Seasonal CO_2 storage in Q16-Maas, The Netherlands

M. Koenen, F. Neele, C. Hofstee, J. Veltin, A. van Wijhe, R. Bhardwaj (TNO) and Y. Le Gallo (GGR)

Email: marielle.koenen@tno.nl

ABSTRACT

Greenhouses use elevated CO_2 levels to enhance crop growth. Currently, they obtain most of their CO_2 through combustion of natural gas in combined heat and power installations. In The Netherlands an increasing number of greenhouses is moving away from natural gas, switching to geothermal energy as a heat source and using CO_2 from industrial sources. Supporting this transition to sustainable energy for greenhouses would require an increase in, and secure supply of external CO_2. Seasonal storage in Q16-Maas, injecting excess CO_2 in winter and back-producing in summer, could realize this.

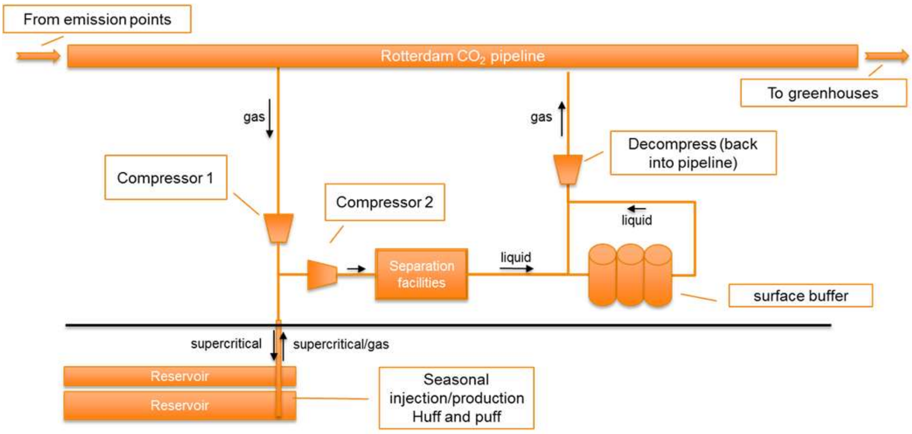

Fig 1: Schematic layout of the buffer design. The pipeline from the emission points to the greenhouses is operated by OCAP at pressures between 7 and 21 bar

INTRODUCTION

The Q16-Maas gas and condensate field, located close to the Rotterdam Maasvlakte, is a potential reservoir for seasonal storage. After depletion, it could be used to increase the supply of waste CO_2 from two industrial sources to the greenhouses North of Rotterdam in the summertime. In the ENOS project, the technical concept of the buffer chain (Fig. 1) is designed and optimized. The response of the reservoir upon cyclic injection and production and potential contamination of the CO_2 is investigated by reservoir simulations in ECLIPSE. OLGA software was used for well dynamics simulations.

RESULTS

Both injection in winter and production in summer can occur for 6 months at a rate of 20 kg/s. This would lead to an additional CO_2 supply to the greenhouses of 300 ktonne in summer. Injecting for two consecutive winter periods, providing cushion

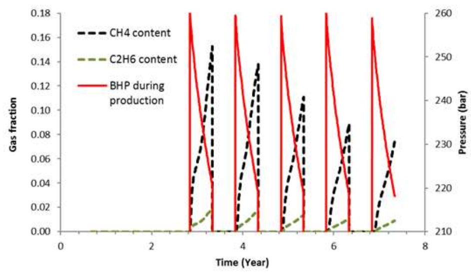

Fig 2: Composition and bottom hole pressure during several cycles of back- production.

gas, would improve the quality of the back-produced CO_2. Still, the back-produced CO_2 will be water-saturated and contaminated with hydrocarbons, primarily CH_4, at about 20% in the first injection cycle, decreasing with each consecutive cycle (Fig. 2). The hydrocarbons can easily be separated from the CO_2 by the use of a condenser and flash separator.

The primary constraint on the buffer potential comes from the back-production conditions in the production well. Well dynamics simulations show that the pressure and temperature decrease of the CO_2 during its ascent from bottom hole to wellhead is higher when the production volume increases. The conditions of the CO_2 during production should remain above both two-phase and hydrate formation conditions. (Fig. 3)

Back-production rates of 20 kg/s can only be obtained when the bottom hole CO_2 temperature is at the reservoir value of 105 °C. This requires significant compression at the wellhead during injection to wellhead conditions of 80 °C and 147-159 bar (Fig. 3). Rough cost estimates for the wellhead facilities and separation technologies show that seasonal buffering could be economically attractive.

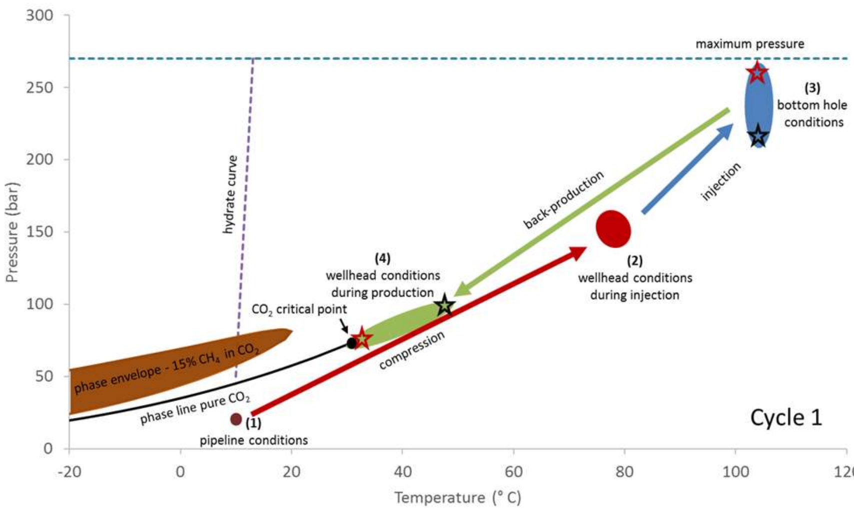

Fig 3: Schematic overview of pressure and temperature conditions from pipeline (1) to wellhead (2), to bottom hole (3) and back to wellhead (4), for a wellhead injection temperature of 80°C. Black and red stars represent initial and final conditions during reservoir filling (blue zone) and back-production (green zone). At the end of the first back-production cycle the CH_4 concentration is > 15%.

CONCLUSIONS

Seasonal buffering in Q16-Maas is technically and economically feasible to increase CO_2 supply to greenhouses by 60% to 800 ktonne on an annual basis. Back-production conditions define the buffer potential. Injection at high temperature is required to maximize back-production rates and prevent two-phase flow conditions and hydrate formation in the production well.

ACKNOWLEDGEMENTS

This work was carried out as part of the ENOS project, which has received funding from the EU Horizon 2020 programme under Grant Agreement No. 653718.

21 – 26 October 2018
GHGT-14, Melbourne