Light hydrocarbon recovery and GOR estimation of retained hydrocarbon in the source rock determined by semi-closed hydrous pyrolysis

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The determination of initial gas-oil ratios (GORi) of shale oil system is critical for assessment of shale resource and development. Many publications mentioned the good correlation between GORi and thermal maturity of shales in the commercial production shales such as Bakken, Barnett and Eagle Ford shale, in which the GORi were calculated by the early term production data or geochemical calculation of hydrocarbon composition. Here we proposed a new approach to estimate the lost light hydrocarbon and GOR within source rock based on semi-closed hydrous pyrolysis experiments.

Imature lacustrine marlstone samples were collected from the third member of the Eogene Shahejie Formation, Shulu Sag in the Bohai Bay Basin. The marlstone sample was crushed into 80 mesh (0.177 mm), homogenized and divided into 5 parts, each 150 g. The experiments were conducted in a semi-closed pyrolysis system in which hydrocarbon product only expelled at the particular pressure condition, thought to be more close to the real subsurface condition.The samples were prepared and heated to 325°C, 335°C, 350°C, 360°C and 370°C (their equivalent vitrinite reflectance value from 0.5% Ro up to 1.5% Ro).

The expelled gas and liquid hydrocarbon and bitumen within pyrolysate were collected and analyzed with GC-MS.

Gas and part of light liquid hydrocarbon associated with bitumen retained in the source rock lost during the reaction-oven open and extraction process, which leads to significant underestimation of residue hydrocarbon and makes the estimation of gas-oil ratios of retained hydrocarbon impossible. Mass balance calculation reveals the lost light hydrocarbon rise from 0.1% to 80% of total retained hydrocarbon with increasing thermal maturity from 0.5% to 1.5%. Based on which, the GOR within residue hydrocarbon(GORR) were calculated as the result of lost light hydrocarbon divided by the amount of bitumen. The GORR has better correlation to the expulsive efficiency than the GOR of expelled hydrocarbon (GORE amount equal to the expelled gas hydrocarbon divided by expelled liquid hydrocarbon). Besides, the GORR provide a method for recovery of Rock-Eval parameter S1.