Evaluation of compositional effects and fluid flow description on near-miscible (water-alternating-gas) WAG modeling have been studied for a North Sea oil field starting production in 1998. A sector model with four wells was applied to simulate a heterogeneous sandstone reservoir, and a compositional model was used to compare different production strategies e.g. waterflooding and a near-miscible (WAG) injection. In the WAG scheme both dry and wet (rich) hydrocarbon gases have been considered for injection. The phase behaviour was quantified by comparing the performance of the different injection gases.

Result obtained shows the WAG injection gives improved recovery compared to water injection, due to better sweep and lower residual oil saturation. Simulations with and without relative permeability hysteresis (two-phase model) were compared. The effect of trapped gas on oil recovery does not seem significant with the compositional model. The WAG process has been optimized with respect to slug size and the water-gas ratio.

A black-oil-model was generated tuned to fit the results from the compositional simulations. A WAG three-phase relative permeability hysteresis model using cycle dependent relative permeabilities for both wetting and non-wetting phases, have been compared to the standard two-phase Killough and Carlson hysteresis models. The results show significant lower gas ratio and a higher oil recovery for the WAG injection when using cycle dependent relative permeabilities.

The simulations show sensitivity toward the three-phase model whereas Carlsen/Killough type hysteresis has little/no influence on the oil recovery.

Simulations indicates that the recovery by WAG-injection may be underestimated in the compositional model due to lack of possibility for cycle dependent relative permeability hysteresis, whereas the black oil model underestimates the phase behaviour effect. The results indicate that the WAG- injection might have an upside potential with respect to the influence of combined phase behaviour and relative permeability effects.