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Determination and Estimation of Hydrocarbon Potential by Calculating Kinetic Parameters and Rock-Eval 6 Pyrolysis Analysis in Sarchahan Formation and Coal Inter-Layers of Faraghoun Formations in Coastal Fars and Persian Gulf, Iran

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Abstract: This paper aims to investigate the hydrocarbon potential and organic matter maturity of Sarchahan and Faraghun formations between coal layers. To do this, we implemented the kinetic parameter and Rock-Eval 6 Pyrolysis analysis methods. Results showed that moving toward the coastal Fars (Sarchahan Formation) and from south of Iran to the central part of Fars bay (Faraghun Formation), there is an increase in the maturity of the organic matter.

Keywords: Hydrocarbon potential, Source rock, Faraghun and Sarchahan formations.

INTRODUCTION

Petroleum geochemistry helps to increase the exploration success through which many parameters of the petroleum accumulations such as source rock quality and maturity, temperature maturity, migration and gatherings for the oil trap are determined [1]. Most of the oil and gas in Arabian plate and Fars bay are derived from Paleozoic source rock, therefore, it has been an interesting region for the petroleum geologists. According to the research studies done on Fars bay countries, it has been stated that the source rock must have had an increasing maturation trend toward Iran, however, with respect to the lack of data, this has been stated as a possibility [2]. In Iran, petroleum system studies on Paleozoic has been neglected compared to the other systems and there are just some scattered investigations such as Saberi et. al. (2015) which has focused on the paleo-logs of the drilled wells in Paleozoic layers which revealed that the Sarchahan formation is the most probable source rock of the Paleozoic formations. Besides, Saberi et. al. showed that the existence of some coaly interlayers in Faraghun may have the potential to produce oil [3].

In this article, regarding the importance of Paleozoic hydrocarbon system, kinetic parameters of the

probable source rocks (Sarchahan and Faraghun formations) in coastal Fars and Fars bay is determined. To do this, the drilling cuttings of Sarchahan formation (Ordovician and Silurian) and Faraghun formation (Permian) in Salmas oilfield and Zireh, Asaluyeh, Golashan, Naar, Homa, Daarang and Kouh Siah gas fields are analyzed and the outcrops of these two formation has been thoroughly investigated (totally 294 samples Rock-Eval pyrolysis and 7 samples Kinetical analysis). Putting together the results of Kinetic analysis along Rock-Eval results, we have scrutinized the Sarchahan and Faraghun formations which reveals that not only the Sarchahan has the possibility of petroleum generation, the Faraghun formation do the same and can be a proper source rock in this region.

METHODS

Study of hydrocarbon source rocks indicated that Rock-Eval pyrolysis is done by heating the organic matter in the absence of oxygen [4,5]. In this study, we have implemented two different approaches, Rock-Eval pyrolysis analysis (organic matter, maturity and hydrocarbon potential determination) and Kinetic analysis (estimation of the produced hydrocarbon) for the samples of Faraghun and Sarchahan formations. The sample analysis is done through standard Rock-Eval 6 and also basic methods which incorporated 25 °Ctemperature range for Rock-Eval pyrolysis and the Optkin method for Kinetic analysis in the temperature range of 5, 15 and 25 °C.

The apparatus method incorporates putting about 100mg for the powdered samples in the pyrolysis oven (absence of oxygen) which is heated in a Nitrogen atmospheric condition (specified heating range due to the specified method) and the emitted gas is studied and recorded in Flame Ionization Detector (S_1 and S_2). Then, the samples are transferred into the oxidation oven and being burnt by oxygen and the emitted gas is analyzed infrared detector (S_3, S_4 and S_5). Then, the results are recorded [6].

In this study we have benefited from Rockint software to interpret the raw data so that we can input them into the Optkin software. Optkin is an optimization software based on the Kinetik model. The reason for optimization is to determinethe best quantity for the activation energy distribution which is accomplished based on several Rock-Eval pyrolysis on mature or immature source rock samples [7]. Kinetic parameters can benefit us for the anticipation of the amount of the produced hydrocarbon as a function of time and temperature in basin simulation software. The speed of hydrocarbon production is related to the type of kerogen structure affecting the gross kinetic parameters (activation energy and frequency factor) [8]. Kinetic parameters application of the petroleum generation in the burial-heating history is used by Arrhenius function.

DISCUSSION

According to Van Krevelen graphs as shown in Figures 1 and 2, Sarchahan Formation is in the early stages of oil window and identified with kerogen type II/III, II and Faraghun Formation is in the early stages of oil window and the kerogen types is III. T_{max} and HI for surface samples of Sarchahan Formation is 51.4 and 441°C and for Faraghun Formation in Salman field is 128.5 and 427 °C respectively.

