CHAPTER VI

DISCUSSIONS AND RECOMMENDATIONS

6.1 Discussions

Clay minerals, sand and soil have been applied extensively to the treatment of radioactive waste solutions over a wide range of conditions. Although kaolinite is also a clay mineral, when exposed to weak acidic conditions, the hydrogen can exchange with cations in solution. In addition, the free hydroxyl groups may exchange with anions when immersed in a salt solution(pH~7). As a result, the kaolinite exchange capacity for anions is low.

Synthetic inorganic exchangers, include zeolites and oxide compounds such as titanium dioxide, antimony pentoxide and HAP.

The synthetic zeolites in particular, are highly specific sorbents for cesium-137 as compared to other types of inorganic ion-exchangers because they act as molecular sieves, as mentioned in the theorical section of this report.

This study has confirmed that antimony pentoxide exchanges anions in acidic solutions, according to theory. The ion exchange properties clearly involve the uptake and fixation of hydrogen ions in acidic solutions, and of hydroxyl ions in basic solutions.

In considering the immobilizing of "loaded" ion-exchangers, titanium dioxide, zeolite, bentonite, kaolinite and sand were mixed with cement to produce suitable waste forms. A comparison of laboratory scale specimens with an actual full-scale cemented waste form is shown in table 6.1.

Table 6.1 Size Comparison between a Laboratory Specimen and an Actual Waste Form.

Parameters	Laboratory Specimens	Actual Full-Scale (200 l.drum) Cemented Waste Form
diameter(d)	3.80 cm.	57 cm
height (h)	5.50 cm	86 cm
h/d ratio	1.447	1.508
surface area	88.34 cm^2	2.05 m^2
volume	62.38 cm^3	0.22 m^3
radioactive	no	yes

A comparison between an actual cemented waste form and a labratory specimens indicates that many conditions or differences may occur as a result of scale-up. Some of these differences are high exotherm due to the hydration reaction, mixing mode, setting time and homogeneity. Therefore, the results obtained in the Laboratory do not entirely reflect those for an actual full scale waste form.

The results of compressive strength tests show the relationship between specimen density and their compressive strength. The data show that the specimens with high densities have higher compressive strength. This indicates important additional information regarding the quality of the immobilized waste forms for interim storage or disposal.

The leachability study provides the basic data for predicting the behaviour of the product over long periods of time. This study was made over a short time period, therefore the result may be slightly in error. Unfortunately, because of the many different leach methods used and the different types of waste forms used for leaching, any comparision of values obtained by different groups of workers must be made with caution.

6.2 Recommendations

The following recommendations are made regarding the treatment of Cesium-137 and Technetium-99 liquid wastes by inorganic ion-exchangers,

1) A number of synthetic inorganic compounds with properties similar to ion-exchangers such as zirconium phosphate, titanium phosphate, uranyl phosphate or uranium mica should also be studied. Also to be include are ferrocyanide molybdate, as reported by Baetsle et al. (1964), from work at Belgium; ammonium-12-molydophosphate, as described by Smit(1961) and potassium hexacyanocobalt II ferrate II, as reported by Prout et al.(1963). These compounds, though highly selective and thermally stable, do not have the high capacity exhibited by the exchangers of the group-IV oxides.

2) This study should be continued to include actual liquid wastes contaminated with various radionuclides using a column method or a small pilot plant facility to load the exchangers.

The following recommendations for the cementation of wastes are:

1) The basic requirement for a cementation process are pre-treatment, cement and waste metering, and the subsequent mixing operation. Pre-treatment by partial dewatering is required for wastes in order to reduce the volume of the final waste products.

2) Good quality control such as waste metering water to cement ratio and adequate mixing are required to assure the production of a solidified and homogeneous waste form.

3) Antimony pentoxide should also have been include in the study of the cementation process.

4) The leachability test should have been determined for longer time periods than was done for this study. Also, a study of different elements, different storage environments, and the predominant mechanisms of leaching should be studied in order to obtain a higher degree of confidence.