ORIGINAL RESEARCH PAPER | Chemistry | Volume : 6 | Issue : 8 | August 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

Evaluation of Some Leachants for Effective Leaching of Sharigh Coal

KEYWORDS: Coal, Minerals, Leaching, Particle Morphology, EDTA

Miss Mahwash Hafeez	* Dr. Johra khan	Dr. M. Shakirullah
Lecturer, Department of Medical Lab Technology, College of Applied Medical Science, Majmaah University, Majmaah, Kingdom of Saudi Arabia	Assistant Professor, Department of Medical Lab Technology, College of Applied Medical Science, Majmaah University, Majmaah, Kingdom of Saudi Arabia * Corresponding Author	Associate Professor, Department of chemistry, University of Peshawar, Pakistan

ABSTRACT *This paper reports the demineralization of coal with EDTA, citric acid, ammonium acetate acid mixture, HCl, and HNO3. The residual coal were water washed and filtrates were evaporated to constant a volume. The residual coals were ashed and mixed with acid mixture followed by two hours of digestion. The filtrate were stored in glass bottles. The absence of some morphological features correspond to inorganic elements in residual samples confirms demineralization. It is evident from the results that amongst the leachants used; acid mixture and EDTA have caused significant reduction in ashes.*

Introduction

In order to fulfil the increasing energy demand, all energy resources need to be utilised. Despite the efforts and the commitment for renewable power to account for a significant share of the total electricity supply, coal is still one of the most important electricity producing fuels. Many environmentalists see coal as inherently dirty.

Coal minerals are objectionable due to process as well as environmental problems. Coal minerals may be epigenetic and syngentic. Both constitute the inorganic part of the coal and if their concentration exceeds certain levels, they are considered unwanted because of no role in combustion of coal. Minerals are desired to certain levels due to catalytic effects in gasification and liquefaction[1-3]. Concerted efforts are needed to reduce the ash forming inorganic elements and to develop clean methods of using coal. Demineralization prior to utilization is an effective way to ensure environmentally friendly combustion of coal and to compel the user to use coal for domestic as well as commercial power generation. Many techniques are in line for demineralization of coal[4-6].However, all these treatments are tedious, obnoxious and costly. Introduction of less time consuming and cost effective techniques is the need of the day. New techniques are being viewed for removal of ash forming inorganic elements from coal[7-8]. EDTA [9], citric acid[10], some lixiviants[11], HCl, HNO_3, NaOH & H_2O_2[12] and forced leaching using water, citrate, oxalate, EDTA & carbonate solutions are in use[9].

It has been reported that many trace elements and noxious gases are liberated from coal-fired power plants. Ash content of coal has been reported to cause many mechanical and operational problems like reactor clogging, scaling, fouling and catalyst passivation[7].

Various analytical protocols have been used in the past for mineral mater identification[13-17]. Leaching is a method to remove soluble components from a solid matrix. The literature identified over 100 leaching methods[18].

MATERIALS AND METHODS

Preparation of Coal Sample

The run of mine coal sample was obtained from Sharigh coal mines in Baluchistan through Pakistan Mineral Development Corporation, crushed and ground in a pestle and mortar, screened through 212 µm sieves using a sieve shaker. The definite sized coal sample was dried in a vacuum oven at 105° C for one hour and cooled in a desiccator. The proximate and ultimate analysis of the virgin coal understudy is provided in Table 1.

Table 1. Proximate analysis of virgin coal used.

Parameters	Level (%)
Moisture	1.41
Volatile ash	27.95
Ash	20.95
Fixed Carbon	49.69
Total Sulphur	5.10
Pyretic Sulphur	0.092
Sulphatic Sulphur	1.64
Chlorine	0.44

Leaching of coal with EDTA

10g portion of coal was taken and mixed with 0.02N EDTA in a 50 ml conical flask. Using magnetic stirrer it is stirred for 1 hour. The slurry was filtered and washed several times to free from EDTA. The washed sample is collected and evaporated till constant volume of 50ml. same procedure is repeated with different EDTA solutions like 0.04N, 0.06N, 0.08N and 0.1N with varying time of leaching like 1, 2, 3, 4 and 5hours.

