ACID GAS STORAGE IN THE
NATURAL GAS STRUCTURE
OF BORZĘCIN,
NEW POTENTIAL PROJECTS
IN POLISH OIL INDUSTRY

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The natural gas produced from the Borzecin reservoirs contain large amounts of sour gases, i.e. 0.3 % of CO₂ and 0.05 % of H₂S

In the 1996 acid gas - injection facilities started to operate

It is used for reinjection gases, by-products of amine gas sweetening process containing 60% of CO₂ and 15% of H₂S into an aquifer directly underlying the Borzecin gas reservoir

The cumulative amount of acid gas injected into the aquifer up now is above 3 mln scm
Diagram showing acid gas injection into Borzecin gas structure
Polish Oil & Gas Company

The picture of Borzecin old amine plant and acid gas injection installation
The picture of Borzecin new amine plant and acid gas injection installation
The view of 2-stage diaphragm compressor
The view of injection well Borzecin -28
The injected gas dissolves in the underlying water saturated by native gas. Solubility of acid gas is 9 times greater than solubility of native gas in res. cond.
The PVT test results indicated that volume of methane gas displaced from reservoir water is in direct proportion to volume of CO₂ injected into the water zone.

Such a displacement process allows to replenish the cap gas (about it I will talk in the next part of our presentation).
Phase transmission diagram for acid gas compression and injection stage for Borzecin

The injected gas remains in a gaseous phase for all temperatures and pressure involved.
The changes of reservoir parameters (POGC).
The drop of injection pressure from 10.4 MPa to 6.6 MPa was recorded after injection of 18 thousands of scum.
The condition of downhole pipes was evaluated using Sondex Multi Finger Memory (POGC)

The MEA vapors which are present in injected gas inhibits corrosion process
The risks of leakage of CO₂ and H₂S during transport and injection

Safety devices

1 km transmission line from compressor station to the well site is cased and vented to the flare with continuous pressure monitoring.
The risks of leakage of CO\(_2\) and H\(_2\)S during transport and injection

Safety devices

In the worst case scenario, such as a blowout of the injection well, the acid gas should be automatically ignited. In the injector tubing/casing annulus is filled with a corrosion inhibiting fluid.
Perspective view of Borzęcin Structure Model
Injected gas migration model in gas-water system. Variation of gas saturation distribution with injection time

Not horizontal but vertical migration of acid gas in water phase take place.
Borzęcin Gas Reservoir. Production Forecast. CO₂ Concentration in Produced Gas Wells: B-21, B-22, B-24, B-27
Injected gas migration and water encroachment in Borzęcin structure. Variation of CO₂ concentration distribution with injection time. Prediction.
NEW POTENTIAL PROJECTS IN POLISH OIL INDUSTRY

Recovery of unconventional gases naturally saturated megaaquifers in the sequestration projects of $\text{CO}_2$

EOR and $\text{CO}_2$ sequestration in Nosówka oil reservoir
Permian structure of Poznań Trough mega-aquifers represents a great potential for long-term underground storage of CO₂ on 5000 km² area.

The aquifer is naturally saturated by native hydrocarbon gases and its tightness is confirmed by the presence of many local gas accumulations in top area of the structure.
Solubility of natural gas in formation brine is about 2.5 Sm$^3$ / m$^3$. So it is calculated that gas reserves in megastructure can reach $120 \times 10^9$ Sm$^3$ on 5000 km$^2$ area.
Laboratory and modeling studies performed in Oil and Gas Institute have confirmed that it’s possible to displace the hydrocarbon gases dissolved in aquifer water by CO₂ directly injected into bottom water of megastructure.
Nosówka – partially depleted oil reservoir – CO₂ sequestration and EOR production

Geological model – Carpathian Flysch region, Carbonate formations: limestone & dolomitic limestone, structure confind by system of faults, no active aquifers

3-phase fluid interactions (oil, gas, CO₂) by Soave-Redich-Kwong EOS

Simulation Model calibrated w/r 20 years’ production (production rates, bhp’s, gas oil ratios)
Perspective view of the Nosówka Structure Model
CO₂ sequestration and EOR simulations

1. sequential conversion of producers into injectors
2. injection before production + final injection (most effective)

results

oil production total, OPT = 488 x 10³ Nm³ (increase of recovery coeff. by 17%p of OOIP)
total CO₂ injection, GIT = 285 x 10⁶ Nm³
CO₂ injection into Nosówka oil reservoir.

Oil production rate, CO₂ injection rate,
CO₂ injection into Nosówka oil reservoir.

Bottom hole pressure of producers, BHP vs original saturation pressure, Ps
CO₂ injection into Nosówka oil reservoir. Distribution of oil saturation, So, and CO₂ concentration in liquid phase C₃CO₂ - general view
Summary and Conclusion

1. 15-years experience of acid gas injection into Borzęcin structure confirmed practical feasibility of acid gas storage in continuously producing gas reservoir

2. Methan displacement process by CO$_2$ injection into Poznan Trought aquifer saturated by native gas allows to replenish the gas bearing zones

3. EOR and CO$_2$ sequestration in Nosówka reservoir allows to recover 64 % of OOIP