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Overview and Preliminary Results from a Field Study to Determine the Feasibility of Developing Salt Caverns for Hydrocarbon Storage in Western North Dakota

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Abstract

As oil production from North Dakota's portion of the Bakken petroleum system has escalated, associated production of natural gas and natural gas liquids (NGLs) has followed the same trend. The availability of natural gas, NGLs, and infrastructure is driving discussions about the technical viability of siting a petrochemical plant in North Dakota. Subsurface hydrocarbon storage is commonly used to provide a consistent, reliable supply of feedstock to maintain the operational balance required at a petrochemical plant. One technique used to meet these needs is to store hydrocarbons in solution-mined salt caverns. In 2020, the Energy & Environmental Research Center (EERC) was awarded a contract by the North Dakota Industrial Commission Oil and Gas Research Program to evaluate the technical feasibility of developing and operating salt caverns in North Dakota to store NGLs and/or natural gas to provide future potential support for petrochemical and/or energy industries. Following the initial feasibility report, the EERC was awarded additional funding to conduct a field study with goals to collect salt-specific data and then use that data to validate the depth, thickness, and geologic and geomechanical suitability of North Dakota salt formations for subsurface gas or liquid storage. This presentation shares benefits and challenges of salt cavern storage in North Dakota, an overview of the components included in the field study, and some preliminary core analysis results. A geologic site screening was conducted to determine the best possible locations to drill a stratigraphic test well. Several criteria were used to screen locations for the highest chance of success. The well, HALITE 1, was drilled near Williston, North Dakota. Core and wireline logs from the Dunham and Pine salts were successfully collected. The core testing performed identified bulk characteristics of the formations of interest. For this study, samples were selected and tested to determine lithology, thickness, porosity, permeability, mineralogy, geomechanical competency of the overlying and underlying sealing formations, geomechanical properties of the salts, dissolution properties of the salts, and potential for the ability for caverns to close due to overlying stresses (salt creep). Because the structural stability of a solution-mined cavern partially depends on the strength and deformational characteristics of the host salt and non-salt units, geomechanical testing was a large component of the core testing program. The core analysis and testing program informs geologic and geomechanical modeling needed to evaluate the feasibility of salt cavern development within the respective salt formations. Geologic modeling, geomechanical modeling, and engineering analysis and design are ongoing at the EERC (results expected July 1, 2023); however, preliminary results show that the lithology, solubility, and creep testing in the Dunham and Pine salt members are encouraging for potential commercial salt cavern development and operation in the future.