BENEFICIATION OF LOW GRADE IRON ORE FINES BY MAGNETIZING ROASTING

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INTRODUCTION

Due to depletion of high grade and medium grade iron ore, it has become essential to use low grade ores and rejects after proper beneficiation. Conventional beneficiation techniques are not capable of improving the grade of rejects, because of liberation at very finer size. Beneficiation at ultrafine size becomes difficult, once the reject or low grade ore is roasted to magnetite and subjected to grinding, liberation takes place due to thermal degradation as well as size reduction. Afterward low intensity magnetic separation becomes effective.

MECHANISM OF MAGNETIZING ROASTING

Figure (A) shows the equilibrium relations of iron oxides and iron at conditions of various C/CO concentrations and temperatures (most magnetizing roasting are under such conditions) from thermodynamics analysis. The reduction of iron oxides is a stepwise progress, that is, the reduction of Fe2O3 to Fe is multi-stage reaction. In this paper, the reduction of Fe2O3 to magnetite Fe3O4 is mainly discussed. Reaction curve (1) in Figure A is very close to the horizontal axis, namely, the equilibrium concentration of CO/C is very low at any temperature. In fact, only very low CO/C concentration can reduce Fe2O3 to Fe3O4 so this reaction is actually irreversible. From Figure A, it can be seen that CO/C concentration control is also important. High CO/C concentration should be avoided as it may lead to the excessive reduction of Fe3O4. From above analysis generally, the transition of ferric oxide Fe2O3 to magnetite Fe3O4 is very easy to take place by reduction roasting using CO/C as
Fe\textsubscript{2}O\textsubscript{3} \rightarrow Fe\textsubscript{3}O\textsubscript{4} \rightarrow FeO \rightarrow Fe

Fe\textsubscript{2}O\textsubscript{3} + C \rightarrow Fe\textsubscript{3}O\textsubscript{4} + CO\textsubscript{2}

Fe\textsubscript{3}O\textsubscript{4} + C \rightarrow FeO + CO\textsubscript{2}

Fe= Magnetic, FeO = Non magnetic, Fe\textsubscript{3}O\textsubscript{4} =Magnetic, Fe\textsubscript{2}O\textsubscript{3} = Non Magnetic

From the analysis, the transition of hematite Fe\textsubscript{2}O\textsubscript{3} to magnetite Fe\textsubscript{3}O\textsubscript{4} is very easy to take place by reduction roasting using C as reductive.

**EXPERIMENTAL PROCEDURE**

Iron ore from Gua dump fines and non-coking coal sample from Eastern Coal Field Ltd. were collected for the present investigation. Iron ore assayed 59.02% Fe, 3.64% alumina, 3.87% Silica and 6.11% LOI. Proximate of coal and iron ore analysis was carried out and the result are shown in Table 1. Iron ore and non coking coal were crushed and ground to proper size. Mineralogical studies of iron ore fines by optical microscope was carried out.
that most of the soft laminated lateritic and friable ores are relatively low grade carrying various proportions of impurities (Figure B (c)).

### ROASTING PROCESS

Goethitic iron ore sample was ground in a laboratory ball mill to get the (−300 mesh) fineness for roasting purpose. These iron fines were mixed thoroughly with non-coking coal samples in different proportions. The iron coal mixture of known weight was placed in a container. These container were kept inside the furnace at fixed temperature and then taken out of the furnace at different time intervals. The loss in weight was recorded. Then the product was subjected to low intensity magnetic separator and the concentrate was analyzed for its grade.

### EXPERIMENTAL PROCEDURE

Iron ore fines and coal fines were mixed thoroughly in different proportion and these mixtures were stored separately. A known weight (100 g) of mixture was taken into alumina crucibles and kept inside the furnace for desired period at fixed temperature. Then the crucible was taken out from the furnace at different time interval. The product was subjected to low intensity magnetic separate. The above procedures were performed with various percentages of coal and iron ore as well as at different Temperature.

### EFFECT OF ROASTING TIME AT 450°C

The series of experiments were carried out at 450°C and the time was varied from 5 to 40 min. The grade of concentrate obtained was in the range of 65 to 67% with iron recovery in the range of 72.86 to 79%. The results obtained have been plotted in Figures (3) with increased in coal content from 1 to 5 g. The time has great influence on the magnetizing roasting of ores.
Therefore, proper temperature and time are more efficient for magnetizing roasting and above 35 min time, yield and grade decreases.

EFFECT OF TEMPERATURE ON ROASTING PROCESS

The effect of temperature on roasting was studied at different temperature in the range of 300 to 650°C for same proportion of iron and coal mixture. The results obtained have been plotted in Figure 3. It is observed from Figure 1 that with increase in roasting time at 450°C. The amount of magnetic fraction increased with increased in time upto 20 min and there is marginal increased with further increased in roasting time. Similarly, the yield of magnetic content increased upto 450°C and then it becomes almost constant or starts decreasing (Figure 2). The Fe content of the concentrate also maintains similar relationship.

Based on the observations the next series of experiment was carried out at 450°C for different time interval (10 to 50 min) and the result obtained have been plotted in Figure 3. The grade of concentration and recovery of iron has also have plotted in Figure 3.

EFFECT OF COAL CONTENT

To study the effect of coal Content (1, 2, 3, 4, 5, 6, 8, 10 g) on the yield and grade of concentrate the next series of experiment was carried out. The results obtained have been plotted in Figure 1 and 2 with increased in coal content from 1 to 5 g, there was gradual increase in the yield upto 3 g coal with a sharp increase in the yield upto 4 g coal. Further increased in coal content showed marginal increase in yield of the concentrate.

EFFECT OF IRON ORE AND COAL SIZE ON ROASTING PROCESS

To study the effect of size of iron ore on the roasting rate, a few tests were carried out using
non-coking coal as a reducing agent at 450°C. The results obtained are shown in Figure 5. The iron fines size were (0.26, 0.149, 0.105, 0.074, 0.053, 0.044 mm) and coal size of 0.26 mm. For 0.053 mm sizes, iron ore sample, iron recovery was 77.85 and grade was about 67.76. Therefore, smaller particle size is more beneficial to the magnetizing roasting of ore. Now in second case effect of coal size on roasting rate, the results obtained are shown in Figure 6. The composition are same but coal size are (0.26, 0.149, 0.105, 0.074, 0.053, 0.044, –0.044 mm) and iron fines are –0.044 mm. For +0.044 mm sizes, iron ore sample, iron content recovery was 76.85 and grade was about 69.76. Therefore, these coal and iron particle sizes properly contact each other in heating process.

In magnetizing roasting process, depend on time, temperature, and particle size of iron ore and coal size. Therefore, the ore particles contact with solid carbon sufficiently. The effects of heat transmission are improved. The magnetizing roasting result is as follow, for raw ore containing 59% Fe, the grade of magnetic concentrate is about 69% Fe, and the recovery of iron above 85%, the tailing of iron is very low, that means the effect of reduction roasting is good. It can seen that the technical indexes of magnetizing roasting for 300-mesh size ore sample are much superior to those for other fines samples under the same testing conditions.

**CONCLUSION**

From the results obtained and discussed in above section.

- Iron ore fines can be beneficiated by magnetizing roasting achieved higher yield with acceptable grade.
- The grade of concentrate increases with increased time and temperature up to 450°C.
- By applying the roasting process Goethitic iron ore will be converted to magnetite and it may be successfully used in pelletization process. Combined moisture is also removed during magnetizing roasting.

**REFERENCES**