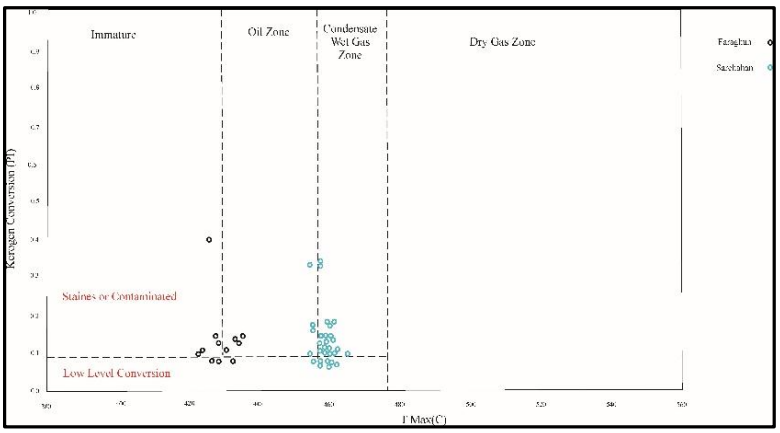

Figure 1. PI versus T_{max} for Sarchahan and Faraghun samples

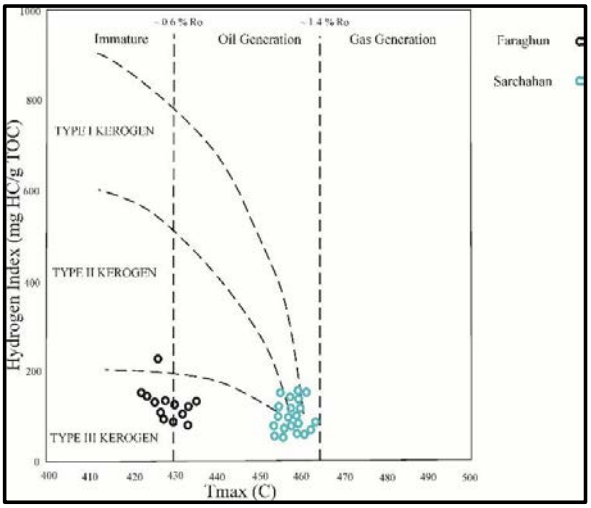

Figure 2. HI versus T_{max} for Sarchahan and Faraghun samples

Also results of kinetic from pyrolysis with Optkin method has been identified with error less than 1 that shows a great optimization is accomplished (Figure 3). Considering activation energy distribution, Sarchahan Formation has kerogen type II with 45-55 Kcal/mole content and Faraghun formation kerogen is of type III with a content of 46-54 Kcal/mole.

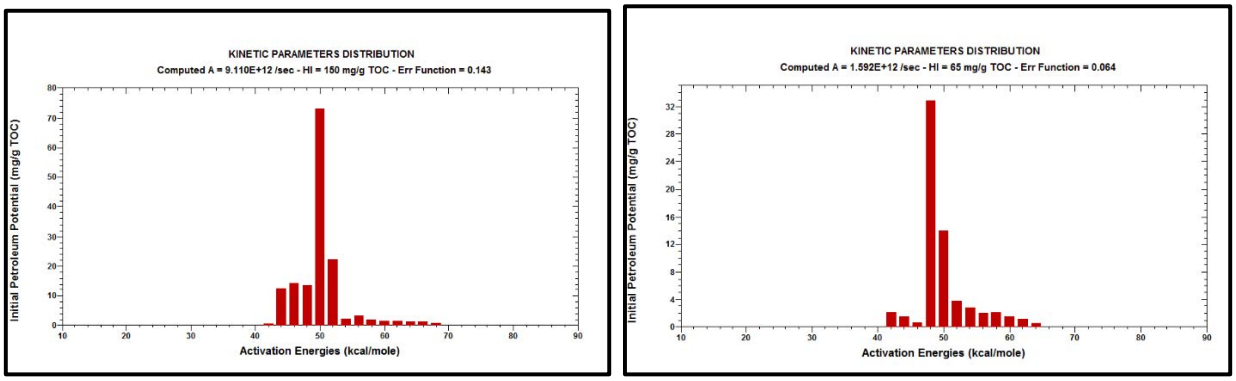

Figure 3. Activation energy distributions (kcal/mole) for Sarchahan Formation (right) and Faraghun Formation (left), Samples from open system pyrolysis at three different heating rates (5, 15 and 25 °C/min)

CONCLUSION

At the end of Ordovician, and melting of the natural ice, the upcoming streams were dominated which has caused the organic rich shales to be precipitated (Sarchahan formation). Studies showed that we can divide Sarchahan formation into the upper Sarchahan (poor organic material) and the lower Sarchahan (rich with organic matter). The lower part of Sarchahan has the hydrogen index of 73 mg hydrocarbon per each grams of the rock and the total of organic carbon reaches to 2.5% and the maximum temperature of 459^{C}. We can also state that Sarchahan is mainly composed of the kerogen type II and II/III which is in the end of the oil window.

Based on Faraghun Rock-Eval analysis, the possibility of hydrocarbon potential could be seen in the interlayers of coaly layers. These layers stand at the beginning of the oil window and mainly comprised of kerogen type II. The hydrogen index is estimated to be 120 mg hydrocarbon per each grams of the rock and the total of organic carbon reaches to 3.9% and the maximum temperature of 427^{C}. Faraghun's hydrocarbon in some coaly interlayers can be stated to have a potential of source rock.

With respect to the upper section kinetic result of Sarchahan formation, the activation energy is 55-80

Kcal/mol and the kerogen is of type III. The lower Sarchahan formation has activation energy of 48-52 Kcal/mol and the kerogen is of type II which the subsequent samples are semi- mature. Regarding the dissipation of the activation energy, Faraghun formation kerogen in of type III with activation energy of 40-60 Kcal/mol and samples are in at the very first stage of the oil window.

With due attention to the constituent of the Faraghun formation (sandstone, siltstone and coaly shales) which can play a role as a reservoir rock and due to the fact that some interlayers of this formation in the studied area are capable of having the hydrocarbon potential, we propose that this formation can be considered as an exploration target of Paleozoic era. The coaly interlayers of Faraghun formation can be capable of charging the sandy layers of itself (reservoir section) and produce hydrocarbon reservoirs (sandy sections of this formation needs further investigation to accentuate the possibility of being a reservoir). The produced result of the current research can be used in kinetic functions regarding the simulation of sedimentary basin of this region.

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