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Impact of Sodium Chloride on Reduction of Barite at High Temperature

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Abstract: The present work is aimed to study the effect of sodium chloride as a reaction promoting agent on the carbothermal reduction of barite to improve the yield of water soluble barium sulphide. Sodium chloride in different ratio, was mixed in heterogeneous mixture of barite and coal for the carbothermal reduction of barite at high temperature. Experimental results show that sodium chloride has marginal effect on the yields of barium sulphide.
Keywords: Black ash, low melting, iodometry.

Introduction

India is one of the leading producers and exporters of barite in the world. Barite a non-metallic mineral, extensively used as weighting agent in oil and natural gas drilling. Barite when mixed with cement, use to make containers to store radioactive materials. It is also used as filler, aggregate, extender as well as for production of different barium chemicals, etc[1, 2]. In general carbothermal reduction of barite is the most common method used in practice by industrialist to convert insoluble barite into water soluble BaS.

When carbon and barite are in contact, at high temperature proposed reactions are as follows:

$$BaSO_4 + 4C \rightarrow BaS + 4CO \quad \ldots\ldots (1)$$

This generated CO diffuses and further react with barite:

$$BaSO_4 + 4CO \rightarrow BaS + 4CO_2 \quad \ldots\ldots (2)$$

Produced CO_2 reacts with carbon and forms more CO which is a strong reducing agent

$$C + CO_2 \rightarrow 2CO \quad \ldots\ldots (3)$$

Theoretically after carbothermal reduction of pure sample of barite yield of barium sulphide should be 70% or so. But in practice, during carbothermal reduction of barite a lot of barite remains unreacted resulting poor yield of barium sulphide, which gives not only economical dent but also lead to loss of such an important mineral.

To increase the yield of barium sulphide[3-4] author worked on different physical and chemical aspects. Recently author has reported that by using calcium chloride as a reaction promoting agent, yield of BaS has increased 40% to 52%. This encourages author to explore new reaction promoting agents. Present experimental investigations are based on the effect of sodium chloride on carbothermal reduction of barite under anaerobic conditions in the pit furnace at high temperatures in order to increase the yield of barium sulphide. Sodium chloride had been chosen as a reaction promoting agent by keeping in mind its capacity to act as a comparatively low melting ionising solvent.

Materials and Methods

Barite (barium sulphate):

Basic raw material of investigation was snow-white and pink shade barite. Both were pulverized separately and powder was checked for reactive impurities like dolomite/ limestone etc. Finally sieved through standard sieves of mesh number 150 meshes[5].

Coal:

Hard coal was used in the pit furnace as a source of high temperature in the carbothermal studies. Steam coal **was** first pulverized and graded through 80 mesh number standard sieves. After this it was mixed with barite for the carbothermal reduction of barite. **Clay Pots:** Clay pots of 250 ml were procured from potter used for carbothermal reduction of barite.

Chemical reagents:

Iodine (0.1N), sodium thiosulphate (0.1N), hydrochloric acid (5N apporx.), sodium chloride, starch (Indicator solution) etc. were required for the estimation and prepared by using AR grade reagents and double distilled water as per the standard procedures[6, 7].

Experiments were conducted to investigate the influence of sodium chloride on the yield of reduced barite i.e. barium sulphide as follows:

For the carbothermal reduction, in heterogeneous mixture of barite (both white and pink shade separately) and steam coal, sodium chloride in different proportions (1, 2, 3, 4, and 5% by weight of barite) was mixed thoroughly and filled in clay pots. In the pit furnace, both coal (hard and steam both) and clay pots filled with the charge were placed over the furnace gratings in alternating manner and the furnace was fired. After cooling, the reduced mass was obtained after breaking the clay pots carefully in the form of lumps. The entire process took about 48 hours. Reduced crude lumps of barium sulphide were recrushed in the pulveriser. The black powder (BaS) so obtained is called black ash[7]. This powdered black ash was extracted with boiled water for making barium chemicals in subsequent steps.

To estimate the percentage of sulphide ions, black ash was added into hot water and boiled for 4 to 5 minutes. After filtering, the residue was washed with hot water for say about 3 – 4 times. The filtrate was made up to the required volume.

The amount of barium sulphide percentage in the reduced mass was found out by the estimation of sulphide ion in accordance with the available Indian standards[7]. As sulphide ion in presence of hydrochloric acid reacts with iodine ions in molar ratio. The latter is estimated conveniently iodimetrically[8].

Results and discussion

Effect of sodium chloride on carbothermal reduction of barite:

The effect of sodium chloride on white and pink variety of barite is shown in the following figure.

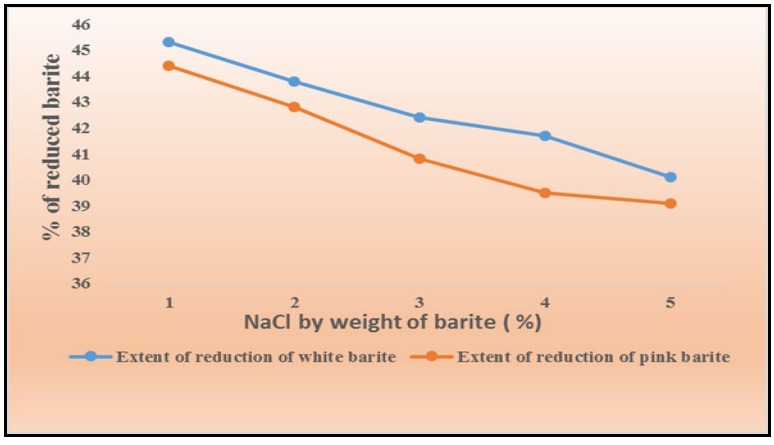

Figure: Extent of reduction on white and pink shade barite using sodium chloride.

It can be noticed form figure that the general impact of sodium chloride in the reduction is to increase the yield of barium sulphide but increased proportion of sodium chloride causing adverse effect on carbothermal reduction of barite.

Probable reason for this may be that at high operational temperatures of the pit furnace when sodium chloride is allowed to react with the heterogeneous mixture of barite and coal, due to its lower melting point it assumes molten and vapour form in that pit furnace. This molten and vapour may form protective adsorbed layer of indifferent ion pairs on the surface of barite and coal. This should naturally retard the carbothermal reduction of barite. Decreasing trend in the yields of barium sulphide with increasing percentage of sodium chloride in the matrix is therefore quite expected.

Conclusion

High temperature of pit furnace under anaerobic reducing situation, reforms solid sodium chloride into molten and vapour form which is not favourable for the heterogeneous carbothermal reduction of barite within the experimental limits.

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