technology' in the mining industries with low cost and capital inputs required as compared to conventional methods that are very expensive for the recovery of metals from low and lean grade ores such as shales and schist as well as increase the environmental hazards[1]. The bioleaching allows the cycling of metals by a process close to natural biochemical cycles reducing the demand for resources such as ores, energy or landfill space. This process has gained importance in a variety of mineral industries. On the basis of interaction between metals and microbes, bio hydrometallurgy comprises of different disciplines such as bioremediation, bio sorption, bioaccumulation and bioleaching [2]. The mechanism of bio leaching is direct and indirect type. Direct mechanism originates from the observation regarding microbial attachment to metal sulphides and further evidence comes from studies involving synthetically prepared sulphide mineral free of iron [3]. Due to the attachment of bacteria to mineral surfaces enzymatic action(of bacteria) take place which causes solubilization of the mineral and this can be termed as direct leaching. Dissolution by the action of ferric sulphate is termed as the indirect leaching mechanism because it takes place even in the absence of oxygen or any viable microorganism. Due its strong oxidizing property, ferric ion has the ability to dissolve a wide variety of metal sulphides. In the presence of Thiobacillus ferrooxidans in the leaching system, ferrous sulphate gets converted to ferric sulphate rapidly [5]. When bacterially produced ferric sulphate cause dissolution of the mineral it is considered to be indirect leaching.

2. Materials and methods

Assam coal sample was obtained from Ledo Open Cast project from ledo which comes under Makum Coalfield area in Tinsukia district. The sample was collected from 60ft seam which have thickness of 8 meter. The total sample collected was 25 Kg. This mine has three seams of 8 ft, 20 ft thickness. Further the material is subjected to Petrography studies of Assam coal which is carried out by optical microscope. In this method different micro constituent of coal has been studied. Micro constituents of coal can be classified into three groups as 'vitrine', 'liptinite', and 'Inertinite'. Simutanously Crushing of coal is carried out in roll crusher (0.25 inch gape). Then sampling is taken place by conning method. After that, grinding is followed and -200(mesh) sample taken out. Once the sample preparation has been done the microbial culture preparation is started. For this process Thiobacillus ferrooxidans is used [2]. The microbe were isolated from tailing ponds of Malanjhkhand copper mines, Malanjhkhand. Sub culturing of the microorganisms was carried out by using 9K nutrient medium in an incubator shaker at 30 C. The growth of the microbes was ascertained by monitoring the pH.

Composition of 9K media

$(NH_4)_2SO_4$	3.0 g/L
$MgSO_4 \cdot 7H_2O$,	0.5 g/L
K_2HPO_4,	0.5 g/L
KCl,	0.1 g/L
$FeSO_4 \cdot 7H_2O$	44.2 g/L

This experiment was carried out in column to know the effect of aeration in leaching process. In this process 12 gram of coal mix in 270 ml of 9K media .it was inoculated with 30 ml of Thiobacillus ferrooxidans and initial pH was 2.5. The temperature was maintained around 32^0 C. This experiment was run for 30 days and three was sample was taken out in each 10 days intervals from column. After 30 days ultimate and proximate analysis is carried out. The ultimate analysis determines all coal component elements, solid or gaseous and the proximate analysis determines only the fixed carbon, volatile matter, moisture and ash percentages.

3. Results and discussions

A. Petrography of Assam coal

Initially the coal samples were subjected for petrography analyses. The result of the studies are given in Table-1 and 2.

Table 1
Maceral group and mineral matter content in volume percentage

Sample	Vitrinite%	Liptinite%	Inertininte%	Mineral matter%
Ledo	41	17	16	26

Table 2
Maceral percentage on mineral matter free basis

Sample	Vitrinite%(mmf)	Liptinite%(mmf)	Inertininte%(mmf)
Ledo	55.40	22.97	21.62

From the tables it may be seen that a maximum of 41% (based on volume percentage) and 51(based on mineral matter free) vitrinite in the coal sample.

B. Proximate Analysis of ledo coal before treatment

Apart from petrographic studies the sample were subjected for proximate and ultimate analysis. The results of proximate and ultimate analyses are given in Table 3 and Table 4 respectively.

