Underground Storage of Natural Gas Liquids in Ohio’s Underground Salt Deposits

Prepared by: Thomas E. Tomastik, CPG and J. Daniel Arthur, P.E., SPEC, ALL Consulting

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Introduction

• With the development of the world class Marcellus Shale play and the Utica, the wet gas production of natural gas liquids (NGLs) such as propane, butane, and ethane have risen dramatically.

• Natural gas production from these plays are projected to rise by 30% or more by 2022 (currently at 24 Bcf per day) and NGLs are expected to increase even more quickly.

• This production will continue to push development of NGL infrastructure such as takeaway capacity, gas-processing plants, and fractionators, which all leads to the demand for storage of NGLs.
NGL Volumes Grow; Cracker, Pipelines

Source: Brockett, Penn State Extension, 2015
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Demand for NGL Storage

- Shell Chemicals and the potential PTT Global Chemical cracker plants are driving the need for NGL storage.
- The recently released report identifies the potential for an Appalachian Storage Hub for NGLs.
- The geological evaluation included mined caverns, depleted gas reservoirs, and salt-solution mined caverns.

Source: WVU, 2017
Figure 3-1. Generalized subsurface stratigraphy for the AOI, indicating acronyms for intervals of interest and type of storage options.
Shell Chemicals Ethylene Cracker Plant in Beaver County, PA
Current Underground Storage Operations in Ohio

- Ohio currently has four NGL underground storage operations that are active.
- These facilities store mainly propane and butane.
- Three of these active NGL storage facilities are in hard rock mined out caverns.
- One facility is in solution-mined caverns.
- Three of these facilities are located at Ohio refineries.
- These NGL storage operations commenced in the late 1950s to early 1970s.
The state of Ohio lies directly in the center of attention relative to underground storage.

Favorable geologic conditions in the underlying Salina salt deposits along the Ohio River exist for the development of salt cavern storage for NGLs.

Liquid hydrocarbon storage in salt is the most common form of bulk storage used in the U.S. today.
Salina Salt Deposits

- The Salina salt deposits have been mechanically mined in Ohio since the 1950s and have been solution mined since the late 1800s.

- Salt thicknesses can vary, but the F salt unit is the primary target.

- Depths to the top of the salt ranges from about 1,900 feet along Lake Erie to over 6,700 feet along the Ohio River.

- The only active storage in the salt in Ohio is at Marathon Petroleum’s refinery in Canton, Ohio, where butane is currently being stored.

Source: Tomastik, 1996
Salt-Solution Mining Process

• Water is injected down the tubing and is returned to the surface through the annular space.
• Referred to as “reverse circulation” or “tubing injection”.
• Produces a more desirable shaped cavity, but with a reduced production rate.

Source: Tomastik, 2001
Cavern Creation and Storage

- Initial Class III salt-solution mining injection operations dissolve the salt to create caverns for storage.
- After the caverns are created, NGLs are injected, which displaces brine in the caverns back to the surface.
- A surface impoundment must be constructed for storage of the brine displaced from the cavern and to access the brine to inject to displace NGLs when needed.

Source: Google Earth, 2018
Permitting Requirements and Challenges

- Requires coordination with multiple state and federal regulatory agencies:
  - Corps of Engineers – 404 permit
  - Ohio DNR, Division of Oil and Gas Resources Management, UIC Section - Class II solution mining well permits
  - Ohio DNR, Division of Water Resources, Dam Safety Section - Dam permit for impoundment
  - Ohio EPA - Groundwater monitoring plan and 401 permit

- And other potential regulatory agencies:
  - WV DEP Division of Water and Waste Management
  - Local Ohio EMA - floodplain
  - Local WV EMA - floodplain
  - Ohio Historical Society
  - Ohio DNR, Office of Real Estate
  - Ohio Dept. Transportation
  - U.S. Fish and Wildlife Services
Political and Regulatory Issues

• In 2013, the Todd Hunter NGL facility in Middletown, Ohio, which operated NGL storage in mined out hard rock caverns, leaked propane.

• Storage of NGLs in Ohio in mined out hard rock or salt-solution caverns are not currently regulated by any Ohio agency.

• This has led to concerns and conservative approaches regarding underground storage of NGLs in Ohio.

• Regulatory agencies are now looking for a risk-based mitigation analysis.

• However, over one billion barrels of liquid hydrocarbons have been stored underground in the U.S. with very few releases.

Source: caplaconference.com, 2015
Ohio DNR Permits Requirements

- There are two primary permit applications within Ohio DNR.
- The Division of Oil and Gas Resources Management, UIC Section requires Class III salt-solution mining permits to drill the wells to dissolve the salt and create the caverns.
- The Division of Water Resources, Dam Safety Section requires a dam construction permit for the creation of a surface impoundment for the storage of the brine from the solution mining caverns.
UIC - Class III Permit Requirements

- Permits issued with permit conditions:
  - All casing strings must be cemented to the surface.
  - A cement bond log must be performed on the production casing.
  - Initial mechanical integrity testing using the standard annulus pressure test.
  - Establishment of benchmark and survey loops for subsidence monitoring and requirement for annual subsidence monitoring with submittal of an annual report.
  - Five-year mechanical integrity testing requirement using the freshwater-brine interface test.
Dam Safety - Dam Construction Permit Requirements

- Application form with preliminary design, type of dam, and proposed dam classification (I-IV).
- Cross sections, maps, log of borings, and written report on surficial surface - geology, topography, and cultural features.
- Ability to quickly empty the impoundment in the event of a leak.
- If proposed impoundment located over an abandoned underground mine, additional technical analysis and reports will be required.
Example of Existing Dam Over Abandoned Underground Mine

Source: ODNR, 2017

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Additional Dam Requirements

- Statutory filing fee and surety bond.
- Final design report.
- Detailed cost estimate of the construction.
- Plans and specifications.
Conclusions

• The permitting process alone, requires a lot of coordination with multiple state and federal agencies.

• Addressing all regulatory considerations and technical hurdles can be extremely challenging.

• Best addressed by cooperative efforts with the agencies through meetings, technical assessments, and analysis to satisfy all of the regulatory concerns.
Contact Information:
Tom Tomastik, Senior Geologist & Regulatory Specialist
ttomastik@all-llc.com
ALL Consulting, Tulsa, OK
www.all-llc.com

Citation Information: