Storing fuels inside salt deposits

Underground Fuel-Tanks

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For those unversed in the arcana of hydrocarbon economics, it might seem like utter nonsense to pump oil or natural gas back underground. Even so, doing so can help solve the problem of storing key energy commodities, especially in countries that do not have sufficient reserves

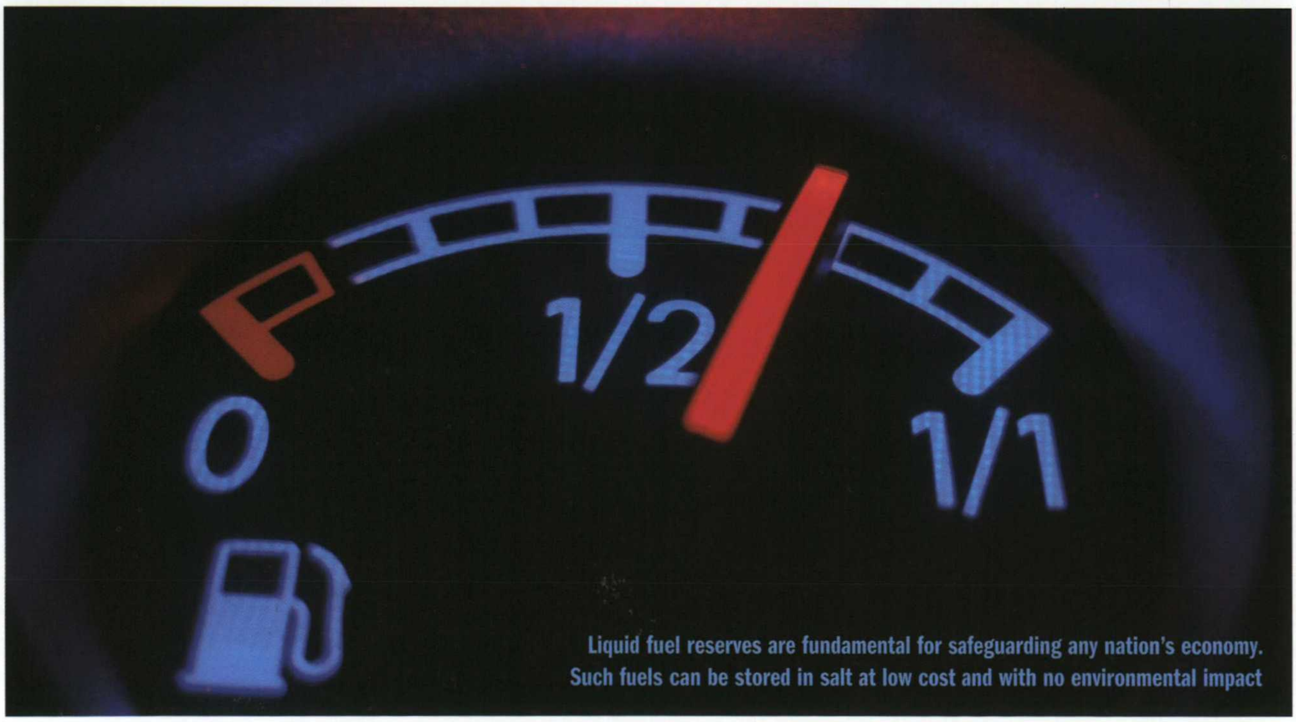
The technique of storing liquid and gaseous hydrocarbons in high-volume underground repositories has now been in use for decades, ever since the problem of maintaining strategic fuel reserves first arose. Such storage can also be applied to other fluid substances, facilitating their better management.

This subsurface storage system has caught on chiefly in very industrialized countries with high-capacity plants that consume large quantities of energy commodities and components for further chemical processing. Properly stored reserves can help preserve continuity in the supply of such commodities, and thus the fuller harnessing of production capacities. Extensive storage facilities can also help streamline the management of gaseous fuels, whose consumption is subject to considerable seasonal fluctuation.

What you can't see...

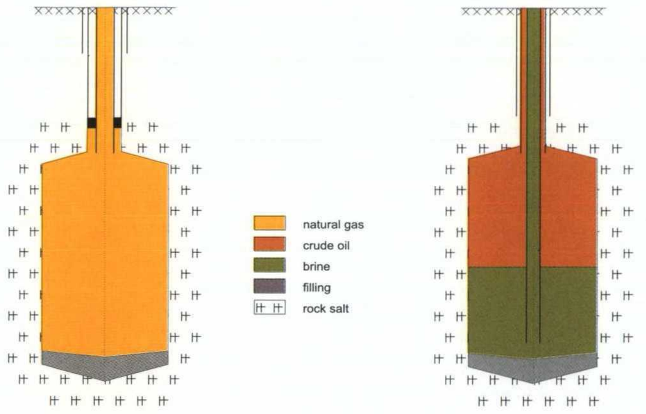
World practice has shown that the subsurface storage technique has many advantages. Very high-volume repositories can be constructed while minimizing the surface area required to build industrial facilities. Moreover, the depth and hermetic closure of such repositories minimizes the risk of environmental contamination. Finally, using natural or artificial rock caverns consumes less steel and other materials, thereby bringing investment costs down.

