Synergy Between Production of Natural Gas and Warm Water: A Reservoir Modeling Exercise Assessing Recovery Factor Sensitivity*

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Abstract

The Netherlands evolved from a net natural gas exporter to being a net importer. With renewable energy in The Netherlands still not able to fully replace natural gas as an energy source, the Dutch security of energy supply is at risk. On a local scale, especially for greenhouses, geothermal energy has proven to be a reliable replacement for natural gas as the primary heat provider. Yet with the ambition of the Dutch government to achieve a 49% CO2 emission reduction in 2030, of which partly is assigned to the realisation of geothermal heat production, the maturation of the geothermal potential is too low. One of the main causes for this low maturation rate is the financial risk attached to both the exploration and exploitation phases of a geothermal project.

Synergy between hydrocarbon and geothermal exploitation could improve the aforementioned security of supply and simultaneously reduce financial risks of geothermal projects. The positioning of a geothermal doublet in the water leg of a gas field potentially extends field life and subsequent earnings from natural gas-production which in turn can be invested in the aligned geothermal project(s). This poster presents the results of two case studies, examining synergy at the Roden and Boskoop gas fields, that demonstrates geothermal production close to the gas-water contact that could delay water breakthrough in the gas well(s), potentially increasing the recovery factor.

The magnitude of increase of the recovery factor predominantly depends on the amount of aquifer support. Synergy in a weak aquifer (Boskoop case study) has no significant impact on the recovery factor. However, the addition of an artificial strong aquifer resulted in a 20% increase in recovery factor. Synergy with a moderate aquifer (Roden case study) resulted in a 3.3% increase in recovery factor.
Furthermore, although not as strongly, the magnitude of increase relies on positioning of the geothermal wells relative to gas producer(s), geothermal flow rate and potentially the permeability. This study also demonstrates that gas fields in a late stage of gas production could still benefit from the addition of geothermal doublets. It might be too late to achieve the full potential of synergy between gas and geothermal production, but a modest increase in recovery factor can still be expected. The Roden case study showed that a 1.1% increase in recovery factor could be achieved with the instalment of a geothermal system at a late stage of gas production.
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INTRODUCTION

• Interference between gas- and geothermal production can occur when hydraulic connection exists.
• Clever placement of the geothermal wells with regard to the producing gas well(s) can potentially create synergy between geothermal- and gas production (figure 1A).
• This synergy can be an opportunity to enhance natural gas production while providing financial benefits for the development of geothermal systems.

• Research question: What are the critical elements for synergy?
• Two case studies looked into potential synergy at the Roden and Boskoop gas fields (figure 1B).
• A first order approach reservoir model of the Rotliegend reservoir of each field was constructed.
• Numerous parameters are tested, including well placement, flow rate and aquifer strength.

CASE STUDY #1: RODEN

• Produced 6.5 BCM from Ten Boer (2m net) and Slochteren (135m net) reservoir.
• Both wells ROD-101 and -102 watered out, final production in 2002.

• Gas discovered in 1995, but deemed uneconomical: stranded field.
• Volpriehausen residual gas, Slochteren gas-bearing (50m net).
• Located close to future heat grid

CASE STUDY #2: BOSKOOP

• Increased Permeability + Increased Doublet Rate
• Increased Permeability with strong aquifer support (figure 1C).

CONCLUSIONS

• The two case studies demonstrate it is possible to (significantly) increase the recovery factor.
• Addition of a geothermal doublet in the water leg of a gas field provides potential benefits for development of a gas field (increase field life) and a geothermal system (reduced financial risk).
• Aquifer strength is the main critical element for synergy to be beneficial.
• Well placement and geothermal flow rate are lesser critical elements.
• Beneficial synergy can still be achieved at later stages of natural gas production.

FUTURE RESEARCH

• Refinement of the static (grid size) and dynamic (time step) reservoir models.
• Test impact of permeability thickness.
• Introduce heterogeneous reservoir property distribution.
• Test optimum flow rates for gas- and geothermal wells.
• Test optimum geothermal production well placement and independently geothermal injection well placement.
• Find optimum flow rates in combination with optimum well placement.