Petroleum Generation Kinetics of Mississippian Mudrocks in Central Oklahoma: Evidence from Hydrous Pyrolysis

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Abstract

Mississippian mudrocks of central Oklahoma has proven to encompass hydrocarbon-rich unconventional reservoirs. Many factors control the success in hydrocarbon producibility from the STACK Play in Oklahoma including rock minerology, thermal maturity and organic-richness. In recent studies, it is confirmed that petroleum sourcing in these Mississippian reservoirs is complex encompassing multiple hydrocarbon-charges from different source rocks, in addition to the Woodford Shale. Therefore, determining the petroleum generation kinetic parameters of Mississippian mudrocks is crucial to understand elements controlling organic-matter maturation and generation of hydrocarbon fluids, which ultimately aid with identifying sweet-spot within STACK Play. A collection of core samples collected from Lincoln county were examined for petroleum generation kinetics using hydrous pyrolysis reactor. A series of isothermal experiments were performed on immature rock samples with temperature ranging from 290°C to 360°C for 72 hours. Generated hydrocarbon products from the experiments were subjected to further molecular examination using gas chromatography triple quadrupole mass spectrometry (GC-QQQ/MS) monitoring for sterane and terpane biomarkers. Results from hydrous pyrolysis experiment and the constructed Arrhenius plot suggest a slightly lower reaction rate for generating hydrocarbons from Mississippian mudrocks. Such reaction rates are reflected in lower activation energy and frequency factor values for Mississippian source rock compared with the Woodford Shale Mississippian petroleum source rocks are capable of generating oil and gas at a lower temperature than the Woodford Shale; therefore,

petroleum generation in Mississippian rocks could have started at shallower depths than the previously well-accepted depths for the Woodford Shale. The low kinetic parameters of petroleum generation in Mississippian source rocks is postulated due to organic-matter structure co-occurring as infused amorphonite and bituminite within the mineral matrix. The large surface area between the macerals and the mineral matrix could increase the reactivity, with clays acting as catalysts for petroleum generation.

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