

Table of Contents

1. INTRODUCTION AND OBJECTIVES.....	1
2. LITERATURE REVIEW.....	4
2.1. Basic terminology	4
2.1.1. Spallation and Fission	5
2.1.2. Multi megawatt spallation sources and target configurations	6
2.1.3. Liquid mercury target inventory.....	9
2.2. Overview of aspects for safe disposal of mercury and liquid wastes	14
2.3. Decommissioning and final waste disposal	16
2.4. Mercury and its compounds	21
2.4.1. Mercury salts	24
2.4.2. Metal alloys or amalgams.....	26
2.4.3. Stabilities of mercury compounds as chalcogenides and amalgams	28
2.5. Mercury solidification/stabilization in a compound.....	35
2.5.1. Safety aspects consideration during chemical processes.....	35
2.5.2. Overview of mercury stabilization technologies	36
2.6. Immobilization by encapsulation techniques.....	39
2.6.1. Solidification/stabilization in a cement matrix	40
2.6.2. Material for immobilizing nuclear wastes	41
2.6.3. Polysiloxanes in nuclear waste management.....	42
3. EXPERIMENTAL SECTION.....	45
3.1. Introduction.....	45
3.2. Experimental details.....	45
3.2.1. Reagents and materials.....	45
3.2.2. Preparation of salt brines	46
3.3. Analytical instruments	47
3.4. Leaching experiments and sample preparation	47
3.4.1. Leaching experiment sample preparation using solid mercury compounds	47
3.4.2. Preparation of cement-mercury compounds as matrices	48

3.4.3. Preparation of Polysiloxane-mercury compounds as matrix form	49
3.5. Leaching experiments under irradiation	51
3.6. Batch leaching experiments	55
3.7. Methods and Procedures for the stabilization / solidification	56
3.7.1. Formation of cinnabar	56
4. RESULTS AND DISCUSSIONS	58
4.1. Leaching experiments for mercury compounds	58
4.1.1. Performance comparison of leaching samples	58
4.1.2. Limitations of mercury under radioactive disposal conditions.....	59
4.1.3. Leaching experimental studies without γ -irradiation	59
4.1.4. Leaching experimental studies under γ -irradiation.....	62
4.1.5. Comparison studies on mercury sulfide and silver amalgam under irradiation.....	63
4.1.6. Leaching behavior of mercury sulfide and mercury selenide under irradiation	67
4.2. Encapsulation of mercury compounds in cement	69
4.2.1. Leaching behavior of mercury sulfide and Hg (I) nitrate embedded in cement matrix under irradiation	69
4.2.2. Mercury waste (Hg) in ordinary Portland cement (OPC).....	73
4.2.3. Chloride effect on mercury embedded in cement matrix	73
4.2.4. SEM investigations on mercury sulfide embedded in cement.....	75
4.3. Encapsulation studies for mercury compounds using polysiloxane material	79
4.3.1. Leaching behavior of mercury compounds embedded in polysiloxane matrix	79
4.4. Chemical engineering study of HgS generation	83
4.4.1. Selection of a process for formation of HgS from liquid mercury	83
4.4.2. Formation of mercury sulfide by wet chemical process.....	87
4.5. Development and scale up studies	94
4.6. Cost estimation studies	95
5. SUMMARY	98
5.1. Selection of solid mercury compounds	98
5.2. Matrix embedding studies in HgS with cement and polysiloxane materials	99
5.3. Conversion of elemental mercury to mercury sulfide	100

6. OUTLOOK.....	101
7. ACKNOWLEDGMENTS.....	102
8. LITERATURE.....	104
9. APPENDIX	113