Combination of two techniques to mitigate an integrity issue in an aquifer storage

The fastest way to release the reservoir pressure in the event of a serious unwanted event is to vent the CO_2 through any suitable well. Especially in a large storage project, this may lead to very significant emission rates. Here we describe efforts to reduce those emissions by combining the venting of the CO_2 with water injection in the same well.

Our research object was an actual aquifer in which large scale storage was considered. The field underwent a technical feasibility study in which the impact 50 Mton of CO_2 injection was investigated. Figure 1 shows the CO_2 saturation distribution at the end of the injection phase.

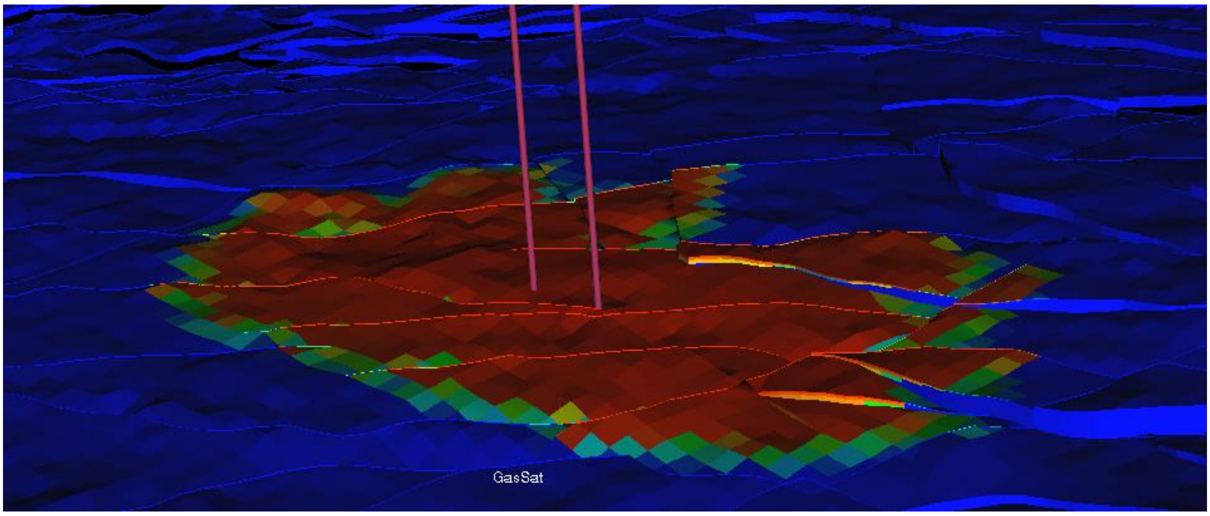

Figure 1 final CO_2 distribution (red and green) after injection of around 50 Mton of the gas.

Our current approach was to inject (at high injection rates) water or brine into the well which is also used for the venting. In other to avoid unwanted increases in reservoir pressure, the amount of water, which is injected is produced from the same aquifer by a well which is far away from the injector. To correctly describe the impact of the injected water on the CO_2 in the aquifer, the relative permeability relation were made hysteretic.

It was found that even in case water is injected before the venting starts, emissions still occur (Figure 2). The anticipated completely trapping of the CO_2 by the imbibing water has clearly not been successful. Simultaneous injection of water and venting of CO_2 leads to reduced emission rates, but also cannot completely stop the flow of the gas in the producing injector. In this situation it is essential to continue the water injection for enough time so that emission rates remain low. Premature ending of the water injection lead to resuming of the original venting behavior (Figure 3)

