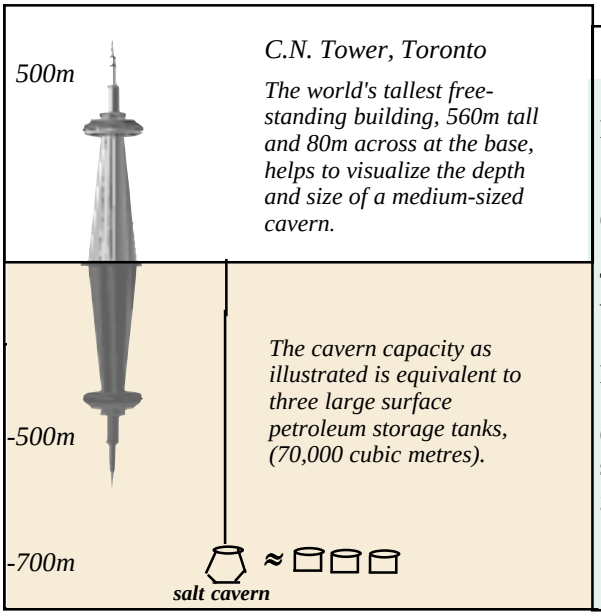
Sarnia • Lambton Environmental Association
Industries Working Together

Deep-Well Storage in Salt Caverns - Lambton County

This monograph, one in a series of single issue documents dealing with Lambton County environment, has been prepared by the Sarnia-Lambton Environmental Association in co-operation with the School Boards of Lambton Kent.

Introduction

From the early 1950s salt caverns located some 600 metres below the earth's surface have been used for safe storage of hydrocarbons. Solution mining is used to construct these storage caverns in salt strata of the Salina Formation. The Salina consists of alternating beds of dolomite, shale, gypsum and salt. The salt beds measure up to 100 metres in thickness. Solution mining involves drilling a hole to the Salina, cementing a casing in place, injecting water to dissolve the salt and finally pumping the resultant brine to the surface. Rock salt is soluble in water but is quite insoluble in hydrocarbons and therefore the cavern walls provide a good storage medium. Hydrocarbon products fill the upper portion of the cavity while the lower part is filled with the denser brine solution; the absence of air is an important safety factor.



C.N. Tower, Toronto

The world's tallest free-standing building, 560m tall and 80m across at the base, helps to visualize the depth and size of a medium-sized cavern.

The cavern capacity as illustrated is equivalent to three large surface petroleum storage tanks, (70,000 cubic metres).

Salt Caverns in Sarnia-Windsor

Number of active salt caverns	73 in Sarnia-Windsor Michigan State has several
Capacity of individual caverns	9,200 m^3 to 250,000 m^3
Total capacity of the Sarnia-Windsor caverns	3.5 million m^3
Equivalent to:	over 200 storage tanks
Gaseous hydrocarbons, when stored under pressure, are generally in liquid form.	Examples include: methane butane propylene propane ethylene butylene

Ministry of Natural Resources, 2005

Key Words

brine - water that will not dissolve more salt (sodium chloride) without an increase in temperature

salt cavern - a totally enclosed self contained vault or cavity in the Salina Formation

hydrocarbons - compounds composed of hydrogen and carbon (eg. propane)

combustion - the burning of a substance; heat is given off and, in most cases, light is too

salina - derived from Salinae, the Latin word for salt pit; the expression "workers who are worth their salt," dates back to Roman times when salt and other necessities were a worker's wages.

Salina Formation Salt Beds in S.W. Ontario

Salt deposits in Ontario occur principally along the eastern shoreline of Lake Huron, Lake St. Clair and the St. Clair and Detroit Rivers. These salt deposits are continuous with and form extensions of the Michigan Basin salt deposits.

Manocha J.S., page 2

In the late Silurian Period, some 400 million years ago, marine waters are thought to have periodically entered the Basin and then evaporated, thus building up alternating beds of dolomite, shale, gypsum and salt.

Cochrane R.O., exhibit 24

Centennial Park, Sarnia

1904 - the Empire Salt Company began a salt mining operation at the present Centennial Park site.

1910 - Dominion Salt purchased the operation.

1965 - the land was sold to the City of Sarnia with the condition that a park be created.

1967 - Centennial Park was officially opened on Canada's 100th birthday.

Salt dissolves readily in water; it has been mined hydraulically at Windsor, Detroit, Sarnia, Port Huron, Goderich and Midland Michigan. Solution and conventional mining methods are currently used at Windsor and Goderich. Solution mining yields salt for table and pickling uses while that produced by conventional processes (dry mining) is used on icy roads and also in water softeners.

