Oil shale ash as a source of Ca for $CaCO_3$ production

Olga Velts

Tallinn University of Technology
(Estonia)

GHGT-10 Student Mentoring Programme

19. September 2010

http://www.physorg.com/

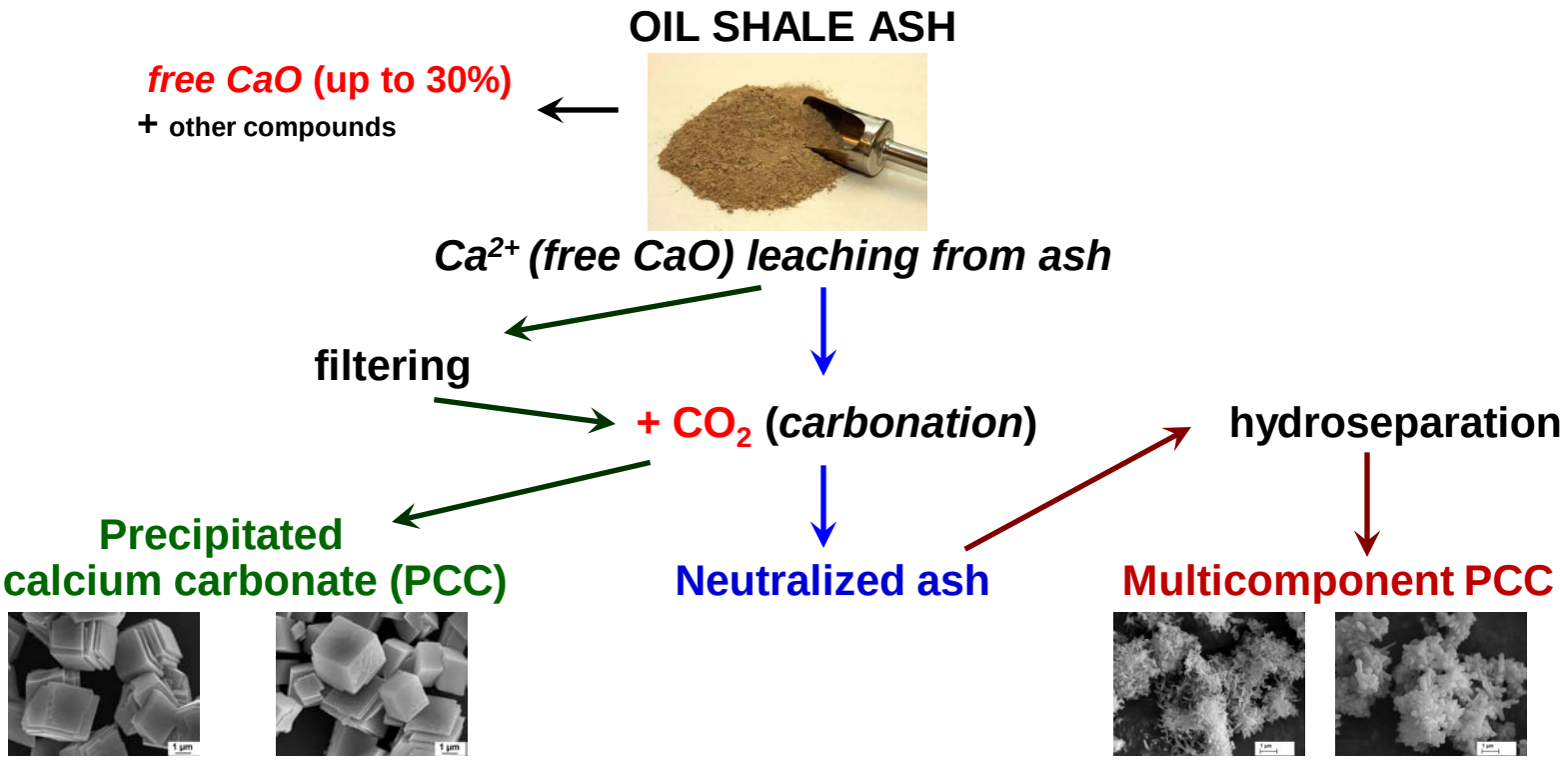
Problem overview

- In Estonia, over 90% of the basic power supply is provided by the use of oil shale as a fuel for power plants
- Oil shale-based power production is responsible for about 72% of total Estonian energy-related CO_2 emissions
- The processing of oil shale for heat and power production has also created over 200 million tons of alkaline waste ash

