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CHLORINATION OF ZIARAT LATERITE – A PRELIMINARY INVESTIGATION*

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Chlorination of Ziarat laterite was studied for the recovery of iron, aluminium and titanium as volatile chlorides. Optimum conditions such mesh size, temperature and amount of wood charcoal as reductant are reported. It is found that –85 to +100 laterite when chlorinated at 900° – 950° (fixed carbon 47.74%) gave a recovery 92–96 % iron, aluminium and titanium.

INTRODUCTION

Laterite is a weathered rock containing mainly hydrated oxides of aluminium, iron and titanium mixed with some silicates. Laterite is abundantly available in Ziarat (Baluchistan), Sargodha (Punjab) and Hazara (N.W.F.P.) districts of Pakistan. This rock being low in iron and aluminium is of little industrial importance. It is found that these deposits contain appreciable quantities of titanium. The recovery of titanium in conjunction with iron and aluminium offers an attractive feature for its industrial exploitation [1] .X-ray analysis of the ore revealed that most of the iron present is in the form of iron oxide and the silica is mainly located in aluminosilicates. In samples of high aluminium content, dispore/ boehmite is present. The maximum percentage of chamosite (iron and aluminium silicate complex) is less than 4%.

Sodium carbonate sintering method [2] for extracting alumina from laterite of Ziarat (SiO_2 3.6 to 4.76%), alkali leaching [3] and Soda/lime sintering processes [4] for the recovery of constituents from laterite have already been tried. The economics of these processes did not prove viable. As an alternate, chlorination of laterite under different experiemental conditions was investigated. This is discussed in the present communication.

Chlorination as a pyrometallurgical tool is not new and the thermodynamic data of many industrially important chlorination processes are available in the literature. The highly reactive nature of chlorine, the ease of formation of metal chlorides and their volatility makes chlorine a very attractive reagent. The removal of undesired constituents from a mineral by chlorination leaves enriched residue or otherwise the desired constituents could be recovered by selective chlorination.

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MATERIAL AND METHODS

1. *Chemical Composition of Ziarat Laterite*

The samples were powdered and analysed by standard methods. The results of the analysis are given in Table 1. The alumina content of the Ziarat laterite varies from 26.12 to 42.9%, iron oxide 39.8 to 48.4% and titania 4.30 to 6.30%.

2. *Chlorination of the Ore*

50 g of preheated ore of different mesh were chlorinated in a Vycor tube-reactor at a temperature ranging from 900° to 950°. The iron was collected as ferric chloride in the receivers. The chlorine gas acted as a carrier of the heavier ferric chloride vapours. The residue remaining in the reactor was mixed with carbon and again chlorinated at 900 – 950°. The alumina and titania were volatilized and collected as their respective chlorides in cooled receivers. During chlorination the moisture contents produce hinderance in the voltatilization of iron as ferric chloride. The ore was preheated and then chlorinated without any difficulty.

The residue left over after extraction of valuable components was found to contain silica, calcium oxide and magnesium oxide. Titanium tetrachloride was sublimed from the mixture at 150° – 175° and aluminium chloride remained as residue.

RESULTS AND DISCUSSION

Effect of Particle Size on Chlorination

Various mesh sizes of the ore ranging from –5, +10 to –85, +100 were chlorinated at temperature 900 – 1000°. The chlorination of the ore having mesh size –5, +10 to –16, +25 was found to be incomplete which may be due

Table 1. Analysis of laterite samples from Ziarat area.

Sample No.	1	2	3	4	5	6
SiO_2	5.20	3.79	4.04	4.81	16.67	6.15
Al_2O_3	27.43	40.87	42.92	30.62	26.12	32.91
Fe_2O_3	48.40	39.80	36.51	48.40	41.60	45.20
TiO_2	6.39	5.83	5.65	4.73	4.30	5.60
CaO	0.35	Nil	Nil	0.17	Nil	1.05
MgO	1.27	2.03	1.52	1.77	0.69	0.89
L.O.I.	10.07	9.73	10.19	8.77	11.20	8.45
Total:	99.11	100.75	100.83	99.29	100.58	100.25

Table 2. Effect of temperature on chlorination.

Temperature °C	wt. of sample g.	time in minutes	% recovery Without carbon Fe_2O_3	In presence of Carbon Al_2O_3	TiO_2
700	50	30	61.5	69.5	68.1
800	"	"	90.00	87.20	88.6
900	"	"	92.90	93.40	94.30
950	"	"	94.00	95.80	96.00
1000	"	"	94.00	95.80	96.00
1200	"	"	94.00	95.80	96.00

to the bigger particle size of the ore. With mesh size – 25, +30, to –30, +85 the rate of chlorination was slow. Chlorination with the particle size –85, +100 was favourably rapid and the same mesh size was used for further work.

Effect of Temperature on Chlorination

Chlorination was carried out at various temperatures ranging from 700 to 1200°. The results of this study are given in Table 2.

From Table 2 it can be seen that approximately 94 % of the iron oxide present in the ore could be recovered by simple chlorination at 900 – 950°, 95.8 % alumina and 96% titania could be recovered when chlorinated at 950° in the presence of carbon.

The Optimum Residue/Carbon Ratio

The ore from which iron had been chlorinated out was mixed with different amounts of carbon (Fixed carbon 47.74%) and again chlorinated as 900 to 950°. A ratio of 100:80 of iron free residue to carbon was found to give 95.8 % alumina and 96 % titania conversion at 950° into their respective chlorides. The results of this investigation are given in Table 3.

From these experiments it is concluded that the optimum chlorination parameters for the recovery of iron, aluminium, and titanium from laterite ore are –85, +100 mesh size of the ore, 900 to 950° temperature and with 80 % carbon. Although no precise measurements of the flow rate of chlorine were made, it was controlled at a rate

Table 3. Optimum residue/carbon ratio.

Iron leached residue/carbon	% Conversion Al_2O_3	TiO_2
100:45	65.50	92.80
100:60	80.60	95.50
100:80	95.80	96.00
100:100	95.80	96.00

of 100 to 110 bubles per min. Under the conditions mentioned above the reaction is complete in a period of less than half an hour. It is observed that at elevated temperature (900 to 950^{o}) the chlorine becomes highly corrosive and is liable to pose problems in the material of construction of the reactor, particularly for commercial exploitation. If however, the temperature of the reaction is lowered (650 to 700^{o}) the rate of chlorination becomes slow and the time of chlorination will have to be correspondingly increased. This aspect of the investigation and the effect of various fluxes for the recovery of valuables at comparitively low temperatures is under investigation.

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