CORROSION OF CARBON STEEL IN CONTACT WITH BENTONITE

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Carbon steel canisters were chosen in a number of disposal concepts as reference material for disposal canisters. The corrosion rates of carbon steels in water solution both in aerobic and anaerobic conditions are well known, but only scarce data are available for corrosion behaviour of carbon steels in contact with bentonite. A special apparatus, which enables to measure corrosion rate of carbon steels under conditions simulating conditions in a repository, namely in contact with bentonite under high pressure and elevated temperatures was therefore prepared to study:

– Corrosion rate of carbon steels in direct contact with bentonite in comparison with corrosion rate of carbon steels in synthetic bentonite porewater.

– Influence of corrosion products on bentonite.

The apparatus is composed of corrosion chamber containing a carbon steel disc in direct contact with compacted bentonite (Figure 1). Synthetic granitic water is above compacted bentonite under high pressure (50 – 100 bar) to simulate hydrostatic pressure in a repository. The experiments can be carried out under various temperatures. Bentonites used for experiments were Na-type of bentonite Volclay KWK 80 – 20 and Ca-Mg Czech bentonite from deposit Rokle. Before adding water into corrosion system the corrosion chamber was purged by nitrogen gas. The saturation of bentonite and corrosion rate were monitored by measuring consumption of water, pressure increase caused by swelling pressure of bentonite and by generation of hydrogen. Corrosion rate was also determined after corrosion experiments from weight loss of samples.

The results of experiments show that the corrosion behaviour of carbon steels in contact with bentonite is very different from corrosion of carbon steels in water simulating bentonite porewater solution. The corrosion rates of carbon steel in contact with bentonite reached after 30 days of corrosion the values approaching 40 mm/yr contrary to values of approximately 2-3 mm/yr in bentonite porewater solution. No significant pressure increase was observed due to generation of hydrogen. The results of surprising behaviour of carbon steels in bentonite could be explained by the different composition of solution after granitic water flow through bentonite or by hypothesis based on our modelling experiments (Vokal et al, 2005) that corrosion rate increase is caused by so called pumping effect of bentonite which is in turn caused by different solubilities of corrosion products in the corrosion layer and bentonite.

Influence of corrosion products on bentonite is another important question. It was clearly visible that the transport of corrosion products into Volclay bentonite is approximately 1 mm after 30 days of corrosion at 70°C (Figure 2).

The reason why no pressure increase was observed due to hydrogen evolution could be explained by higher rate of hydrogen transport in bubbles than is its evolution rate. But these hydrogen bubbles might be also accumulated between carbon steel layer and bentonite what results in inhomogeneity of corrosion layer (Figure 3).

The results achieved significantly affect performance assessment of concept of disposal with carbon steel and bentonite. Only rather short term (30 days) experiments were carried out. In the next period longer experiments will have to give answer if the increase of corrosion rate of carbon steel in contact with bentonite is transient or will last for long time.

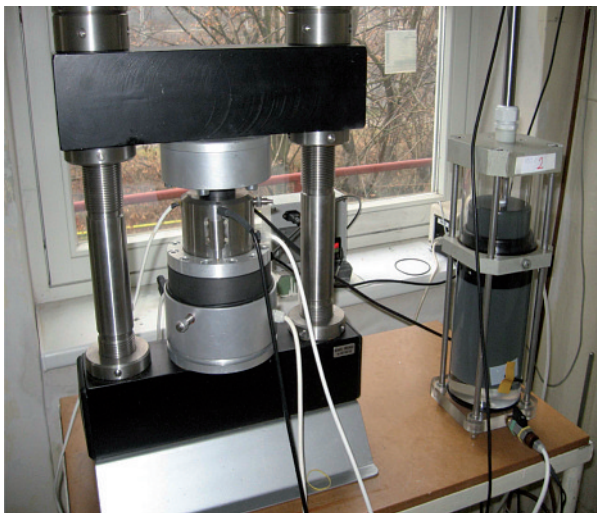

Figure 1: Picture of the apparatus for corrosion experiments.

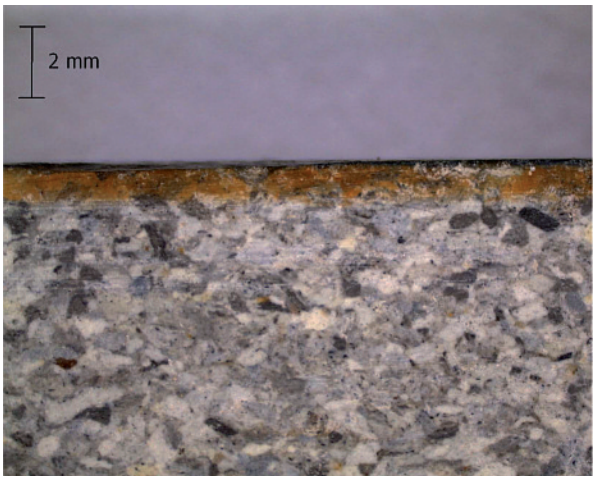

Figure 2: Transport of the corrosion products into Volclay bentonite.

Figure 3: Carbon steel plate after experiment with ventonite Rokle at 80°C.

References

Vokál, A., Lukin, D., Vopálka, D., Carbon steel canister performance assessment: Iron transfer study, Mat. Res.Soc, Symp. Proc., Vol. 932, 877, 2006.