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Experimental Study about High Geologic Pressure Action on Hydrocarbon Generation and Expulsion 0f Marine Shale

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Hydrocarbon generation and expulsion (HGE) occurs in the high temperature and pressure condition in aquifer and porous rock containing catalytic minerals. This capability and the process status of marine shale deep-buried received continuous attention from petroleum exploration companies and geologists. Previous researches developed a series of pyrolysis experiments, such as autoclave, high pressure gold-tube system [1-6]. In them mineral catalysis, water, temperature, heating time, fluid pressure and secondary generation are taken into account. And these experiments data brought some important cognitions: natural gas successive generation from organic material [7-8], differential retardation of OM (organic matter) maturation by overpressure [9-12]. Hoverer, the data is still scare in the lithostatic pressure and has nothing of geologic pressure. This paper emphasizes the lithostatic and fluid pressures coupling effect on shale organic matter. Applying to Hydrocarbon Generation and Expulsion Rig in SKL-EOR (State Key Laboratory-Enhanced Oil Recovery), the pyrolysis experiment are carried out approaching to geologic conditions (semi-close pyrolysis system). The experiments of different size sample and different compacting shape show the effect of lithostatic pressure on marine shale maturity, and indicate that lithostatic pressure retards hydrocarbon generation by reducing contact area between water and catalyzing mineral and restraining exchange freedom of ionic water in rock pore. That is, permeability and catalyzing mineral content of source rock affect the process of HGE. The data of different pore pressure experiments display that higher pore pressure retards oil expulsion and arises more cracking gas yields, but high pore pressure plays negative role on gas generation. Furthermore, the effects of pore pressure on OM maturity and on hydrocarbon generation are not parallel. Hence vitrinite reflectance is probably less accurate to ascertain hydrocarbon generation phase. Taking the burial history of the real sample as geological model, the experiments doubled pore pressure and lithostatic pressure suggest that geologic doubled pressures retardates hydrocarbon generation and oil expulsion. The experiment data with the higher doubled pressure show the higher value of Ro of the hydrocarbon generation summit, lower hydrocarbon yields, lower expulsion efficiency and the higher ratio of cracking gas from occluded oil in gas product.

1. Pyrolysis Experiments of Different Size Samples

The experiment rents MSSV open system. The lower maturity sample (TOC 0.32%, Rb

0.61%) comes from marl outcrop of Pingliang Formation, Ordovician in Ordos Basin and the higher maturity sample (TOC 1.06%, Rb 1.2%) is Cambrian shale at 4946m of Well ML1, Tarim Basin. Sample teams are 10-20, 20-30 and 60-75 in mesh. The experiments are carried out at a temperature rising rate 5 K/Hour from room temperature to Celsius 800. The hydrocarbon yields and components are analyzed in sample size team in Fig 1. The oil yields are measured according to its weight and the relative density of gas 0.768.

