Underground gas storage in salt caverns

Natural gas can be stored in many ways, both above ground and underground, in a rock formation. The choice of a site for an underground gas storage facility depends first of all on the geological and topographical conditions. The geological structure of the site determines the parameters of the storage facility’s work and the method chosen to build and operate it.

Jerzy Bojanowicz

Salt caverns located in bedded salt deposits and salt domes have been gaining in importance as underground gas storage facilities in recent years. In such cavern-type facilities, gas is stored in cavern formed in the process of leaching, also called solution mining. These modern storage facilities have high cycling rates – they are able to perform many cycles of gas injection and withdrawal over a year. They also have very high injection and withdrawal capacity, which means that large amounts of natural gas can be injected into and withdrawn from the caverns within a short period of time.

Salt cavern reservoirs have been designed, built and operated in Poland by Investgas SA, a company set up in 1993 and owned by PGNiG SA. The first two storage cavern, created through leaching in the Mogilno II salt deposit as part of the Mogilno cavern-type underground gas storage facility, were started up and put into operation in 1997. Since that time Investgas has operated the facility while at the same time building more caverns.

“It was a big challenge because this project, the most important one for us, was a pioneering undertaking. Until that time, the technology of gas storage in salt caverns had not been used in Poland and this is why we introduced many innovative solutions,” says Teresa Laskowska, president of Investgas, who has worked for the company since 1993.

But we have developed suitable design, control and execution methods and have acquired world-class staff and technical equipment. Thanks to acquiring the Research and Development Centre for Mining of Chemical Raw Materials Chemkop, we are the only company in the country able to carry out the full range of work involved in the design and construction of underground storage facilities for liquid and gaseous hydrocarbons.”

The first stage in the construction of the Mogilno underground gas storage facility was completed in 2005. Ten storage cavern, with a combined capacity of around 538 million cubic metres of gas, complete with surface infrastructure were built in this stage.

Three years later, Investgas started the expansion of the Mogilno facility by another 10 storage cavern. Their total capacity will ultimately reach 1,150 million cubic metres. At present, 11 storage cavern with a total capacity of 586 million cubic metres are in operation while three cavern are being formed through leaching.

In 2009, Investgas started to build the Kosakowo cavern-type underground storage facility in a salt bed near the Bay of Puck. Ten storage cavern with a combined capacity of around 300 million cubic metres will...
be built in the first stage of the project. The cavern will be located at a depth of 1,035–1,158 metres under the surface. So far five wells have been drilled in Kosakowo to provide access to the deposit. The formation of the first five cavern through leaching began in September 2010. The wells are grouped into clusters to minimize the adverse impact of the project on the environment. One well was drilled vertically and four were drilled directionally (S-shape) from a single place. As a result, the area of land occupied by the facility is significantly reduced. Two clusters, each with five wells, will be formed in the first stage of the project.

The Kosakowo storage facility will be catering for peak demand. It will have a maximum withdrawal rate of 9.6 million cubic meters per day and will rank second in this respect after the Mogilno facility. Kosakowo will be a very important element of the energy security of the region and the country as a whole. To illustrate the scale of the project – a single storage cavern could easily accommodate the 1.44-meter-high Sea Tower in Gdynia, which is one of the largest buildings in Poland.

**Innovative environment-friendly solutions**

The process of injecting and withdrawing gas from a storage facility takes place many times during the year. Consequently, it is important to keep the facility on constant standby. Investgas conducts continuous and multi-level monitoring of all pieces of process equipment, facilities, control systems, security systems, the state of wells, storage cavern, work safety and environmental protection.

While building the Kosakowo facility, several innovative solutions, which have largely contributed to minimizing its negative impact on the environment and reducing project costs, have been used for the first time in Poland. Treated sewage from a local sewage treatment plant has been used for the first time on a project of this kind to leach salt from the deposit and build storage cavern. Another innovative method applied for the first time in Poland is the use of nitrogen, which is neutral for the waters of the Bay of Puck, as a medium lining the ceiling of the storage cavern instead of solar oil, as is the case in the Mogilino facility.

The Leaching Plant needed to create the storage cavern and a pipeline transporting the brine obtained in the process of leaching to the Bay of Puck were built in the first stage. The brine is pumped from a surface tank to the DN 300 pipeline and to the Bay of Puck. It is dispersed in the waters of the bay using a distribution cavern and a system of diffusers situated 2.3 kilometres from the coast. To ensure the best possible protection of the natural environment, the system uses 48 nozzles placed on 16 heads, which is an innovative solution. The stream of brine from a nozzle is directed towards the water surface at an angle of 45 degrees and a speed of 35 metres per second, which ensures the proper propagation of the brine in the waters of the bay. Up to 300 cubic metres of brine is discharged to the bay per hour, which determines the pace at which successive storage caverns are built.

Before this innovative method was used in practice, it had been checked in the laboratories of the Institute of Hydroengineering Polish Academy of Sciences in Gdańsk. Analyses of water samples taken from places located up to 1 kilometre or more from the site of brine discharge showed that the brine mixes very well with the water. So far no significant increase in the salinity of the bay has been detected. The method has also been checked by the Deltares research institute in Holland.

“Our first test discharges of brine to the Bay of Puck confirmed that the method is friendly to the natural environment. The key issue in our discharge system is the monitoring of the whole process,” says Teresa Laskowska. “The process is continuously monitored by 14 maritime and five coastal measurement stations. The measurement results are compared with the standard salinity levels for the bay waters. The experience we will gain will be paying off in the construction of further storage facilities in rock salt deposits.”

In September 2010, Investgas started the process of leaching to form the first two cavern. In 2013, they will be filled with natural gas and put into operation. The other cavern will be completed successively until 2022. Apart from building the storage cavern, Investgas has been simultaneously constructing the surface part of the facility necessary for gas injection and withdrawal.

“Over the nearly 20 years of Investgas’ activity in the area of designing, building and operating cavern-type underground gas storage facilities in rock salt deposits, we have developed construction techniques which meet both environmental and economic requirements. Our expertise and experience enable us to carry out this kind of projects at home and abroad” says Teresa Laskowska.