Table 3
Proximate analysis of coal (initial)

Parameters	**Percentage**
Ash	5.5
Moisture	4.2
Volatile matter	47.2
Fixed Carbon	43.1

C. Ultimate analysis of ledo coal before treatment

Table 4
Ultimate analysis of coal (initial)

Parameters	**Percentage**
carbon	74.29
nitrogen	1.783
Hydrogen	2.433
Sulphur	2.433

Proximate analysis of ledo coal shows high volatile matter and low ash content. From the ultimate analysis it is observe that the coal contains high amount of sulphur is attributed to its genesis. Further, after completion of characterization, experiment was carried out to know the desulphurization of coal using laboratory pachuka type column. These studies were carried out for a period of 30 days at 30 ^{0}C. During the investigations, reduction in ash and sulphur were carried out. The results of the studies are given in the following sections.

D. Reduction of ash in column

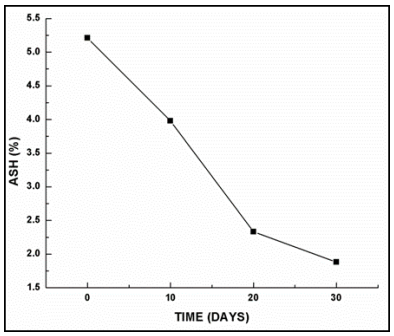

Fig. 1. Reduction of Ash in column

Further the tests were extended to know the reduction of ash in laboratory pachuka type column. These experiments were carried out at 30 $_0$C over a period of 30 days. The result of this experiment for ash removal is given in fig. 1.

From the figure, it is observed that the Ash content is reduced from 5.21 to 1.88.Thus Maximum 63.91 % ash is reduced for the period of 30 days.

E. Reduction of sulphur during column bioleaching

After completion of studies of ash reduction the experiments were preceded for reduction of sulphur in laboratory pachuka type column. The results of the studies are given in fig. 2.

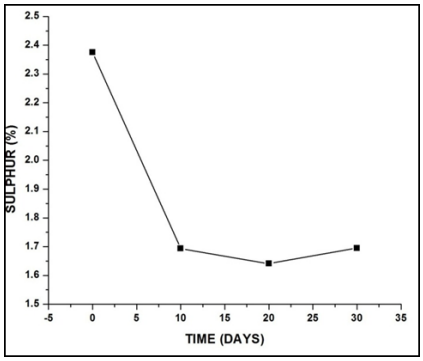

Fig. 2. Reduction of sulphur during column leaching

From fig. 2, it may be seen that sulphur is reduced from 2.37 to 1.641 and maximum 30.7% sulphur content has been removed over a period of 30 days, which may be attributed to oxidation of pyrite.

4. Conclusion

From above experiment, following things are observed Petrography study of coal: From the result of petrography study is has been seen that vitrinite is present in maximum amount which attributed to its genesis. Other macerals of Assam coal such as Liptinite and Inertininte are present in small amount. Higher vitrinite may be attributed to brightness of the coal.

- *Proximate and ultimate analysis:* From the proximate analyses, it was found that Assam coal has low ash percentage whereas the presence of High sulphur was drawn by ultimate analyses. These both characteristics may be attributed to its genesis
- *Microbial leaching in column:* Maximum 63.91 % ash, 30.7 %sulphur is reduced over a period of 30 days with initial pH 2.5 in laboratory pachuka type column.

Acknowledgement

The authors are grateful to Dr. N R Mandre for the encouragement and granting permission to publish this paper.

References

[1] Prayuenyong, P., 2002. Coal biodesulphurization processes, Song klanakarin J. Sci. Technol, Vol. 24, No. 3, pp. 493-507
[2] Yadav, B. K., Rajak, K. K., Mandal. R. B, Saxena, V. K., Mandre, N. R., “Reduction of sulphur and nitrogen by microbial treatment of Assam

coal," in National conference on CSECS 2010, Allied Publishers Pvt. Ltd., pp. 195-199, 2010.

[3] Garcia, F., and Blazquez, M. L, "A comparative study of the Biodesulfurization of Two Spanish coals with Thiobacillus and sulfolobus, Biorecover, vol. 2, pp 179-194, 1993.

[4] Acharya, C. Kar, R. N., and Sukla, L. B., "Microbial Desulfurization of Different Coals," in Applied Bio-chemistry and Biotechnology, vol. 118, pp. 47-63, 2004.