

BEČEJ CO₂ GAS FIELD CASE

The natural CO₂ gas field Bečej was discovered in 1951 and represents one of the largest natural CO₂ fields in Europe. It is situated between Bačko Petrovo Selo and Bečej, and extends partially beneath the city of Bečej, in the northern part of Republic Serbia – Vojvodina Province, at the bank of the river Tisa.



Figure 1: Location of Bečej field.

During the drilling of well Bč-5 at the end of 1968, an uncontrolled and spontaneous gas eruption happened when the bit entered layers of Miocene age. The blowout could not be controlled and lasted for eight months (until mid 1969 - 209 days) when the lower section of the open borehole collapsed. After that, the blowout continued for another 57 days. During this second period of the blowout, the free gas jet created a crater at the surface around the borehole and discharged high amounts of slurry containing clay and sand. Unfortunately, the eruption claimed several human lives and caused serious damages to surface facilities.

After this second period of blowout, the surface eruption ceased. However, gas continued to migrate from the geological reservoir. Regular periodic measurements and monitoring of the reservoir pressure after 1975 showed intensive migration of CO₂ through the well channel into shallower layers. This was also supported by chemical analysis of gas stored in those layers. From 1968 to 2001, the reservoir pressure dropped from 150 bar to 117 bar, which cannot be explained solely by CO₂ production. Daily production of gas is about ten times smaller than the daily amount of the gas leak. The existence of CO₂ gas leakage and refilling of the shallower horizons was confirmed by regular measurements at the production wells.

Several other issues, especially unfavorable reservoir geological parameters, led to an understanding that the gas migration problem could not be solved by conventional and routinely used well treatment or work-over techniques such as cementing.

Subsequently, NIS engaged in a series of activities in 2007 in order to control and stop the CO₂ migration (Medic et al. 2008, Lakatos et al. 2009, Lakatos et al 2012).

To the best of our knowledge, this is the first field application of remediation measures deployed to remedy leakage from a natural CO₂ reservoir – a natural analogue for geological storage of CO₂.

Rehabilitation of uncontrolled migration of CO₂ on the Bečej gas field - remediation operations

The goals of these activities were the following:

1. Restriction of gas migration to upper layers in the reservoirs and mitigation of the loss of CO₂ reserves (reservoir engineering objective).
2. Blocking of leakage in the open wellbore and subsurface porous strata/layers to restrict CO₂ emission to the atmosphere around the well (environmental objective).

These activities included the in-situ setting of chemical solutions with a long or retarded gelation time, to stop the gas migration.

Solutions were deliberated and implemented as follows:

- a) A gel-forming solution prepared on-site using the deployed surface facilities;
- b) The different chemical solutions were injected into the auxiliary wells;
- c) The borehole was filled up by permeability-reducing agent to restrict vertical gas migration in the borehole;
- d) The blocking phase partially penetrated into the upper porous layers; and
- e) The depression zone around the bottom region of the well was flooded extensively with the gel-forming chemicals as to restrict the gas flow in the vicinity of the well.

The basic concepts of remediation and chemical formulations were made by Professor Dr. Istvan Lakatos from the university of Miskolc - Research Institute of Applied Chemistry.

Remediation operations

- The operation was performed using new methods and technical procedures which had not been used before in NIS,
- The solutions were injected through the well Bč-9 and the monitoring of formation pressure conducted on the wells Bč-5 and Bč-x1 (Figure 2),
- The most critical point during remediation operations was well Bč-5 and it was extremely important to prevent occurrence of the CO₂ gas through the collapsed wellbore which could have caused a new disaster,

- The fluid laboratory was installed on the site to control the physical and chemical properties of fluids - especially new polymers produced to break processes of making gel,
- Two electric-power driven triplex plunge pumps Union TD 60 injected the solutions through well Bč-9 in the bottom of the damaged well Bč-5,
- The different chemical solutions including water glass, polymer, activator, crosslinking agent and acids, in total of 1700 m³, were injected. According to the designed protocols the operations were divided in five stages (capacity was 50 m³ per day with the pressure of injection from 5 to 35 bar),
- The constant moderate increase of pressure and the inflow of fluid through open interval in the well Bč-x1 were recorded at the early phase of operations and these characteristics were especially pointed up in the last week and after the completion of operations,
- After increase of gas emission from water accumulation formed on site of well Bč-5 in the first week, the permanent reduction of CO₂ was registered during injection of chemicals into the well Bč-9.