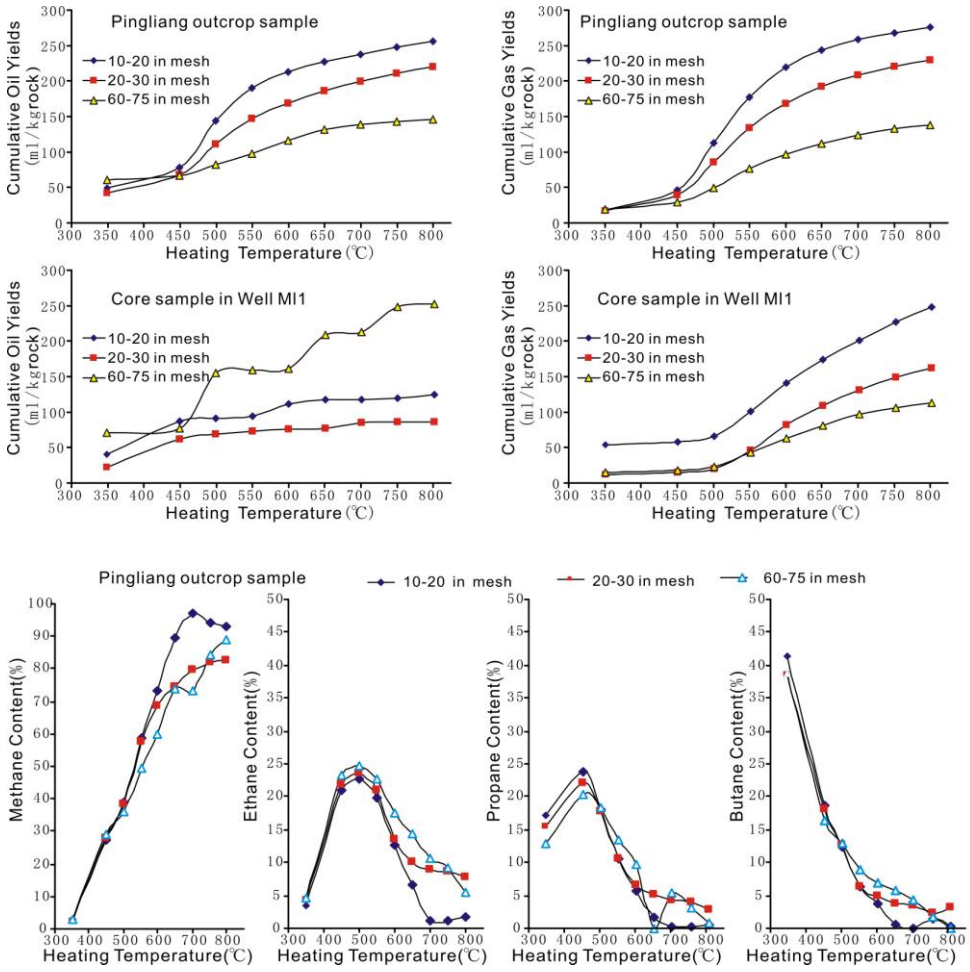

Fig. 1 Variation of hydrocarbon yields and components content with heating temperature and sample size

2. Experiments of Different Compacting Shape Samples

The experiments take the calcareous shale of Fm. Xiamaling Proterozoic North China as sample, whose size is less than 1.33mm. the heating program is 48 hours isothermal after aimed temperature with temperature rising rate 90K/Hour. The pore pressure is 60 MPa. In the first experiments, the sample is filled into autoclave and its surface keep in plane without compaction. The second experiments like as the first one but compaction. The sample is compacted in natural repose 30°.

3. Experiments of Different Porous Pressures

The experiments are divided into two team by the porous pressure 10MPa and 20MPa. All of them apply Permian calcareous shale of Mentana (Rb 0.6%, TOC 0.95%, sample size 0.3-1.0cm) to Hydrocarbon Generation and Expulsion Rig. The heating program is same to the above. In order to make up for the lack of vitrinite of above samples, the experiments are carried out again using coal sample and setting porous pressure 10MPa and 35MPa. The coal sample (966m, Ro 0.79%, TOC 78.09%) comes from Jurassic at Well CSH1, Jungar Basin.

4. Experiments doubled pore pressure and lithostatic pressure

The experiments are carried out according to the conversed heating program which is transfer from the geologic burial model by Kinetics 2.4. The burial model of Well LN46 in Tarim Basin is characterized with decreasing geothermal gradient, multiple fluctuation in sedimentary process and rapid deep-burial in late stage. The pressure parameters are set by the real geologic value. The experiments are teamed into threee. Two of them are geologic doubled pressures and atmospheric pressure experiments in the conversed heating model of Well LN46. The third is doubled pressures experiment in continuous burial and heating model. The data of experiments are analyzed in Fig 2.

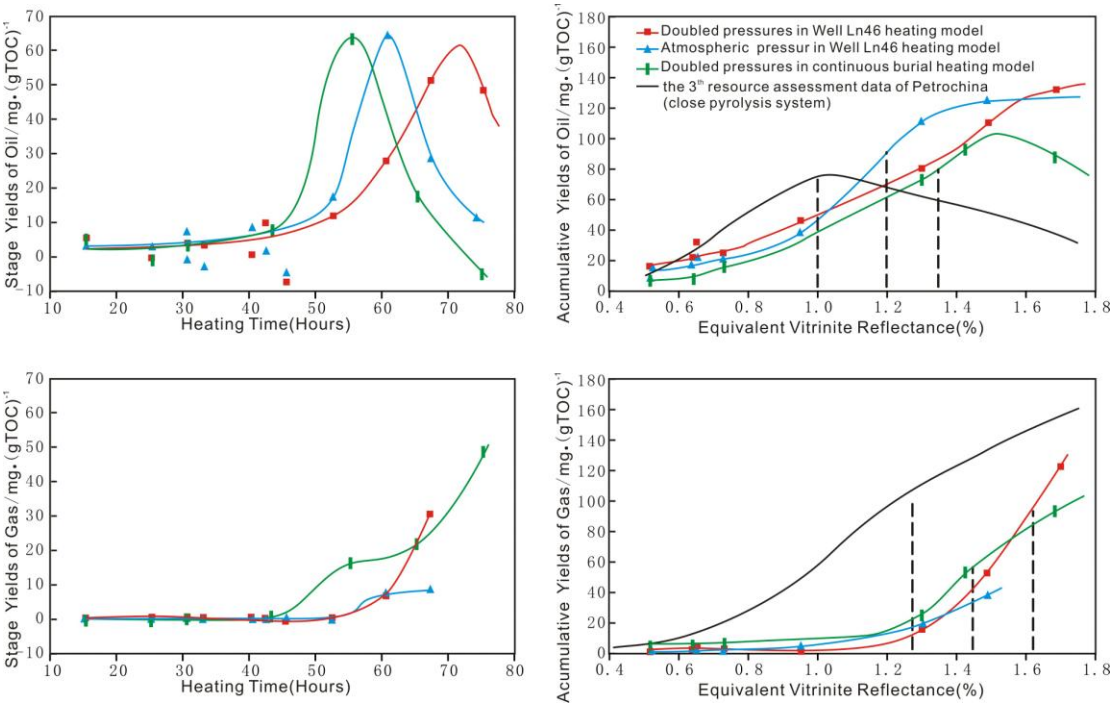

Fig. 2 Variation of hydrocarbon stage yields with heating time and accumulative yields with maturity in different experiment conditions

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