Mechanism of Salt Deposition in the Michigan Basin

1. A wide shallow sea extended across the basin
   - *the water was salty*

2. Dry climate persisted for a prolonged time
   - *little rain fell*
   - *high levels of evaporation occurred*
   - *the concentration of dissolved salts increased*

3. Evaporation of the sea occurred
   - *salt was built up on the sea floor, evaporation of a six inch column of water left a one inch layer of salt*
   - *the buildup of salt was exposed to the atmosphere; dust was deposited on the salt*

4. The sea gradually re-entered the basin
   - *algal mats grew on the sea floor forming a seal over the salt bed and also trapping carbonate sediments*

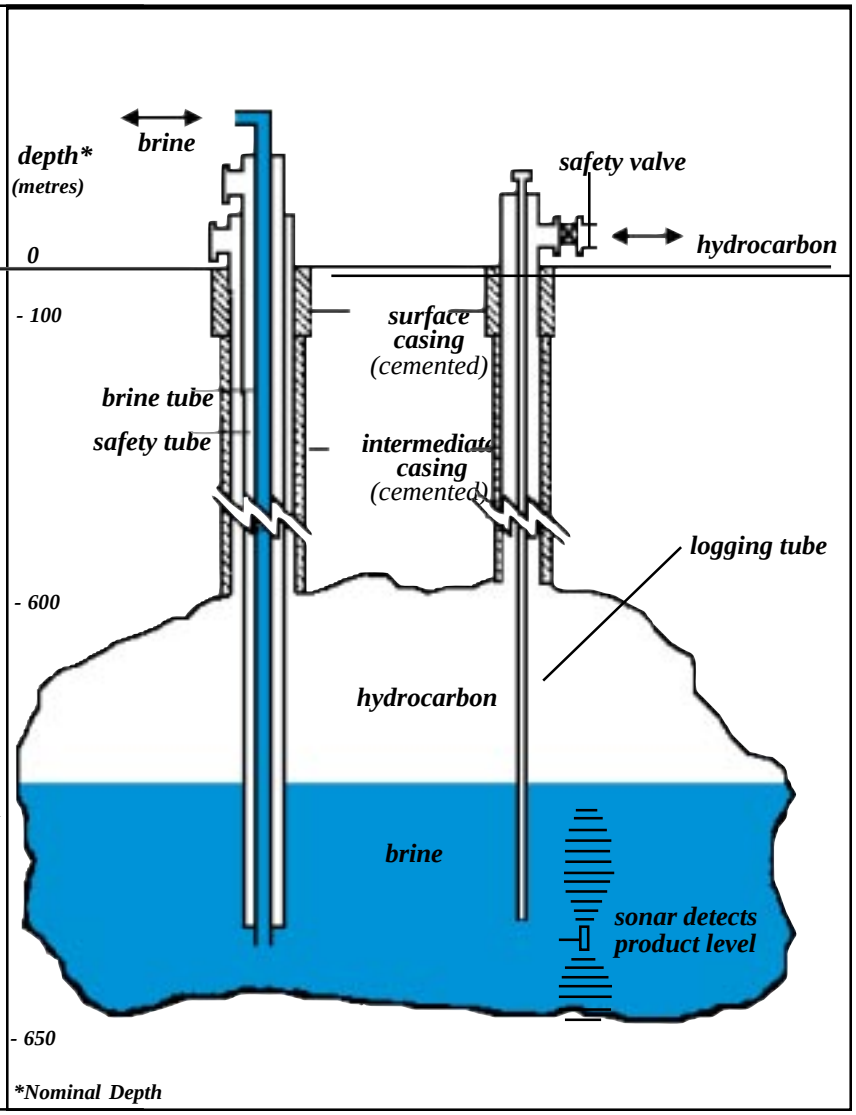
5. Steps 1 to 4 occurred many times
   - *each repetition produced a layer of salt*