Leaching of coal with citric acid

10g portion of coal was taken and mixed with 0.2N citric acid in a 50 ml conical flask. Using magnetic stirrer it is stirred for 1 hour. The slurry was filtered and washed with hot distilled water several times till pH paper stop giving red colour. The washed sample is collected and evaporated till constant volume of 50ml. same procedure is re-

Volume : 6 | Issue : 8 | August 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

peated with different citric acid solutions like 0.4N, 0.6N, 0.8N and 1N with varying time of leaching like 2, 3, 4 and 5hours.

Leaching of coal with acid mixture

10g portion of coal was taken and mixed acid mixture of HCl, HNO_3, HCl and HF in ration of 10:5:1:1 in a 50 ml conical flask. Using magnetic stirrer it is stirred for 1 hour. The slurry was filtered and washed with hot distilled water several times till it become free from ammonium acetate. The washed sample is collected and evaporated till constant volume of 50ml same procedure is repeated with different concentration of acid mixture with varying time of leaching like 2, 3, 4 and 5hours.

Leaching of coal with chemical leachants

10g portion of coal was taken and mixed with 1M HCl in a 50 ml conical flask. Using magnetic stirrer it is stirred for 1 hour. The slurry was filtered and washed with hot distilled water several times till it become free from acid. The washed sample is collected and evaporated till constant volume of 50ml same procedure is repeated with 1M HNO_3 solutions with varying time of leaching 5hours.

Result and Discussion

Leaching of coal with EDTA

The coal was leached with EDTA in order to remove lithophillic inorganic elements i.e., Ca, Mg, Fe, etc., and data of ash depletion is provided in Table 2. Leaching time was varied in order to study the effect of contact time on effective removal of the metals to be studied. Time duration was varied from 1 to 5 hours. It was found that 0.08N EDTA with 4 hour of contact time is effective in highest demineralization.

Table 2: Demineralization of Virgin lump Coal with different Concentrations of EDTA

Hr	0.02 N (%)	0.04 N (%)	0.06 N (%)	0.08 N (%)	0.1 N (%)
1	27.14	14.76	30.00	25.03	15.43
2	17.03	14.26	15.55	20.18	24.04
3	15.31	14.20	27.54	23.15	15.9
4	22.83	26.56	23.45	30.16	25.96
5	17.63	22.93	23.34	20.00	19.36

Leaching of coal with citric acid

Leaching with citric acid caused a remarkable ash depletion in the beginning but with increasing the time of stirring, the value of ash depletion decreased (Table 3). Time duration was varied from 1 to 5 hours. With varying the concentrations of citric acid, the value of ash depletion more or less remained the same. The reason for poor ash depletion may be with increase in citric acid concentration viscosity of the slurry increases so the leachants are not able to admit to micropores.

Table 3: Demineralization of Virgin Lump Coal with Citric Acid

Hr	0.2 N (%)	0.4 N (%)	0.6 N (%)	0.8 N (%)	1 N (%)
1	22.6	19.6	22.6	27.4	14.0
2	24.6	23.5	26.2	26.0	18.76
3	26.0	25.0	28.3	24.6	25.9
4	27.4	31.0	29.3	17.0	16.4
5	28.6	27.6	27.3	16.4	21.8

Leaching of coal with acid mixture

Leaching with acid mixture was done by making a mixture of acid with H_2O, HCl, HNO_3 and HF. Acid mixture is found effective (Table 4). In case of leaching performed for small time duration, the sites that are enclosed in these pores have not been accessed effectively. On extension in time, the accessibility was believed to have enhanced. Time duration was varied from 1 to 5 hours.

Table 4: Demineralization effect of Acid Mixture 2 on Virgin Coal

Time of stirring (Hr)	% of Ash Depletion
1	14.43
2	20.08
3	25.46
4	22.51
5	20.23

Leaching of coal with chemical leachants

An attempt was also made to study the effectiveness of HCl as leachants. The micrograph of the residual coal from this treatment is provided in Table 5. The treatment of coal with HCl caused a little amount of ash depletion. No pronounced effect of extension in leaching time can be seen. HCl has been found to remove detrital mineral inclusions.

Table 5: Demineralization effect of 1M HCl on Virgin Coal

Time of stirring (Hr)	% of Ash Depletion
1	33.45
2	23.46

Conclusion

The study shows that coal beneficiation can be accomplished effectively with leachants containing HCl, HNO_3 and HF and there acid mixture[19]. Extension of leaching time has no significant effect in either case. EDTA was also found to be a significant leaching agent.

