A Study on Hydrocarbon-Generating Potential and Kinetics of Source-Rock Pyrolysis

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Abstract: A study on the potential and kinetics of hydrocarbon (HC) generation of 30 source-rock samples from a certain depression has been made by means of ROCK-EVAL technique. In the pyrolysis experiment, the source material types, maturation and hydrocarbon-generating potential of source rocks from three Upper Jurassic horizons of that area have been evaluated in terms of such indicators as the type-index, hydrocarbon-generating potential and maximum pyrolysis temperature ($T_{max}$). The results show that the pyrolysis HC yield of immature source rocks is much higher than that of mature rocks in case that the source material is of high quantity and organic matter is abundant, which suggests that it is important for evaluating the HC-generating potential to use immature samples for pyrolysis. In the pyrolytic simulation experiments on other two immature samples, it was found that the hydrocarbon yield is temperature-dependent, and thereafter the kinetical parameters for source rocks, such as reactional grade, appearant activation energy and frequency factor were calculated.

Key words: pyrolysis; ROCK-EVAL; hydrocarbon-generating potential; hydrocarbon-generating kinetics; activation energy

Introduction

The study on the hydrocarbon-generating potential of source rocks is of great importance in oil/gas exploration and can provide the quantitative and qualitative grounds for the calculation of oil/gas yield and resource assessment. Especially, the study on kinetics of hydrocarbon generation of source rocks can not only provide the kinetic parameters for the calculation and assessment of oil and gas yields, but also lay a theoretical foundation for the quantitative simulation of hydrocarbon generation. So far there have been developed many methods which can be used to study the hydrocarbon-generating potential of source rocks, such as those geochemical methods to study the type, abundance and maturation of kerogen in source rocks. In regard to the study of the kinetics of hydrocarbon generation, the routine methods based on
nonisothermal methods (i.e., iso-rate temperature rising method) include DTA (Wang Tingfen et al., 1981), TGA (Yang Jitao et al., 1984) and ROCK-EVAL (Wang Jianqiu et al., 1984; Wu Liyan et al., 1986). As for the validity and efficiency of the analytical methods, it is recommended to use the ROCK-EVAL technique for the analysis of hydrocarbon-generating potential and kinetics, which is fast, accurate and economical. The main assessment indices and kinetic parameters for source rocks have been acquired from pyrolytic experiments on 26 source-rock samples and pyrolytic simulation experiments on 4 samples from a certain depression by means of the ROCK-EVAL II technique.

**Samples and Experiments**

**Samples**

In order to accurately evaluate the hydrocarbon generation, samples of immature source rocks were used in the pyrolytic experiment instead of kerogen. The samples used in the experiment were collected from B2 and M3 wells in a certain depression, which range from 601m to 1262m and from 343m to 582m in depth respectively, corresponding to the Upper Jurassic series. A total of 30 samples were collected, of which 26 samples were used for regular pyrolytic analysis and 4 samples for kinetic parameter analysis. Organic carbon contents of the source rocks are generally 1.24%-2.70% and come up to 4.38%-5.71%, and the samples measure 80 mesh in grain size.

**Pyrolysis experiments**

The samples for pyrolysis were first heated up to 300°C and kept constant at this temperature so as to get the peak $S_1$ (soluble hydrocarbon) and then heated up to 550°C at the rate of 25°C/min to obtain the peak $S_2$ (pyrolytic hydrocarbon). The peak $S_3$ (CO$_2$) was trapped at 300~390°C. Meanwhile about 100~200 mg of samples were input. During the pyrolytic simulation experiment, the temperature rose from 300°C to 550°C at the rate of 5°C/min and the pyrolytic hydrocarbon yield was recorded on the curves by the integrator, which can provide the information about the instantaneous hydrocarbon yield in the temperature range of 300°C to 500°C. The moving rate of recording paper was set at 10 mm/min.

**Analysis of the Experiment Results**

**The results from pyrolytic analysis**

The results of pyrolytic analysis for 30 source-rock samples are given in Table 1, which can be used to evaluate the source material type, maturation and hydrocarbon-generating potential of source rocks.

1. Source-rock types According to the evaluation criteria of the four types of source rocks in China (Wu Liyan et al., 1986), the type index ($S_2/S_3$), the oil yield ($S_2+S_1$), the maximum degradation rate ($D$) and hydrogen index ($S_2/C$) show that most samples in Table 1 belong