CHAPTER 10

CONCLUSIONS

The conclusions drawn from the results obtained in this study may be summarised as follows:

1. Ordinary Portland cement and its blends with slag and fly ash have successfully been used to remove phosphate from aqueous solution. The adsorption capacity values of 83, 78 and 75 mg PO_4^{3-}-P/g obtained for OPC, OPC/slag and OPC/FA, respectively, are quite substantial in comparison with values reported in the literature for other adsorbent-solute systems. Although the target solute in this study was phosphate, it will not be surprising if, as reported for slag in the literature, these materials are also found to be capable of removing other pollutants such as heavy metals from aqueous solution. This study suggests a novel application for these traditional construction materials, namely, as low cost adsorbents for laboratory studies on the removal of impurities from aqueous solution.

2. Improved phosphate removal efficiency is obtainable at higher solute concentration, higher temperature, lower pH and smaller adsorbent particle size, albeit to varying degrees. Using OPC to illustrate this statement, the following improvements in phosphate removal efficiency were observed

(for 2 g adsorbent agitated with 200 ml of phosphate solution, 80 mg/l PO_4^{3-}-P at 25°C and initial pH 9.0 unless otherwise stated): 76 and 92 % for 20 and 80 mg/l PO_4^{3-}-P, 89 and 98 % at 25 and 60°C, 89 and 99 % at initial pH 9 and 3, and 82 and 89 % for >300 and 45-75 μm particle fractions, all respectively.

3. The predominant mechanism contributing to the removal of phosphate from aqueous solution is evidently adsorption. The rate of phosphate adsorption by these cementitious materials follows first order kinetics, and the experimental adsorption data may be modelled by the Frumkin isotherm. Precipitation of phosphate ions by dissolved calcium ions contributes to the overall phosphate removal. However, the contribution of the Ca-P mechanism is minor.

4. Due to environmental conditions that occur in the field. Care must be taken in trying to extrapolate the results of a laboratory study to the field situation. However, this study suggests that OPC, OPC/slag and OPC/FA may be capable of removing phosphate from wastewater. This concept, as a possible application, merits further investigation, probably on a pilot scale. Obviously the levels of heavy metal leachate from the materials into the water would have to be closely monitored.

5. Another important consideration related to the recommendation made in 4 above is the question of what to do with the phosphate-contaminated material once it has done its job. It must be pointed out that this issue is a challenge that also applies to the established method of using lime for removing phosphate from wastewater. In that method the spent lime sludge is dewatered and then simply discarded, or calcined in a furnace to recover part of the lime. Since the materials suggested involved in this study are used in the construction industry, it was logical to envisage the production of masonry bricks from the spent material. The results of this study suggest that high strengths are indeed attainable. As long as high compressive strengths are obtained, the actual cement to aggregate ratio required to produce this strength should not be of crucial importance, since this would be an added value process anyway. The possible long term effect of immobilized phosphate on the strength of the bricks will have to be investigated further.