



## REFERENCES

- A division of Suffolk Business Services. (2003). Innovative Block Machine Sales [Online]. Available from: <http://www.blockmachines.com/sbs234.html> [2004, January 23]
- AAron Equipment Company. (2003). Buying and selling process equipment made easy! [Online]. Available from: <http://www.aaronequipment.com/inventory.asp?categoryID=24&subcategoryID=25> [2004, January 23]
- Adeel, Z., and Ali, A. M. (n.d.). A comparative evaluation and field implementation of treatment technologies for arsenic removal from groundwater [Online]. Available from: <http://www.unu.edu/env/Arsenic/Adeel%20KJIST%20Paper.doc> [2003, October 18]
- Amy, G., Edwards, M., Brandhuber, P., McNeill, L., Benjamin, M., Vagliasindi, F., Carlson, K., and Chwirka, J. (2000). Arsenic treatability options and evaluation of residuals management issues. Denver: AWWA Research Foundation and American Water Works Association.
- Baur, I., and Johnson, C., A. (2003). Sorption of selenite and selenate to cement minerals. Environmental Science & Technology 37: 3442-3447.
- Benjamin, M. M. (2002). Water chemistry. Singapore: McGraw-Hill.
- Bishop, M., Bott, S. G., and Barron, A. R. (2003). A new mechanism for cement hydration inhibition: solid-state chemistry of calcium nitrilotris (methylene) triphosphonate. Chem. Mater. 15: 3074-3088.

- Brown, K. G. (2002). Arsenic drinking water, and health [PDF file]. Available from: <http://www.acsh.org/publications/reports/arsenic2002.pdf> [12. August 2005]
- Bothe, Jr. J. V., and Brown, P. W. (1999a). Arsenic immobilization by calcium arsenate formation. Environmental Science & Technology 33: 3806-3811.
- Bothe, Jr. J. V., and Brown, P. W. (1999b). The stabilities of calcium arsenates at 23± 1 °C. Journal of Hazardous Materials 69: 197-207.
- Bureau of Tread and Economic Indices. (2003). Construction materials prices: 2002, july [Online]. Available from: [http://www.price.moc.go.th/struct/data/bangkok/jul/jul\\_45.html](http://www.price.moc.go.th/struct/data/bangkok/jul/jul_45.html) [ 2003, January 11]
- Cocke, D. L., and Mollah, M. Y. A. (1993). The chemistry and leaching mechanisms of hazardous substances in cementitious solidification/stabilization systems. In R. D. Spence (ed.), Chemistry and microstructure of solidified waste forms, pp. 187-242. Ann Arbor: Lewis Publishers.
- Conner, J. R. (1993). Chemistry of cementitious solidified/stabilized waste forms. In R. D. Spence (ed.), Chemistry and microstructure of solidified waste forms, pp. 41-82. Ann Arbor: Lewis Publishers.
- Dixit, S., and Hering, J. G. (2003). Comparison of arsenic(V) and arsenic(III) sorption onto iron oxide materials: implication for arsenic mobility. Environmental Science & Technology 37: 4182-4189.
- Dutré, V., and Vandecasteele, C. (1995a). Solidification/stabilization of hazardous arsenic containing waste from a copper refining process. Journal of Hazardous Materials 40: 55-68.
- Dutré, V., and Vandecasteele, C. (1995b). Solidification/stabilization of arsenic-containing waste: leach tests and behavior of arsenic in the leachate. Waste Management 15: 55-62.

- Dutré, V., and Vandecasteele, C. (1996). An evaluation of the Solidification /stabilization of industrial arsenic containing waste using extraction and semi-dynamic leach tests. Waste Management 16: 625-631.
- Dutré, V., and Vandecasteele, C. (1998). Immobilization of arsenic in waste solidified using cement and lime. Environmental Science & Technology 32: 2782-2787.
- Frey, M., MacPhee, M., Bernosky, J., and Clark, K. (n.d.). Residuals characterization for arsenic control technologies [PowerPoint files]. McGuire Environmental Consultants. Available from: [http://www.sandia.gov/water/forumDocs/MFrey\\_abstract.pdf](http://www.sandia.gov/water/forumDocs/MFrey_abstract.pdf) [2003, October 18]
- Glasser, F. P. (1993). Chemistry of cement-solidified waste forms. In R. D. Spence (ed.), Chemistry and microstructure of solidified waste forms, pp. 1-40. Ann Arbor: Lewis Publishers.
- Goldenberg, S., and Johnston, C. T. (2001). Mechanisms of arsenic adsorption on amorphous oxides evaluated using macroscopic measurements, vibrational spectroscopy, and surface complexation modeling. Journal of Colloid and Interface Science 243: 204-216.
- Harun-ur-Rashid, Md., and Abdul Karim Mridha, Md. (1998). Arsenic contamination of groundwater in Bangladesh. 24<sup>th</sup> WEDC Conference: Sanitation and Water for All: 162-165.
- ICPI. (1999). Guideline specification for the construction of interlocking concrete pavement. Tech Spec No.9. Also available from: <http://paverdepot.com/icpi-guide-specs.pdf> [2003, 28 November]
- Inkeep, W. P., McDermott, T. M., and Fendorf, S. (2002). Arsenic(V)/(III) cycling in soils and natural waters: chemical and microbiological processes. In W. T. Frankenberger Jr (ed.), Environmental chemistry of arsenic, pp. 183-215. New York: Marcel Dekker

