Abstract for Third Annual Conference on Carbon Capture and Sequestration
NETL

May 2–6, 2004
Alexandria, VA

# $CO_2$ Injection in the Altmark Natural Gas Field, Germany: Simulations of Water Injection to Delay $CO_2$ Breakthrough

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Numerical simulations of $CO_2$ injection into the nearly depleted Salzwedel-Peckensen (Sw/Pes) reservoir of the Altmark gas field, North Germany, have been carried out to investigate the feasibility of carbon sequestration with enhanced gas recovery (CSEGR). The Sw/Pes gas reservoir is a faulted and compartmented anticlinal structure covered by a massive salt cap rock. The reservoir is composed of alternating sandstone, claystone, and siltstone at a depth of approximately 3000 m. The reservoir pressure and temperature are approximately 20 MPa and 120 ˚C. The average usable storage porosity in sand layers is estimated to be 8%. Permeability varies from $10^{-12}$ $m^2$ in the sandy units to very low values in the clayey units. The natural gas is rich in nitrogen ($N_2$), ranging from 40-90%, with an average methane ($CH_4$) content of 32%. We have carried out reservoir simulations of $CO_2$ injection into a model reservoir with nine layers and six different rock types spanning 226 m of total thickness. The geometry modeled is a quarter of a five-spot pattern with a well spacing of 2.1 km. Various injection and production strategies were investigated. In general, the high-permeability layers allow breakthrough of $CO_2$ at the production well after 3–10 years. We tested the effects of pre-CSEGR water injection into the high-permeability layers for mobility control. The simulations suggest that water injection can be used to delay $CO_2$ breakthrough. In general, CSEGR appears to be

promising for increasing gas production in the Altmark gas fields while simultaneously sequestering $CO_2$.