High Pressure Ramped Temperature Oxidation and Pyrolysis Study of Bazhenov Oil Shale

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Abstract

Bazhenov formation is the largest oil shale reserves in Russia, which have not been developed extensively. High-pressure air injection (HPAI) is one of the most promising enhanced oil recovery techniques for Bazhenov shale. HPAI involves initiation of an oxidation front in the formation, which does not only displace the oil by combustion gases, heated fluid and steam, but also causes reservoir pressure and temperature to increase. Oil shales contain organic matter, kerogen, that is insoluble in organic solvents and can generate oil and gas while heating. Hence, processes occurred during HPAI implementation in shales are very complex. That is why unique experimental research is needed for better understanding of kerogen oxidation and thermal decomposition mechanisms.

This research includes experimental studies of Bazhenov oil shale kerogen oxidation and pyrolysis, namely high pressure ramped temperature oxidation and pyrolysis tests. Aim of this work was to evaluate a potential of HPAI method in generating hydrocarbon gases and oil from kerogen using special experimental equipment. Oxidation and pyrolysis tests consisted of air and nitrogen injection, respectively. Non-extracted crushed core was packed into a one-inch flow reactor, which was subjected to a uniform heating at a rate of 40°C/h up to 500°C under reservoir pressure (28 MPa). During the tests, evolved gasses were identified and liquid samples were collected for further analysis.

As a result of the study, temperature profiles, gas compositions, volume and composition of generated/displaced fluids were obtained. Results of core post-analysis showed that no kerogen/organic matter remained in the core samples. Temperature profiles identified the start of kerogen oxidation and maximum temperatures that can be reached during the exothermic processes of HPAI. Unique experiments have made it possible to eliminate some gaps associated with oxidation and pyrolysis of oil shales.