IR Mentor Pro 6.5 [Computer software]. (1998). Philadelphia: Bio-Rad Laboratories

Itle, C.H., Novak, J. T., and Edwards, M. (2001). Disposal alternatives of drinking water treatment residuals containing arsenic. Available from: <http://www.scholar.lib.vt.edu/theses/available/etd-07242001-161747/unrestricted/ItleETD.pdf> [ 2003, 12 August]

Jing, C., Korfiatis, G. P., and Meng, X. (2003). Immobilization mechanisms of arsenate in iron hydroxide sludge stabilized with cement. Environmental Science & Technology 37: 5050-5056.

Johnston, R., Heijnen, H., and Wurzel, P. (2001). Chapter 6: safe water technology [PDF file]. Available from: [http://www.who.int/entity/water\\_sanitation\\_health/dwq/en/arsenicun6.pdf](http://www.who.int/entity/water_sanitation_health/dwq/en/arsenicun6.pdf) [2003, August 18]

Khundkar, R. (2003). The largest mass poisoning of a population in history: arsenic in drinking water. Oxford Medical School Gazette Vol. 53(2) [Online]. Available from: <http://www.medsci.ox.ac.uk/gazette/volume53-2/19/> [2003, October 18]

LaGrega, M. D., Buckingham, P. L., and Evans, J. C. (2001). Hazardous waste management. 2<sup>nd</sup> ed. Singapore: McGraw-Hill.

Lea, F. M. (1970). The chemistry of cement and concrete. 3<sup>rd</sup> ed. New York: Chemical Publishing Company.

Leist, M., Casey, R. J., and Caridi, D. (2002). The fixation and leaching of cement stabilized arsenic. Waste Management 23: article in press.

Leist, M., Casey, R. J., and Caridi, D. (2000). The management of arsenic wastes: problems and prospects. Journal of Hazardous Materials 76: 125-138

- MacPhee, M. J., Charles, G. E., and Cornwell, D. A. (2001). Treatment of arsenic residuals from drinking water removal process [PDF file]. Available from: <http://www.epa.gov/ORD/IRMMKL/Pubs/600R01033/600R01033.PDF> [2003, January 4]
- MacRae, J. D. (n.d.). Arsenic's murky past [Online]. Available from: [http://www.umeciv.maine.edu/MacRae/arsenic\\_history.htm](http://www.umeciv.maine.edu/MacRae/arsenic_history.htm) [2003, December 18]
- Matches. (2003). Dryer Cost Estimate [Online]. Available from: <http://www.matche.com/EquipCost/Dryer.htm> [2004, January 21]
- Melicher, M. (1994). Encapsulation and stabilization of copper-chromium – arsenic (CCA) sludge from timber treatment plants [Online]. Available from: <http://www.ifa.unimelb.edu.au/abstracts/master/1994/melicher1994.htm> [2003, October 18]
- Meng, X., Bang, S., and Korfiatis, G. P. (2000). Effects of silicate, sulfate, and carbonate on arsenic removal by ferric chloride. Water Research 34: 1255-1261.
- Meng, X., Korfiatis, G. P., Christodoulatos, C., and Bang, S. (2001). Treatment of arsenic in bangladesh well water using a household co-precipitation and filtration system. Water Research 35: 2805-2810.
- Meng, X., Korfiatis, G. P., Jing, C., and Christodoulatos, C. (2001). Redox transformation of arsenic and iron in water treatment sludge during aging and TCLP extraction. Environmental Science & Technology 35: 3476-3481.
- Method 1311: Toxicity Characteristic Leaching Procedure [PDF file]. Available from: [http://www.ene.gov.on.ca/envision/env\\_reg/er/documents/2000/ra00e0002\\_TCLP.pdf](http://www.ene.gov.on.ca/envision/env_reg/er/documents/2000/ra00e0002_TCLP.pdf) [2002, October 18]

