

**STUDY ON REMOVAL OF ARSENIC FROM
GROUND WATER FROM A SELECTED
SOURCE**

PhD DISSERTATION

KHIN MAR MYINT

**DEPARTMENT OF INDUSTRIAL CHEMISTRY
UNIVERSITY OF YANGON
MYANMAR**

NOVEMBER, 2007

ABSTRACT

The presence of arsenic was first detected in early 2000 in some tube wells by Save the Children (U.K) in some regions of Myanmar. Later, during extensive Water Quality Surveillance and Monitoring by WRUD and UNICEF, it was found that arsenic was present mostly in Shallow Tube Wells. These tube wells tap the ground water from the upper strata. In extreme cases, arsenic concentration was found to be as high as 0.2 mg/l (200 µg/l) and the concentration ranging between (0.01 and 0.05) mg/l is quite common. Consuming water having high arsenic content will eventually result in a serious health problem known as arsenicosis. Ways and means for the mitigation of arsenic to an acceptable level need to be explored in the country in order to safeguard the health of the public. As such, the aim of this research is to obtain a comparatively simple but effective and affordable arsenic removal unit for the public in areas where drinking water is contaminated with arsenic. Locally available materials were mostly used in the research and there is a strong indication that arsenic can be removed to less than acceptable level of 10 µg/l by household removal unit. The experimental household unit was set up at a selected site in a village. The site is close to a well, contaminated with arsenic. Filtration using a dual-media consisting of sand and laterite yielded good results in reducing arsenic as well as iron content from water. A better result can be obtained by chemical coagulation followed by a short sedimentation period before the filtration process; ferric chloride was found to be the most suitable coagulant. This treatment method of coagulation and filtration has been documented in countries dealing with arsenic problem. All the selected parameters related to arsenic were duly tested. However, due to the limited availability of some chemicals, extensive tests were unable to be carried out.

**STUDY ON REMOVAL OF ARSENIC FROM GROUND WATER
FROM A SELECTED SOURCE
TABLE OF CONTENTS**

CHAPTER	TITLE	PAGE
	Acknowledgements	i
	Abstract	iii
	Notations	iv
	Table of Contents	vi
	List of Tables	x
	List of Figures	xviii
	List of Photo Plates	xxv
CHAPTER I		
1	INTRODUCTION AND SCOPE OF THE STUDY	1
1.1	Introduction	1
1.1.1	Background History	1
1.1.2	Source of Arsenic	2
1.1.2.1	Natural Sources	2
1.1.2.2	Properties of Arsenic	3
1.1.2.3	Principal Compounds of Arsenic	4
1.1.3	Objectives of the Study	6
1.1.4	Methodology	6
1.2	Scope of the Study	7
CHAPTER II		
2	LITERATURE REVIEW	10
2.1	Current Situation in Myanmar on Arsenic Contamination in Drinking Water	10
2.1.1	Arsenic in Myanmar	10
2.1.2	Concentration of Arsenic in Drinking Water	10
2.2	Technologies for Arsenic Removal	18
2.2.1	Oxidation	18
2.2.1.1	Chemical Oxidation	19
2.2.1.2	Solar Oxidation	19
2.2.2	Coagulation and Filtration	20

TABLE OF CONTENTS (CONT'D)

2.2.3	Ion-exchange Resins	23
2.2.4	Bucket Treatment Unit	25
2.3	Bangladesh Perspective on Arsenic Contamination	27
CHAPTER III		
3	EXPERIMENTAL APPROACH	29
3.1	Laboratory Set Up and Experiments	29
3.2	Field Investigations and Experimental Unit Set up	30
3.3	Field Experiments	30
3.4	Salient Features of Arsenic Testing Instrument	32
3.4.1	Merck Arsenic Test Kit	32
3.4.2	Arsenator (International Digital Arsenator)	32
3.5	Use of Arsenic Test Kits and AAS	33
3.5.1	Brief Instructions for Use of Merck Test Kit	33
3.5.2	Use of Arsenator Operation Manual (International Digital Arsenator)	34
3.6	Other Instruments Used	35
3.7	Jar Test	40
3.7.1	Apparatus	40
3.7.2	Coagulant Dosing Solution or Suspension	41
3.7.2.1	Stock Arsenic Solution	41
3.7.2.2	Intermediate Arsenic Solution	41
3.7.2.3	Standard Arsenic Solution	41
3.7.2.4	1% Ferric Chloride Solution	41
3.7.2.5	1% Alum Solution	41
3.7.2.6	1% Poly Aluminium Chloride (PAC) Solution	41
3.7.3	Test Procedure for Coagulation Treatment in the Laboratory	41
3.7.4	Test Procedure for Coagulation Treatment in Field	42
CHAPTER IV		
4	RESULTS OF EXPERIMENTS AND EVALUATION OF TEST RESULTS	44
4.1	Locations of Sites Selected for Testing Water Samples	44
4.2	Field Experiments	46

TABLE OF CONTENTS (CONT'D)

4.3	Methods of Treatment Used in the Experimental Unit	46
4.3.1	Treatment Methods	47
4.3.2	Filter Media Used	47
4.3.3	Chemical Coagulants	47
4.4	Results of Laboratory Experiments	50
4.5	Results of Field Experiments	51
4.6	Experiments Using Other Filter Media	54
4.7	Evaluation and Summary of Laboratory and Field Experiments	54
4.8	Analysis of Pyin-bon-gyi Sand for Effective Size and Uniformity Coefficient	55
4.9	Gravel Support	55
4.10	Laterite	56
4.11	Washing of Filter Media and Gravel Supports	56
 CHAPTER V		
5	DESIGN AND CONSTRUCTION OF THE EXPERIMENTAL HOUSEHOLD TREATMENT UNIT	175
5.1	Design Parameters	175
5.1.1	Data Selected for Experiments	175
5.1.2	Flowsheet	177
5.2	Results of Experiments and Evaluation of Test Results for Experimental Household Unit	177
5.2.1	Description	177
5.2.2	Treatment Process	178
 CHAPTER VI		
6	EVALUATION OF THE PERFORMANCE OF THE EXPERIMENTAL HOUSEHOLD TREATMENT UNIT	206
6.1	Filter Media	206
6.2	Filtration Rates	206
6.3	Length of Filter Run	206
6.4	Removal of Arsenic	207
6.5	Cleaning of the Filter Media	208

TABLE OF CONTENTS (CONT'D)

CHAPTER VII

7	CONCLUSION	210
	SUGGESTIONS FOR FUTURE RESEARCH	214
	APPENDIX (1)	215
	APPENDIX (2)	217
	APPENDIX (3a)	218
	APPENDIX (3b)	219
	APPENDIX (4)	220
	APPENDIX (5)	221
	APPENDIX (6a)	222
	APPENDIX (6b)	223
	CREDIT SEMINARS COMPLETED	224
	REFERENCES	225