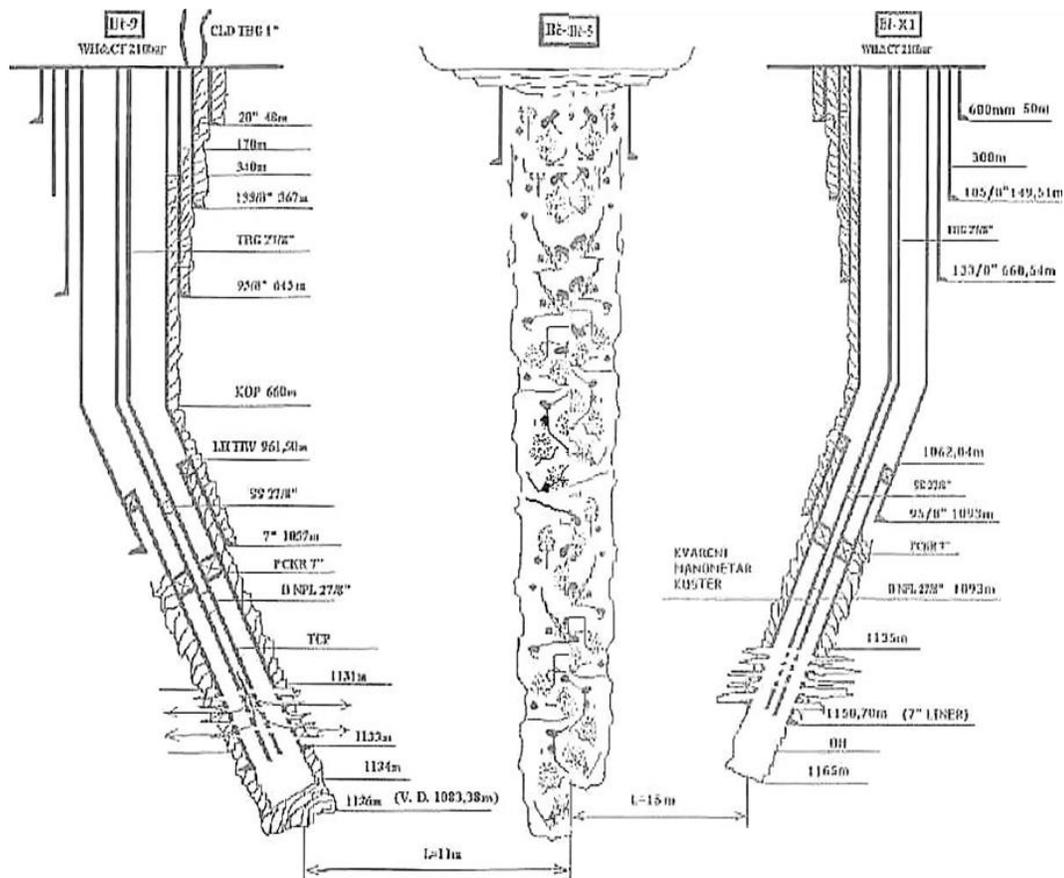


Figure 2: Position of wells Bč-9, Bč-5 and Bč-x1

Resume

The first indications in the damaged and the observation wells have shown good results in stopping the gas migration from the CO₂ field, while further analysis of the pressure

measurements before and after the injection shows that the gas migration into the upper layers was at least significantly reduced if not completely stopped (Figure 3).

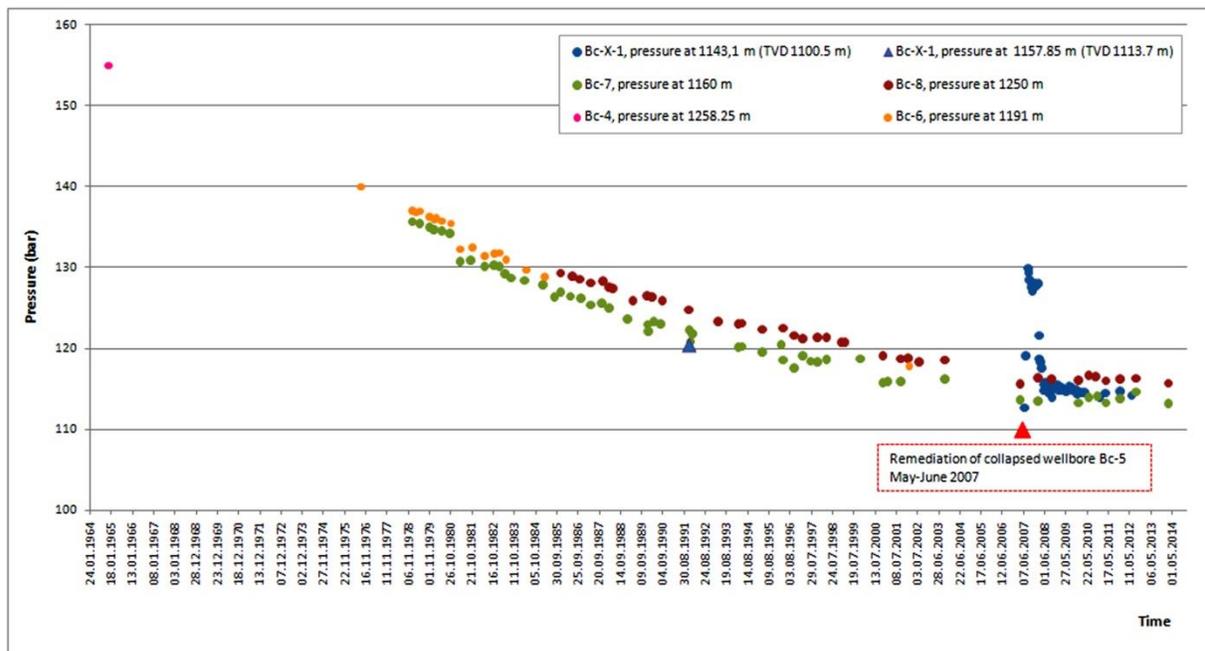


Figure 3: The monitoring of the formation pressure in Becej CO₂ field

References:

Lakatos et al. 2009.: *Prevention of vertical gas flow Becej CO₂ field (SPE-121045)*
 Lakatos et al. 2012.: *Reservoir conformance control in oilfields using silicates (SPE-159640)*
 Medic et al. 2008.: *Rehabilitation of Uncontrolled Migration of CO₂ on the Gas Field Becej (DIT, NIS-Naftagas, Volume 38, 08/2008.)*

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