Sealing Capacity Analysis of the Tuscaloosa Marine Shale at Kemper County Energy Facility in Mississippi for CO2 Sequestration

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Abstract

To mitigate global warming, carbon dioxide (CO2) or carbon is captured and sequestered in the subsurface for thousand of years. Numerous viable geologic carbon sinks and seals in the Lower Cretaceous and Paleozoic strata favorable for sequestration and sealing have been identified at the Kemper County Energy Facility in Mississippi and is being investigated as part of the DOE/NETL's CarbonSAFE program. It is imperative to investigate the sealing potential of caprock to mitigate the risk of leakage to overlying formations containing protected underground sources of drinking water. The objective of this study is to (1) determine porosity, permeability, capillary pressure, and saturation of the Tuscaloosa Marine Shale, which is an important sealing formation, and (2) to use the parameters to assess the integrity of the regional sealing units at the Kemper Energy Facility. Well logs and core obtained from three exploratory wells drilled at the facility site were evaluated. X-ray diffraction results indicate that the mineralogy is 33.0-57.0% clay (illite, smectite kaolinite, and chlorite), 0.6 % carbonate, and 42.1-67.1% quartz and other minerals. The helium porosity is 15.0-29.0%, and MICP porosity is 13.0-23.8%. Permeability from pressure decay analysis ranges from 12.4-69.9nD, and Swanson permeability is 3.4-4.5 nD. Based on MICP analysis, the height of the CO2 column that the seal can hold ranges from 4 m (13 ft to 100 m (328ft)) for the strongest seal at 100% water saturation respectively. The corresponding MICP pressures for the seal capacity lies between 4-20 MPa. From well logs, the seal thickness is 56.1-65.4 m (184-214 ft). For good seals, the permeability needs to be low, which is what we observe for the Marine Shale but the

high porosity is attributed to the presence of fractures in the samples that formed after core retrieval from desiccation, and so the permeability and column height values should be considered as minimum values. A comparison of seal thickness with column height that is held below capillary entry pressure suggests the Tuscaloosa Marine is a good seal for CO2 sequestration.