Abstract

Red Mud and red sand are waste products of Alumina refining where the Al in bauxite is dissolved in a solution of NaOH at high temperatures and pressures and precipitated (this is the Bayer Process). Red mud is the most difficult residue to dispose of. At rated capacity the ALCOA refinery at Kwinana can produce 3.1 million tonnes of solid waste. This is 2 tonnes of red mud for every tonne of alumina produced (Robson (1982)).

This amount of waste causes a disposal problem for Alcoa. At present the wastes are impounded in red mud lakes which are costly to build and maintain. ALCOA is investigating the use of red mud as a soil conditioner (Ward (1983) as an alternative to the present disposal system. Ward (1983) and Barrow (1982) established that clovers and medics could grow on red mud and red mud/sand with the addition of gypsum, fertilizer and leaching.

Waste gypsum is used instead of pure gypsum for economic reasons. The amount of F in waste gypsum and red mud has been of concern to the general public. ALCOA measured 0.05% F by weight in red mud and CSBP measured 0.39% F in waste gypsum by weight. No doubt these figures would vary according to the F content of the raw
materials. Ward (1983) found levels of 15 - 25 ppm by weight in the tops of medics and subclovers grown on red mud amended Bassendean sand in an area polluted by airborne fluorides.

From the literature review it was found that F available to plants and by implication to leaching is controlled not by the total amount of F but by pH, Ca and P content of the soil, soil type and the solubility of the added fluorides (Brewer 1965). Also F adsorbed on the soil is reversibly held. This means all adsorbed F is available to leaching.

A batch test has shown that with respect to the recommended levels of F in water for various uses (Hart 1974) high concentrations can be leached from red mud (38.03 ppm) and gypsum waste (554.23 ppm). When combined the concentration of the leached F was much lower at 2.06 ppm for red mud and gypsum AR and 6.08 ppm for red mud and gypsum waste. All the above figures were for 20gm solid/50ml water. This decrease for gypsum amended mud was attributed to precipitation of insoluble fluorides eg. CaF$_2$ and increased adsorption due to the decrease in both ESP and pH. There are two reasons why adsorption should increase with decreasing pH. Firstly the surface would become less negative and the pzc of some hydrous oxides
might be reached enabling F to be adsorbed and secondly the pKa of HF which corresponds to the maximum of F adsorption is closer.

A long term column leaching experiment of red mud amended with waste gypsum (5% w/w) revealed an initial concentration of 9.8 ppm in the leachate which reduced to 5.9 ppm at 0.4 litres. The F concentration then increased to 11.2 ppm at 2.5 litres and thereafter the concentration of F decreased until 1.1 ppm was achieved at 13 litres. Since 1 litre of leachate is equivalent to more than a year's rainfall this experiment shows that the leachate would be a source of pollution to groundwater for many years.

In an other experiment the gypsum requirement of red mud was determined to be 5%. It was noticed that the pH of the leachate of this column experiment rose when Ca was leached to a low level therefore the gypsum requirement to attain and keep a nominated pH depended on the amount of leachate at which the pH had to be maintained.

The hydraulic conductivity of red mud and gypsum waste was determined. A recommendation of 26% red mud:bassendean sand to produce a hydraulic conductivity of 1 m/day was determined. 1 m/day was thought to be an appropriate figure to cope with sudden high rainfall and
any reduction in permeability with agricultural practise. It was noted that the applicability of this work to the field was limited due to uneven mixing of red mud and sand in the field.