DESIGNING A HIGH PRESSURE STAGE FOR CO_2 SEQUESTRATION STUDIES – FRUSTRATIONS, TRIALS AND TRIBULATIONS

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CO_2 capture and storage has attracted billions of dollars of investment in the past few years from governments and industry alike. However questions regarding the effects of all that CO_2 on the well/aquifer chemistry remain unanswered and the non-ideal nature of CO_2 makes the geochemical modeling results less reliable than many will admit. The missing link is experimental data on which to build the assumptions in the models. X-ray diffraction is one of the techniques that are able to probe extreme conditions in-situ. Many of the relevant reactions are quite slow, so extended lab-based experiments are preferable to rapid ones at a synchrotron.

The answer – build a stage to look at reaction kinetics under down-hole conditions to fit on a laboratory diffractometer. Easy to say but a bit more difficult to achieve given that the ultimate design conditions for such a stage to simulate the bottom of an oil/gas/geothermal well are:

300 bar pressure, 300ºC, sour geothermal brines at pH3, CH_4, SO_2, etc

155,000 ppm of acidic chloride is nasty by anyone's standards (c.f. seawater at 19,000 ppm Cl^-) but is rapidly fatal to most metals below 100ºC, never mind over 200ºC. The minute details of high temperature chloride metal corrosion, pressure fittings, sealing technologies, anti-corrosion coating technologies, transducers, relief valves, syringe pumps, etc fill your days. Beryllium isn't renowned for being corrosion resistant so what do you do – coat it with tantalum of course! All this and a fluid-filled chamber isn't too friendly to CuKα or even MoKα, so AgKα starts looking good – but can you get a tube and/or optics, have the new detectors been tested with it?

From here on in we enter the mysterious realm of the boiler and pressure vessel regulations, of which there are a number (CSA B51, ASME Section VIII divisions 1 and 2, B31.3 process piping, etc). Failure of a pressure vessel at 300 bar is not something you want to think about but the hydrostatic test will be at 450 bar – ouch! This is a place where you use approved materials rather than the best one for the job, think 'can I get away without spending $2400 to get a single set of numbers in a couple of tables', trawl every bit of information you can find, dwell on every detail of the finite element analysis, and allowable stresses begin to rule your life.

Now was that allowable stress 30 or 27ksi under B31.3, division 1 or division 2, SB564 or SB574, RT or 600ºF, bar-stock, plate or forging, C-22 or 625……..and where's the Tylenol?