

ABSTRACT

Fly ash is a coal waste produced as a result of coal combustion in coal fired power plants and it is considered as a potential source of aluminium because it contains 14.8-31 wt% aluminium(III) oxide in amorphous and mullite phases depending on the coal type. Mullite is a crystalline structure formed by aluminium(III) oxide and silicate. The extraction of aluminium from a mixture of 31 wt% aluminium(III) oxide and silica as well as from fly ash collected from Eskom, Kendal Power Station using acetylacetone has been studied. A mixture of 31 wt% aluminium(III) oxide and silica was prepared based on the aluminium(III) oxide weight percentage in the fly ash. The extraction temperature, reaction time, acetylacetone flow rate, fly ash particle size distribution and bed weight were varied. The extraction was shown to be dependent on the reaction time, temperature, bed weight and acetylacetone flow rate. The extraction increased with increasing temperature from 90 °C to 250 °C, 250 °C was chosen as maximum temperature to avoid the decomposition of aluminium(III) acetylacetonate. The extraction increased with increasing acetylacetone flow rate from 2 to 6 mL/min and stabilized at 6 mL/min and the extraction percentage increased with decreasing bed weight. A maximum of 64% of available aluminium was extracted from a 31 wt% aluminium(III) oxide and silica mixture after 600 minutes at 250 °C using 6 mL/min acetylacetone flow rate. The extraction from the fly ash stabilized at about 18% after 360 minutes at 250 °C, 6 mL/min acetylacetone flow rate. The result showed that extraction is dependent on the mineralogy of the feed material. The result also showed that the particle size distribution and the introduction of nitrogen, a carrier gas, have no significant influence on the extraction of aluminium from the fly ash. A kinetic model was developed and used to model the extraction results. The model fits the data obtained from the extraction of aluminium from a 31wt% aluminium(III) oxide and silica mixture at 250 °C and 6 mL/min acetylacetone flow rate well. When used to model extraction data of a fly ash sample at similar reaction conditions, the model fits the experimental results only up to 240 minutes extraction time. The activation energy of the reaction was found to be 11.5 kJ/mol. There is need however to develop a model which takes into account the influence of temperature and acetylacetone flow rate.