

CONTENTS

CHAPTER 1: INTRODUCTION

	Page
1.1 Sources of radioactive liquid waste	1
1.1.1 Fuel cycle waste.....	1
1.1.2 Non-fuel cycle waste.....	3
1.2 Types of radioactive wastes	5
1.2.1 Radioactive liquid waste.....	5
1.2.2 Radioactive solid waste.....	5
1.2.3 Radioactive gaseous waste.....	5
1.3 Classification of radioactive waste	6
1.3.1 Low-level radioactive liquid waste.....	6
1.3.2 Intermediate-level radioactive liquid waste.....	6
1.3.3 High-level radioactive liquid waste.....	7
1.4 Industrial solid wastes	8
1.5 Problem of industrial solid wastes	10
1.6 Sorbent materials	12
1.7 Radioactive waste management	15
1.8 Liquid waste treatment technologies	17
1.8.1 Chemical precipitation	17
1.8.2 Evaporation	19
1.8.3 Ion exchange	20
1.8.3.1 Organic ion exchangers	21
1.8.3.2 Inorganic ion exchangers	22
1.8.4 Membrane processes	24
1.9 Immobilization of radioactive waste	24
1.9.1 Cementation processes	25

1.9.2	Modified cementation processes	25
1.9.3	Bituminization processes	25
1.9.4	Polymer processes	26
1.9.5	Vitrification	26
1.9.6	SynRoc	26
1.10	Properties of immobilized waste forms	26
1.10.1	Chemical and physico-chemical properties	27
1.10.2	Radio-chemical properties	28
1.10.3	Physical properties	28
 CHAPTER 2: LITERATURE REVIEW		30
 CHAPTER 3: MATERIALS AND METHODS OF INVESTIGATION		
3.1	Materials	39
3.1.1	Chemicals.....	39
3.1.2	Radioactive tracers.....	40
3.1.3	Low level liquid waste.....	40
3.1.4	Sorbents.....	41
3.1.5	Cement.....	41
3.2	Sorbents pre-treatment	42
3.3	Equipment	42
3.3.1	General.....	42
3.3.2	Radiometric measurements.....	43
3.3.3	Vicat needle.....	43
3.3.4	Load mechanical strength machine.....	45
3.3.5	Soxhlet-leaching apparatus.....	45
3.4	Methods of investigation	45

3.4.1	Surface area measurement	45
3.4.2	X-ray fluorescence analysis	47
3.4.3	X-ray diffraction	47
3.4.4	IR analysis	47
3.4.5	Effect of shaking time	48
3.4.6	Decontamination factors	49
3.4.7	Effect of pH	49
3.4.8	Effect of liquid/solid ratio	49
3.4.9	Effect of sorbent particle size	50
3.5	Immobilization	50
3.5.1	Preparation of cement samples	50
3.5.2	Preparation of cement samples with different additives	51
3.5.3	Curing time	51
3.5.4	Setting time	51
3.5.5	Bleeding of cement paste	52
3.5.6	Mechanical strength measurements	52
3.5.7	Water immersion	53
3.5.8	Leachability	54

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1	Characterization of the industrial solid wastes.....	57
4.1.1	Surface area	57
4.1.2	X-ray fluorescence analysis	59
4.1.3	X-ray diffraction pattern	61
4.1.4	IR analysis	63
4.2	Effect of shaking time	66

4.3	Decontamination factor.....	78
4.4	Effect of pH	79
4.5	Effect of liquid/solid ratio	90
4.6	Effect of particle size	95
4.7	Properties of the immobilized waste forms.....	101
4.7.1	Effect of curing time	101
4.7.2	Setting time	104
4.7.3	Bleeding test	106
4.7.4	Mechanical strength development	108
4.7.5	Water immersion	112
4.7.6	Leachability	114

CHAPTER 5: SUMMARY AND CONCLUSION

5.1	SUMMARY.....	124
5.2	CONCLUSIONS.....	129
	REFERENCES.....	130
	ARABIC SUMMARY	