At present, there are two basic methods in use in the world for the underground storage of fluid substances. The first involves using natural capacities: so-called "geological traps," meaning tightly isolated porous rocks - such as previously-extracted natural gas or crude oil deposits, or layers of water-bearing sand covered with an appropriately tight caprock. The second method involves using underground caverns - either excavated in solid crystalline rocks by the traditional method, or leached out inside salt deposits through drilled holes.



Liquid fuel reserves are fundamental for safeguarding any nation's economy. Such fuels can be stored in salt at low cost and with no environmental impact

Courtesy of Pakize Öztürk, stoper001@mynet.com



Generalized method of operation of underground storage caverns in salt diapirs

The most widespread type of repository is of the latter sort: caverns created inside salt deposits via the leaching method. Because salt deposits offer a very suitable environment for storage purposes - in view of their thickness, compactness, uniformity and impermeability - there are several thousand such salt caverns now in use in the world as subsurface storage repositories.

A key trait of salt that makes it useful for fuel storage is the fact that it does not react with liquid hydrocarbons. This means that once created, salt caverns can be used to store such liquid products as crude oil, fuel oil, light heating oils and gasoline, liquefied gasses (chiefly propane, butane, and their mixtures) - as well as gaseous products, chiefly natural gas and ethylene.

Another advantage of this storage method is that the costs of creating a subsurface cavern using the leaching method are low. Nevertheless, for such a chamber to be suitable, the location must be chosen with precise knowledge of the geological and topographical conditions that are of decisive significance in defining a repository's parameters. The leaching process, too, must meet certain specifications. This operation employs large quantities of water, and thus requires a convenient water source and also a way of disposing of the salt brine so produced. The brine cannot be simply drained into surface waterways, in view of potential environmental damage. The only options are releasing such brine directly into the sea, in the case of sites near the coast, or saturating it and supplying it directly to chemical plants for processing. Also important is the proximity of facilities that will produce and consume the liquid hydrocarbons to be stored in the repositories, as well as the routes of the main industrial pipelines.

Rock cistern

After a repository chamber is created and the proper piping is installed, safety tests are carried out in compliance with general mining regulations.

Gaseous hydrocarbons are stored under pressure - system operation involves gas being pumped into the chamber, or pumped out in specified quantities. The operating capacity of the repository depends on the difference between the maximum and minimum gas pressure - the minimum pressure being the lowest level that ensures the stability of the excavated chamber.

Subsurface repositories for storing liquid hydrocarbons are fitted with two pipe columns, one inside the other. The outside one leads to the upper part of the cavern, the inner one to the lower part. A stored substance that has a density lower than brine is pumped through the external pipe into the upper part of the chamber, while brine is at the same time drawn out through the inner pipe. Vice-versa, the chamber can be drained by pumping brine into the lower part of the cavern and drawing the hydrocarbons out through the external pipe. This system makes it possible to maintain an almost constant pressure of media in the chamber. It does require, however, that the proper reserves of brine be maintained on hand.

Land of salt

The presence of Zechstein (upper Permian) deposits of rock salt in Poland, comprising the eastern portion of the Eastern European salt-bearing formation, offers favorable conditions for building subsurface storage repositories, especially in regions where there is already a developed sodium and chlorine industry to utilize the brine in production processes. The most favorable region in this regard is central Poland, including the Kujawy region with its numerous diapiric salt deposits where salt has pierced through Mesozoic formations from a depth of 5 km to the surface.

The geological and mining criteria for building subsurface repositories are also met by the segments of bedded salt deposits occurring the region of the Sudeten Monocline or located near the Baltic coast in the geological region called the Łeba Elevation. At present, two diapiric deposits in Kujawy are being harnessed for storage purposes, with natural gas, crude oil, and gasoline being stored in subsurface repositories of several thousand m^3 each.

In line with European Commission guidelines (Directive 98/93EC), every member state should possess storage facilities of a certain volume. The Mineral and Energy Economy Research Institute of the Polish Academy of Sciences is currently carrying out pilot work to assess the potential for building further repositories in Polish salt deposits. ■

Further reading

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