Pyrolysis-based Model Prediction of API Gravity in the Producible Fluid Saturations of Organic-Rich Unconventional Reservoirs

May 21, 2019, 4:45 PM - 5:05 PM	Hemisfair Ballroom II

Authors

A. S. Pepper

Abstract

Recent advances in quantifying oil sorption in organic matter - separating non-producible sorbed oil from potentially producible fluid phase oil - now allow us to predict fluid saturations in unconventional reservoir rocks, using bulk pyrolysis measures of volatile hydrocarbons in the first pyrolysis Py1HC yield (e.g. the 'S1' yield in Rock-Eval type equipment). Solvent-based measures of 'oil' in organic rich rocks - including treatments such as 'Dean-Stark' cleaning widely used in core analysis - are compromised because they not only include sorbed hydrocarbons but also significant non-hydrocarbons and fragments of the kerogen structure itself.

Recently developed advanced pyrolysis techniques can split this bulk volatile hydrocarbon yield into different boiling fractions. We use the 'Oil1' through 'Oil4' yields generated using Hawk-PAM™pyrolysis equipment to measure the weight compositions of total (sorbed plus fluid phase) volatile hydrocarbons in rock samples. Calibration of the composition of these boiling fractions, using hydrocarbons of known carbon number, gives the following compositions: Py1.1/'Oil1' is C5-6; Py1.2/'Oil2' is C7-10; Py1.3/'Oil3' is C11-17; Py1.4/'Oil4' is C18-43.

Sample handling protocols that minimize the time between core recovery and analysis are required to ensure well-preserved rock samples with the lower boiling fractions intact. The effects of particle (sieving) size need to be understood since smaller particles allow better transport of the heavier volatile fractions through the sample; while larger particles preserve the more volatile fractions. The t!PsSAT2017 algorithm employs data from both sample sizes to take advantage of these effects.

We present early calibration results establishing the Py1.1-1.4HC compositions of sorbed oil at differing levels of thermal stress; by establishing the expected sorbed weight of each component the fluid phase composition can be calculated by difference.

Predicted fluid phase compositions can be related to oil gravity using a PVT database, given knowledge of the Organofacies of the organic matter. The

four volatile fractions can also be de-lumped to draw a full carbon number range ‘pseudo-GC’.

Successful prediction of API gravity is difficult because it depends on (1) accurate prediction of the fluid phase saturation followed by (2) accurate deconvolution of the four component yields.

We present what we believe to be the world’s first successful blind prediction of API gravity using pyrolysis alone, for a Wolfcamp reservoir in the Delaware Sub-Basin of the Permian Basin.