References

1. Hüttinger, K.J., and Krauss, W., 1981. Catalytic activity of coal minerals in hydrogasification of coal. Fuel, Vol.60, pp. 93-102.
2. Montano, P.A., Bommannavar, A.S., and Shah, V., 1981. Mössbauer study of transformations of pyrite under conditions of coal liquefaction. Fuel, Vol. 60, pp.703- 711.
3. Tomita, A., Higashiyama, K, and Tamai, Y., 1981. Scanning electron microscopic study on the catalytic gasification of coal. Fuel, Vol.60, pp. 103-114.
4. Mukherjee, S., Mahiuddin, S., Bprthakur, P., 2001. Demineralization and Desulfurizatipn of Subbituminous Coal with Hydrogen Peroxide. Energy Fuel, Vol.15 No.6, pp. 1418-1424.
5. Karaca, H., Onal, Y., 2003. Demineralisation of Lignites by Single and Successive Pretreatment. Fuel, Vol.82, No.12, pp.1517-1522.
6. Erol, M., Colduroglu, C., Aktas, Z., 2003. The Effect of Reagents and Reagent Mixtures on Froth Flotation of Coal Fines, Int J Mıner Process, Vol.71, No.1-4, pp.131- 145.
7. Polat, M., Polat, H., Chander, S., 2003. Physical and Çhemical İnteractions in Coal Flotation. Int J Mıner Process, Vol. 72, No.1-4, pp.199-213.
8. Tao, D., Li, B., Johnson, S., 2002. A Flotation Study of Refuse Pond Coal Slurry. Fuel Process Technol, Vol.76, No.3, pp.201-210.
9. Nugteren, H.W., Janssen-Jurkovícová, M.., Scarlett, B., 2002. Removal of heavy metals from fly ash and the impact on its quality. Journal of Chemical Technology & Biotechnology, Vol. 77, pp.389-395.
10. Akers, D J., 1998. Major Changes in US Coal Prep. World Coal, Vol.7, pp.45– 49.

Volume : 6 | Issue : 8 | August 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

11. Kazonich, G., and Kim, A.G., 1997. Leaching Fly Ash with Environmental and Extractive Lixiviants, 12th International Symposium on Coal Combustion By-Product Management and Use, American Coal Ash Assoc., Orlando, FL, 11-18.
12. Kumar, M., Shankar, R.H., 2000. Removal of Ash from Indian Assam Coking Coal Using Sodium Hydroxide and Acid Solutions. Energy Sources, 22, pp.187-196.
13. Lastra, R., Petruk, W., Wilson, J., 1998. Image analysis techniques and applications to mineral processing. In: Modern approaches to ore and environmental mineralogy. Mineralogical Association of Canada. Short Course Series, 27, 327-366.
14. Gabas, S.G., Análise de Imagens Aplicada à Caracterização de Minérios – Análise Modal e Liberação. Dissertação de Mestrado, Escola Politécnica da Universidade deSão Paulo, 1999.
15. Kahn, H., Sant'Agostino, L., Mano, E.S., Tassinari, M.M., 1998. Acta Microscopica.7-A, pp.241-244.
16. Fruehan, R J., Li, Y., Brabie, L., 2003. .Dissolution of magnesite and dolomite in simulated EAF slags. Iron & Steel Society International Technology Conference and Exposition, Indianapolis, IN; USA; 27-30, pp.799-812.
17. Romero, M and Rincón., J.M., 1999. Surface and bulk crystallization of glass-ceramic in the Na2O-CaO-ZnO-PbO-Fe2O3-Al2O3-SiO2 system derived from a Goethite waste. Journal of the American Ceramic Society, Vol. 82, p.1313.
18. Petruk, W., 2002. Imaging of minerals, ores and related products to determine mineral characteristics. Minerals and Metallurgical Processing, Vol.19, pp.50-56.
19. M. Shaakirullah, Imtiaz A., M. Arsala, M.Ishaq, H. Rahmaan and Uzma khan,2006.Leaching of minerals in Degair coal, Jmmee.org.Vol.5 , pp.131-142.