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Ensuring Integrity Of CO2 Storage: An Overview Of Ongoing Experimental Activity

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Summary

The Ketzin pilot site is the longest operating onshore CO2 storage site in Europe. CO2 injection began in June 2008 and ended in August 2013. In total five wells were drilled at the Ketzin pilot site. During the abandonment, well construction material samples were retrieved. The samples were retrieved from the cementitious plug as well as from the steel casing and the production string at different depths. The samples were analyzed by a set of complementary experimental techniques.

Introduction

To promote the confidence in *permanent* large-scale storage of gas an enhanced focus on the quality of the well should be emphasized. In some ways the well could be considered as the Achilles heal in the entire CCS chain. A leaking well from a large-scale storage for CO_2 would detrimental in terms of the economics and reputation for CCS. A recurring issue in the petroleum industry is the performance of cement in relation to its primary role of providing zonal isolation. Enhanced understanding of this subject offers the possibility to improve the planning and design of the cementing job to minimizing the risk of poor bonding of cement and loss of well integrity. The design and execution of the cement job is by no means an easy task, mainly due to the complexity of the material and process, and the variety in conditions one can encounter downhole. The introduction of CCS moves the goal line further ahead due the potential reactivity of CO_2. Another feature adding to the complexity is the potential effect from the increased reservoir pressure from the injection itself. These challenges also affect the casing design.

Study on cement and casing samples from the Ketzin pilot site

The effect of CO_2 on wellbore cement and casing have received attention in numerous publications. However, it is not straight-forward to extrapolate the knowledge from laboratory scale, where the conditions are sufficiently controlled and monitored, but often simplified. The situation in the field scale is opposite in that the conditions are relevant in terms of thermodynamics, chemistry, timescale and dimensions, but the various parameters are monitored with insufficient frequency and/or quality or availability outside the sphere of the operator. The work performed in the Ketzin site outside Potsdam, Germany combined both these elements. The pilot scale study performed a lot of monitoring and logging of the reservoir and the five wells with good data storage.

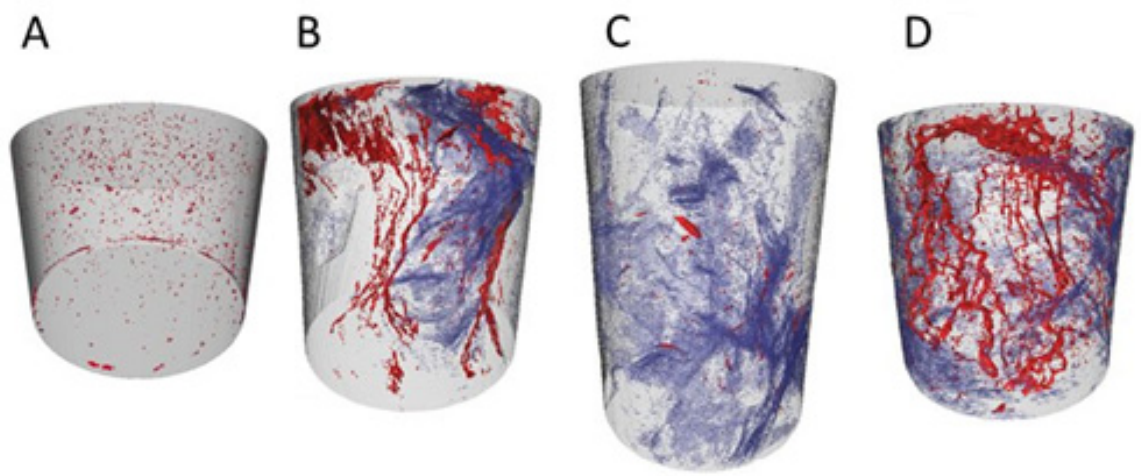

Figure 1 *3D visualisation of cement core volumes: (A) reference sample cured at ambient pressure and temperature; and downhole samples taken from depths of (B) 521 m, (C) 522 m, and (D) 523 m. Cement volume is presented in grey color, voids/ leakage paths- red, and the second material - blue. [1]*

Figure 1 shows the visualization obtained from a cement plug placed in a monitoring well. The top 6 meters of the plug was cored and some of the core samples were scanned using x-ray computed tomography. As one can observe in the figure the three wellbore samples are not fully homogenous. There are several regions with presumably drilling fluid influx. The middle plug (sample C) appears to be the only plug unaffected by contamination of this second material. However, this cement plugs also exhibit some level of porosity. Figure 2 shows four photographs of the injection tubing retrieved from the injection well at the Ketzin site.

Figure 2 *Photographs of 3 ½ injection tubing obtained from various wellbore depths in Ketzin well 201: (top left) from 87 meters depth; (top right) 182 meters depth; (bottom) 277 meters depth.[2]*

Conclusions

In comparison to many previous studies of CO_2 pilot/EOR sites, the advantage of the studies from the Ketzin pilot site was that samples were retrieved from several wells and from different depths. This provided insight in how downhole environment with CO_2 present affected casing steel and cement after several years of CO_2 injection and exposure. Except for significant pitting corrosion (i.e. holes) in the connections of the 3 ½ injection string, level of corrosion can be assessed as not compromising casing integrity. The cement plugs appeared to be solid. However, closer examination using x-ray CT exposed contamination within the cement plug of a second material.

Acknowledgements

Financial support for this work was from the Norwegian Gassnova-funded project "Improving CO_2 well integrity by studies of materials from Ketzin wells", which is an add-on to the German COMPLETE project which is funded by the Federal Ministry of Education and Research, OMV, RWE, Vattenfall, VGS and Equinor.

References

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