Homework 5 Solar Power Africa (Max Yan)

Due September 27 2021

1. Silica is treated at 650°C via magnesiothermic reduction whereas silicon boule is produced at 1500°C.
   1. Assume that the heat used for both processes is generated from a coal-fired plant on site. What is the cost savings per kilogram of silicon using magnesiothermic reduction? State your assumptions. Cite your sources.
   2. Due to the low temperature, an electric furnace can be used to run the magnesiothermic reduction. How much would this change the cost savings?
   3. What are the associated carbon emissions for each process?
2. Your market research analyst found that the demand of silicon you should try to meet is 300 kg. How much SiO2 and how much Mg, in both moles and kg would you need to produce this amount of porous Si, given a yield of your process of 60 mol%?

1. What is the big difference between a lab-scale furnace and an industry-scale furnace?
2. For the purification step, it is safer to use a dilute acid. How do low concentrations of acid affect the process economics?
3. How does the selectivity of Si production affect the value of the final product?
4. Max assumed 50 weeks of plant operation per year; how can you improve that estimate?
5. Can you think of any process handles in addition to the ones that Max suggested?
6. What are the raw material costs/values of magnesium, silicon and silica? Cite your source.

Additional Resources (you will need to log into your Sheffield account to access the digital library resources):

Don W. Green and Robert H. Perry.[*Perry’s Chemical Engineer’s Handbook*](https://find.shef.ac.uk/permalink/f/15enftp/44SFD_ALMA_DS51213072350001441)*, 8th Edition*. McGraw-Hill:London, 2008.

Towler, G.P. [*Chemical Engineering Design: principles, practice and economics of plant process and design, 2nd ed*](https://find.shef.ac.uk/permalink/f/15enftp/44SFD_ALMA_DS51235977050001441). Oxford: Butterworth-Heineman **2013**. See chapters 7, 8 and 9 for costing methods.