Problems when recharging brackish aquifers with membrane concentrate

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ABSTRACT

Brackish groundwater was and still is a serious threat for drinking water companies in The Netherlands and elsewhere, but in the near future it may change into a challenge. Membrane technology (reversed osmosis) is namely expected to be able to prepare drinking water from brackish groundwater on a cost-effective basis. In addition, wells that are threatened by salinization can be protected by using a small capture well for brackish water (the 'fresh keeper'), thus avoiding brackish water to enter the well at risk. The captured water can either be entirely reinjected (without desalination) or reinjected after reversed osmosis (excluding the desalinated water which is used). Reversed osmosis of brackish water inevitably leads to the production of membrane concentrate, to be considered as 'waste water', with a volume of 15-50% of the abstracted brackish groundwater. This membrane concentrate is characterized by a raised salinity, which can be easily integrated on site with some deeper seated, natural, more saline groundwater, and by very high concentrations for specific ions that are not observed in any groundwater on site.

The disposal of membrane concentrate by deep well injection into a brackish aquifer on site, which seems the most desirable solution, may encounter several problems, which we shall discuss in our presentation. The first problem is the infiltrability of the membrane concentrate that may have become supersaturated with respect to specific mineral phases and gases. As a result of supersaturation suspended precipitates and gas bubbles may form that clog the well screen. For various brackish groundwater types in the Netherlands we performed calculations using PHREEQC-2 to determine the degree of supersaturation when concentrating these waters to various degrees. The results indicate that the selection of the right brackish groundwater types and the right concentration factor are of paramount importance in preventing very cumbersome precipitates to form.

The second problem is related to the water quality changes of the membrane concentrate in the brackish aquifer. In general the target aquifer will transform the infiltrate into the direction of the native groundwater composition. When oxygen can be excluded and the use of various antiscalants avoided, then aquifer passage will result in quite acceptable qualities. This is corroborated by PHREEQC-2 simulations. Other problems relate to the hydrological effects of brackish water exploitation and waste injection (like changes in groundwater tables, land subsidence, clay migration and risk on recycling), and legislative aspects including the conditions posed by the European Water Framework Directive (WFD).

Although much of the above cited work derives from a desk study, we expect to plug in the experimental results of a pilot experiment which is currently running at a salinizing well field of Vitens.