- Metropolitan Waterworks Authority. (2003). Water tariffs [Online]. Available from: <http://www.mwa.ot.th/pubrela/cost.html> [2003, January 11]
- Mondess, S., Young, J. F., and Darwin, D. (2003). Concrete. 2<sup>nd</sup> ed. New Jersey: Pearson Education.
- Mollah, M. Y. A., Lu, F., and Cocke, D.L. (1998). An x-ray diffraction(XRD) and fourier transform infrared spectroscopic(FT-IR) characterization of the speciation of arsenic(V) in portland cement type-V. the Science of the Total Environment 244: 57-68.
- Morel, F. M. M., and Hering, J. G. (1993). Principles and applications of aquatic chemistry. New York: A Wiley-Interscience Publication.
- Myneni, S. C. B., Traina, S. J., and Logan, T. J., and Waychunas, G. A. (1997), Oxyanion behavior in alkaline environments: sorption and desorption of arsenate in ettringite. Environmental Science & Technology 31: 1761-1768.
- Natural Research Defense Council. (n.d.). Arsenic and old laws: a scientific and public health analysis of arsenic occurrence in drinking water, its health effects, and EPA's outdated arsenic tap water standard [Online]. Available from: <http://www.nrdc.org/water/drinking/arsenic/aoiinx.asp> [2003, December 18]
- Nriagu, J. O. (2002). Arsenic poisoning through the age. In W. T. Frankenberger Jr (ed.), Environmental chemistry of arsenic, pp. 1-26. New York: Marcel Dekker.
- Oregon State University. (2002). OSU Hazardous Waste Disposal Costs [Online]. Available from: <http://oregonstate.edu/dept/ehs/bulletin/hwcost.html> [2004, January 22]

- Palfy, P., Vircikova, E., Molnar, L. (1999). Processing of arsenic waste by precipitation and solidification. Waste Management 19: 55-59.
- Podjane Inthasaro. (2002). Utilization of municipal solid waste incineration fly ash as a partial cement replacement. Master's Thesis, Inter-department Environmental management, graduate School, Chulalongkorn University.
- SenGupta. A. K., Greenleaf, J. E. (2002). Arsenic in surface water: its chemistry and removal by engineering processes. In A. K. SenGupta (ed.), Environmental speciation of heavy metals: engineering process, pp. 2165-301. Ann Arbor: Lewis Publishers.
- Sincero. A. P. and Sincero, G. A. (2003). Physical-chemical treatment of water and wastewater. New York: CRC Press.
- Smedley, P.L., and Kinniburgh, D. G. (n.d.). Source and behavior of arsenic in natural waters [PDF file]. Available from: [http://www.who.int/entity/water\\_sanitation\\_health/dwq/en/arsenicun1.pdf](http://www.who.int/entity/water_sanitation_health/dwq/en/arsenicun1.pdf) [2003, October 18]
- Smith. A. H., Lopipero, P. A., Bates, M. A., and Steinmaus, C. M. (2002). Arsenic epidemiology and drinking water standards. Science's Compass 296: 2145-2146.
- Stumm, W., and Morgan, J. J. (1996). Aquatic Chemistry, 3<sup>rd</sup> ed. New York: A Wiley-Interscience Publication.
- The Siam Cement Group. (2003). CPAC [Online]. Available from: <http://www.cpacpavingblock.com/en/listprice-uni.html> [2004, January 21]
- USEPA. (1993). Solidification/stabilization and its application to waste materials. Springfield: National Technical Information Service, U.S. Department of Commerce

USEPA. (2000). Arsenic occurrence in public drinking water supplies [ PDF file].

Available from: <http://www.epa.gov/safewater/ars/occurrence.pdf>

[2003, October 18]

USEPA. (2002). Arsenic treatment technologies for soil, waste, and water [PDF file]

Available from: [http://www.epa.gov/tio/download/remed/542r02004/arsenic\\_report.pdf](http://www.epa.gov/tio/download/remed/542r02004/arsenic_report.pdf) [ 2003, October 23]

Vance, D. B. (2001). Arsenic-chemical behavior and treatment [Online]. Available

from : <http://2the4.net/arsenicart.htm> [ 2003, October, 18]

Vandecasteele, C., Dutré, V., Geysen, D., and Wauters, G. (2002). Solidification /stabilization of arsenic bearing fly ash from the metallurgical industry: immobilization mechanism of arsenic. Waste Management 22: 143-146.

