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Extraction of Aluminium from Its Dross by Fusion with Sodium Hydroxide

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Abstract

Extraction of aluminium from its dross by fusion with sodium hydroxide was investigated. The waste dross was mixed with varying amount of sodium hydroxide and heated to 800-1000°C for 2-4 hours. The fused products were dissolved in an sodium hydroxide leaching solution. It was found that over 90% aluminium extraction could be achieved for the fusion temperature and time of 900°C and 3 hours respectively using 100% excess sodium hydroxide for fusion.

1. Introduction

In industries involving aluminium melting, dross usually forms at the surface of the molten metal in contact with furnace atmosphere, It may contain between 30-60% free aluminium metal dispersed in an oxide layer.[1] Several dross treatment processes have been developed to recycle aluminium economically and environmentally friendly to reduce the amounts of hazardous wastes disposed to landfills.[2]

The objective of this work is to extract aluminium from its dross by fusion with NaOH to develop an alternative method for aluminium recovery. The starting material used in the experiments is the waste product from the dross crushing and screening to release and recover metallic portion in the secondary recycling factory. The result of XRF and XRD analyses shows that it contains 32.10%Al, 4.88%Mg, 4.03%Na, 1.09%Fe, 4.91%SiO_2 and 8.20%Cl with the aluminium mainly in the oxide form. By fusion with NaOH, Al_2O_3 is converted into soluble $NaAlO_2$ according to reaction (1) and the fused product can be leached to recover aluminium.

$$Al_2O_3 + 2NaOH = 2NaAlO_2 + H_2O \qquad (1)$$

In the present work, the effect of important parameters, such as fusion temperature, amount of sodium hydroxide and fusion time is studied.

2. Experimental Procedure

The waste dross was screened to obtain particle size of less than 52 μm. 2.5 g dross were thoroughly mixed with varying amount of crushed solid NaOH and placed in a stainless steel crucible. The sample was then dried at 200°C for 30 minutes followed by fusion at 800-1000°C for 2-4 hours. The resulting molten product was cooled in the furnace. It was then ground prior to leaching with 250 ml of 1 M NaOH solution at 60°C for 30 minutes. The leachate was analyzed for aluminium by ICP.

3. Results and Discussion

3.1.Effect of fusion temperature

The effect of fusion temperature was conducted by using 100% excess NaOH in the sample and 3 hour fusion time. Figure 1 indicates that the aluminium extraction increases with increased fusion temperature. The extraction increases from 87% at 800°C to 94% at 900°C. The fusion temperature of 900°C appears to be optimum in this study as further increase in fusion temperature to 1000°C results in some splash of the fused sample leading to lower percent extraction than it should be as shown in Figure 1. It should also be noted here that by fusion with NaOH at 700 °C, only slight fusion of the resulting product was observed.

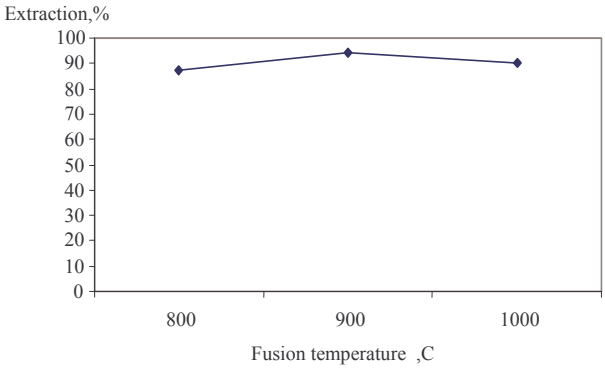

Figure 1 Effect of fusion temperature on extraction of Al with 3 hour fusion time and 100% excess NaOH.

3.2 Effect of fusion time

The effect of fusion time on the extraction of Al is shown in Fig.2 using 900°C fusion temperature and 100% excess NaOH. As the fusion time increases in the range of 2-4 hours, the extraction of Al increases from 87% to 95%. However, 3 hour fusion time is considered to be sufficient since the extraction of Al appears to be almost similar to that of 4 hour fusion time run.

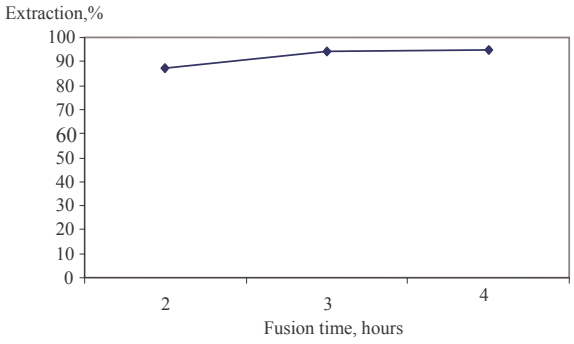

Figure 2 Effect of fusion time on extraction of Al with 900 °C fusion temperature and 100% excess NaOH.

3.3 Effect of the amount of NaOH

The effect of the amount of NaOH on the extraction of Al is shown in Fig.3. According to this figure, the extraction is greatly dependent on the amount of NaOH used. Up to 50% excess NaOH, 82% extraction can be reached for 900 °C fusion temperature and 3 hour fusion time. In order to obtain more than 94% extraction, the waste dross must be fused with 100% excess NaOH.

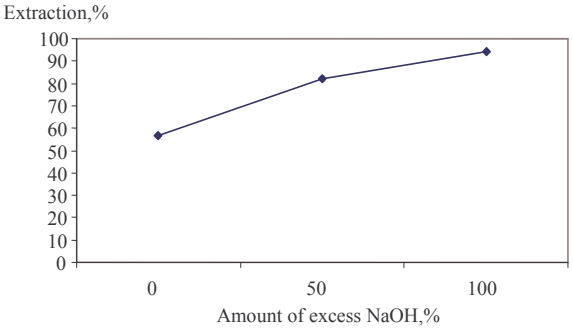

Figure 3 Effect of the amount of NaOH on extraction of Al with 900°C fusion temperature and 3 hour fusion time.

Conclusion

The waste dross from aluminium melting industries can be treated by fusion with NaOH and then leached to recover aluminium. High extraction of 94% can be achieved when using 100% excess NaOH with 900 °C fusion temperature and 3 hour fusion time in this work.

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