Cochrane R.O., exhibit 10

Cavern Operation

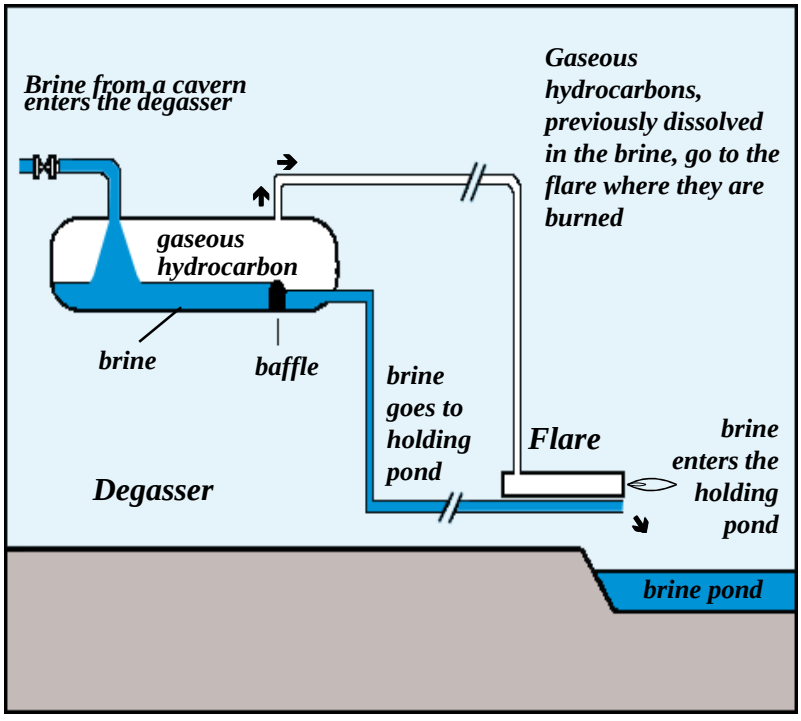
Salt caverns operate on a displacement principle. When product is required, brine is pumped into the cavern. The more dense brine solution goes to the bottom and the hydrocarbon is displaced from the cavern into the pipeline system. When product is stored it is pumped into the cavern, this displaces brine out of the cavern into a holding area (pond). The use of brine, a saturated salt-water solution, minimizes changes in cavern size.

Controls that prevent over-filling of caverns include safety valves in brine pipelines and at the well heads. Another control, the logging system, uses a sonar detector to monitor product level in the cavern.



Degasser and Flare

As product is pumped into a cavern, brine is displaced. The displaced brine contains small amounts of the hydrocarbon product, (caused by high pressure in the cavern). As the brine comes to the surface, it is directed to a degasser where the hydrocarbons, under reduced pressure, separate from the brine. A pilot light ensures a continuing flame which burns the hydrocarbons as they are released from the brine.



Underground Pressure Storage

Depleted/Active Gas Reservoirs

Winter demands for natural gas exceed the capacity of pipelines from Western Canada which supply most of S. W. Ontario's needs. The shortfall is made up by injection of natural gas into depleted/active gas reservoirs during the summer and withdrawal of the same to meet winter needs. Storage is in porous rock strata, mainly the Guelph Formation.

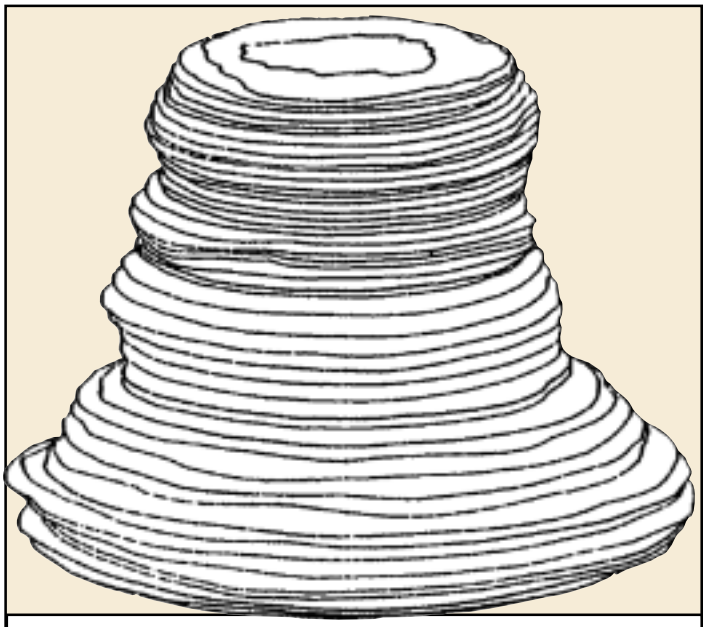
Union Gas operates Canada's largest underground natural gas storage system. The system has a total capacity of 4,292 million cubic metres, enough to heat the 50,000 homes of Sarnia-Lambton for 28 years. This storage system is located in Dawn Township. Enbridge Gas Storage also has a storage system in Lambton County; it services metro Toronto, the Ottawa Valley and Niagara Region; storage capacity is 2,750 million cubic metres.

Manocha, page 2

In Caverns

In 1980, the Morton Salt Co. terminated operations in Marysville, Michigan. Natural Gas is now stored in the salt caverns that were produced through the salt extraction process.

For over forty years, hydrocarbon products have been safely stored in salt caverns located 600 metres below the earth's surface in Lambton County. Pressure testing and logging processes have been developed to ensure the continuing reliability of this system. Logging techniques include sonar; a salt cavern sonar trace is pictured at the right. The sonar trace can indicate possible weaknesses as well as provide baseline data for monitoring the cavern's shape and size.



Sonar Trace of a Cavern

Conclusion

Salt, mined from the Salina formation, is a highly valued resource. Utilization of the resultant caverns for the storage of hydrocarbons is a good example of resourcefulness and technical skill.

Resources

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