Varian. (2001). Vistra CCD simulation ICP-OES Pro and MPX ICP-OES spectrometers: operation manual. New York: Varian

Voegelin, A., and Hug, S. J.(2003). Catalyzed oxidation of arsenic(III) by hydrogen peroxide on the surface of ferrihydrite: an in situ ATR-FTIR study.

Environmental Science & Technology 37: 972-978.

Wilkie, J. A., and Hering, J. G. (1996). Adsorption of arsenic onto hydrous ferric oxide: effect of adsorbate/adsorbent ratios and co-occurring solutes.

Colloids and Surfaces 107: 97-110.

Yamamura, S. ( n.d.). Drinking water guidelines and standards [ PDF file]

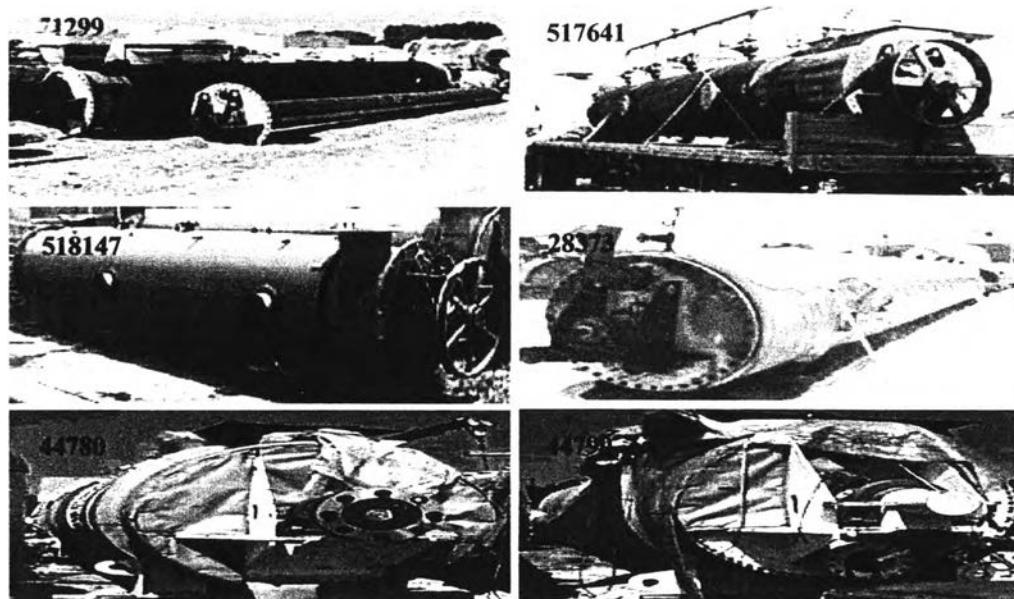
Available from:[http://www.who.int/entity/water\\_sanitation\\_health/dwq/en/arsenicun5.pdf](http://www.who.int/entity/water_sanitation_health/dwq/en/arsenicun5.pdf) [ 2003, October 18]



## **APPENDIX**

**Table A1** USEPA water system categories (Amy et al., 2000:220)

Category	Population range	Design flow (mgd,
1	25-100	0.024
2	101-500	0.087
3	501-1,000	0.27
4	1,001-3,300	0.65
5	3,301-10,000	1.8
6	10,001-25,000	4.8
7	25,001-50,000	11
8	50,001-75,000	18
9	75,001-100,000	26
10	100,001-500,000	51
11	500,001-1,000,000	210
12	greater than 1,000,000	430

**Figure A1** Rotary dryers cited in the Part VI (Aaron Equipment Company, 2003)

**Table A2** Reference of the costs inputted in the fifth step illustrated in Figure 4.119

Item	Cost	Unit	Source
1) Cost of Non-Hazardous Waste Transportation	70	US\$/ton	Tchobanoglous, Kreith, and Williams (2000)
2) Cost of Hazardous Waste Transportation	280	US\$/ton	Assumed
3) Cost of Sanitary Landfill	120	US\$/ton	Tchobanoglous, Kreith, and Williams (2000)
4) Cost of Secure Landfill	1905	US\$/ton	Oregon State University (2002)
5) Cost of Cement	69.6	US\$/ton	Bureau of Trade and Economic Indices (2003)
6) Cost of Sand	4	US\$/ton	Metropolitan Waterworks Authority (2003)
7) Cost of Water	0.457	US\$/ton	Metropolitan Waterworks Authority (2003)
8) Cost of a Skilled Worker	428.57	US\$/month/person	Assumed
9) Cost of an Unskilled Worker	200	US\$/month/person	Assumed
10) Cost of Electricity	57.1428	US\$/ 1,000 hours	Adichart (n.d.)