DOI: 10.1039/b819315k

Oil shale ash as a source of Ca for $CaCO_3$ production

- Oil shale ash could be considered as a low-cost source of water-soluble calcium due to high content of lime (up to 30% of free CaO)
- Binding CO_2 by Ca-rich oil shale ash leachates in the form of stable carbonates permits CO_2 emissions reduction as well as utilization of ash for precipitated calcium carbonate (PCC) production
- The feasibility of CO_2 safe disposal in the form of PCC by gas-liquid reaction is of considerable importance due to applicability of calcium carbonate in a wide range of products including paper, paints, plastics etc



Oil shale ash as a source of Ca for $CaCO_3$ production

Objectives

- The main goal of the research is to develop a mathematical description of oil shale ash based multi-step PCC formation process in order to predict the optimum conditions
- By taking into account kinetics, hydrodynamics and specifics of the process, models will be proposed for each stage of the process, including Ca leaching from ash, CO_2 dissolution from gaseous phase into alkaline liquid phase and $CaCO_3$ precipitation
- These modeling algorithms can be potentially implemented also to design similar processes on the basis of other lime-containing wastes.

Process stages:

1. **CaO hydrolysis (Ca leaching from ash)**

$CaO + H_2O \bullet \quad Ca(OH)_2 \bullet \quad Ca^{2+} + 2OH^-$

2. **CO_2 absorption into alkaline solution**

3. **$CaCO_3$ precipitation via carbonation route**

$Ca(OH)_2 + CO_2 \bullet \quad CaCO_3 \bullet + H_2O$

List of publications

- ***O. Velts*, M. Hautaniemi, J. Kallas, R. Kuusik, Modeling calcium dissolution from oil shale ash: PART 1. Ca dissolution during ash washing in a batch reactor, *Fuel Processing Technology* 91(5) (2010), pp. 486-490.**

- ***O. Velts*, M. Hautaniemi, J. Kallas, M. Kuosa, R. Kuusik, Modeling calcium dissolution from oil shale ash: PART 2. Continuous washing of the ash layer, *Fuel Processing Technology* 91(5) (2010), pp. 491-495.**

- ***O. Velts*, M. Uibu, I. Rudjak, J. Kallas, R. Kuusik, Utilization of oil shale ash to prepare PCC: leachibility dynamics and equilibrium in the ash – water system, *Energy Procedia* 1(1) (2009), pp. 4843-4850.**

- ***O. Velts*, M. Hautaniemi, M. Uibu, J. Kallas, R. Kuusik, Modelling of CO_2 mass transfer and hydrodynamics in a semi-batch reactor, *Journal of International Scientific Publications: Materials, Methods & Technologies* 4(2) (2010), pp. 68-79.**

- **M. Uibu, *O. Velts*, R. Kuusik, Developments in CO_2 mineral carbonation of oil shale ash, *Journal of Hazardous Materials* 174(1-3) (2010), pp. 209-214.**

- **M. Uibu, *O. Velts*, A. Trikkel, R. Kuusik. Reduction of CO_2 emissions by carbonation of alkaline wastewater. Sixteenth International Conference on Modelling, Monitoring and Management of Air Pollution. 22 - 24. Sept. 2008, Skiathos, Greece. WIT Transactions on Ecology and the Environment 2008, Vol. 116, P. 311-320. ISSN 1743-3541. doi:10.2495/AIR08321**

- **Uibu, M., *Velts, O.*, Trikkel, A., Kallas, J., Kuusik, R. (2008). Developments in CO_2 mineral carbonation by oil shale ash. In: Proceedings: 2nd International Conference on Accelerated Carbonation for Environmental and Materials Engineering, Rome, Italy, Oct. 1-3, 2008. (Ed.) Baciocchi, R.; Costa, G.; Polettini, A.; Pomi, R.. Rome, Italy: University of Rome "La Sapienza", 2008, 421 - 430.**