Experimental study of Green River Formation oil shale pyrolysis

Tuong Van Le Doan[1], Andrew Pomerantz[1], Robert Kleinberg[1], Alan Burnham[2], Pierre Allix[3]

[1]Schlumberger Research, USA, [2]AMSO LLC, USA, [3]TOTAL SA, France

While surface retort technologies are appropriate for exploiting near-surface oil shale deposits, in-situ retorting is the only practical way to produce oil from the much larger resources of the Green River Formation that are more than 250 m below the surface. Moreover, underground methods promise improved efficiency, higher oil quality, less surface disturbance, and reduction of spent shale disposal problems. American Shale Oil LLC and TOTAL SA are currently constructing an in-situ oil shale retort pilot facility in Colorado's Piceance Basin. The target formation is the R1 zone. To help predict and interpret the results of this production test, as well as to estimate optimal process conditions, a semi-open laboratory pyrolysis system has been built. Experiments are conducted with homogenized replicate samples of drill cuttings from the target formation, and have been conducted at various operating conditions over ranges of temperature (300-425°C), pressure (10-50 atm), heating rate (2-120°C/h), and time at final temperature (5-12.5 h). The temperature and pressure ranges correspond to those planned for the pilot study. The extent of partial pyrolysis at a given temperature and pressure is controlled by heating rate and plateau duration. Liquid chromatography is used to analyze the produced oil for saturates, aromatics, resins and asphaltenes, and the detailed compositions of saturate and aromatic components are quantitatively analyzed with two-dimensional gas chromatography (GCxGC). Kerogen and bitumen in the native state and spent shale are extracted and quantified. The composition of extracted bitumen is also analyzed by liquid chromatography. The quantities of hydrocarbon gases (C_1 to C_5), CO_2, and H_2 are measured by gas chromatography (GC-FID & GC-TCD). The amount of H_2S is quantified using Drager tubes. These data allow us to establish an empirical compositional kinetic model for oil shale pyrolysis.