**Table A3** Specifications and costs of the rotary dryers cited in Part VI

Code	Diameter (inch) <sup>a</sup>	Length (ft) <sup>a</sup>	surface (ft <sup>2</sup> ) <sup>a</sup>	Volume (ft <sup>3</sup> ) <sup>a</sup>	Capital cost US\$/unit <sup>b</sup>	Electricity required for rotation kw/hr/unit <sup>a</sup>	Electricity required for heating to 105 °C kw/hr/unit <sup>a</sup>	Total electricity required for drying (kw/hr/unit)
1 517641 model RD-42-2 (19.25 ft <sup>3</sup> )	42	2	22	19.25	81,800	44.7	0.54	45.24
3 71299 model RD-42-24 (260 ft <sup>3</sup> )	42	27.1	298.2	260.93	145,600	74.5	7.33	81.84
2 518147 model RD-42-16 (154 ft <sup>3</sup> )	42	16	176	154	118,400	37.25	4.33	41.58
4 28373 model RD-48-34 (427 ft <sup>3</sup> )	48	34	427.4	427.43	173,700	74.5	12.02	86.51
5 47708 model RD-84-30 (1155 ft <sup>3</sup> )	84	30	660	1155	229,000	149	32.48	181.48
6 47709 model RD-88-50 (2112 ft <sup>3</sup> )	88	50	1152	2112.7	323,500	223.5	59.41	282.91

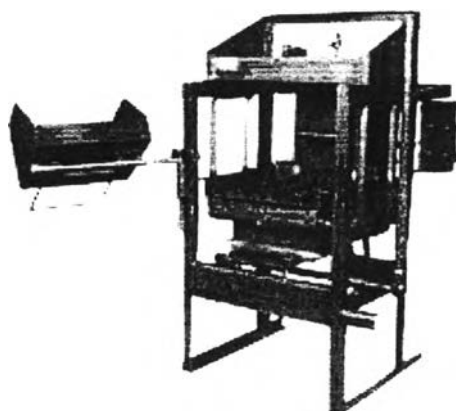
<sup>a</sup> is from Aaron Equipment Company(2003). <sup>b</sup> is from matches (2003)

**Table A4** Specification of the paving block making machine cited in Part VI  
(A division of Suffolk Business Services, 2003)

Machines industrial for Blocks and Pavers

***Model SBS234***

Description	Semi-automatic movement manual machine. Indicated for factories of blocks in Professional activity. It can manufacture also 1/2 Blocks, bricks, blocks and pavers, etc
Ideal number of staffs	1 user of machine: 1 assistant for moving blocks from the machine 1 user of mixer 1 assistant for transporting mix from the mixer to machine 2 assistants for transport of pallets with the blocks.
Production rate in 8 hours	4 blocks of 10,0 = 4.000 blocks/day 3 blocks of 15,0 = 3.000 blocks/day 2 blocks of 20,0 = 2.000 blocks/day Bricks and pavers to 150 m <sup>2</sup> /day Staffs necessary: 3 to 6



**Figure A2** The paving block making machine cited in Part VI  
(A division of Suffolk Business Services, 2003)

**Table A5** Cost of interlocking concrete paving block (the Siam Cement Group. 2003)

Thickness (cm)	Color	Cost (baht)
6	grey	4.1
	red	5.45
	yellow	5.45
	black	5.45
	green	9
	orange	5.7
	brown	5.7
	grey(no chamfer)	4.3
8	grey(HS)	7.8
	yellow(HS)	8.4

## BIOGRAPHY

Mr. Tanapon Phenrat was born on October 18, 1980 in Bangkok, Thailand. He graduated primary and secondary school in 1997 from Rittiyawannalai School, Bangkok. He received his Bachelor's Degree in Civil Engineering from Faculty of Engineering, Kasetsart University in 2001. He pursued his Master Degree studies in the International Postgraduate Programs in Environmental Management, Inter-Department of Environmental Management, Chulalongkorn University in May 2002. He was awarded Master Degree of Science in Environmental Management in September 2004.