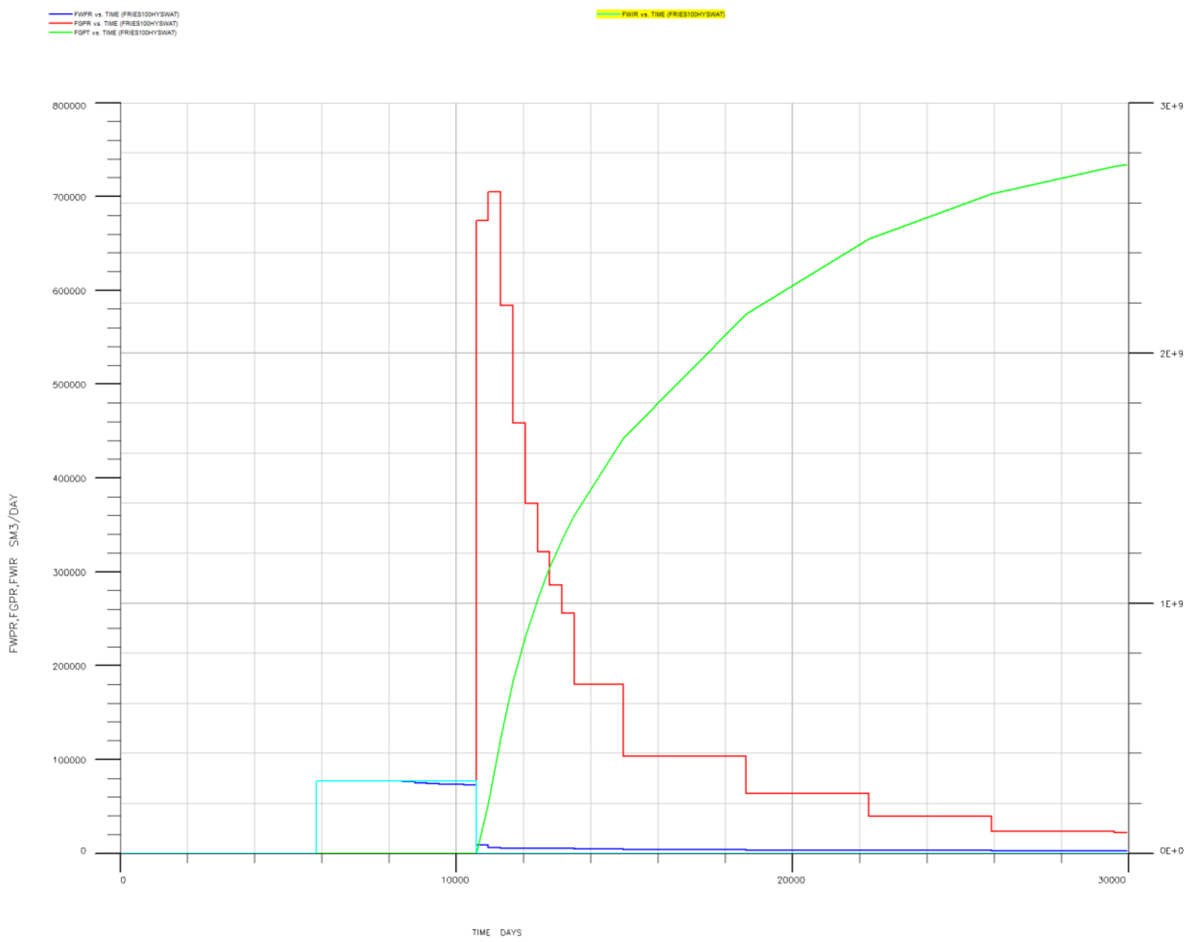

Figure 2 The produced/injected water rates (dark and light blue, respectively) and the vented CO_2 (red).

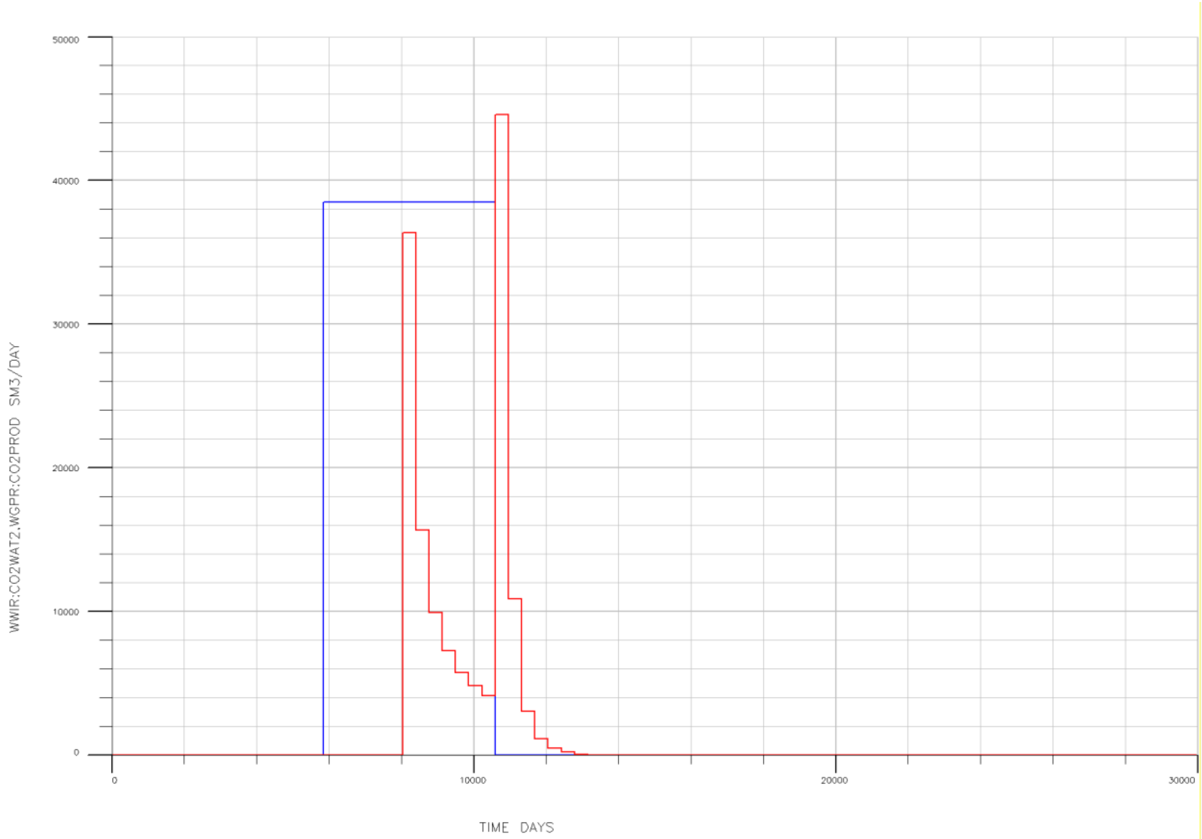

Figure 3 Injected water and venting rates (Sm^3/day) as function of time. Premature ending of water injection.

Overall it was shown that the combined impact of water injection and venting can be an attractive mitigation technique. The approach can be optimized, based on the degree of urgently of the integrity issue, the amount of stored CO_2, time after injection, and the allowable venting rates.

It should be noted that this blog deals with a very large potential flow in combination with an aquifer in which a massive amount of CO_2 was injected (for comparison 5 * as much as currently in Sleipner).

Cor Hofstee

TNO, August 2015