Characterization and identification of petrophysical parameters of Shales from Jhuran Formation, Kachchh Basin, India

Sankari Hazarika
Pandit Deendayal Petroleum University
School of Petroleum Technology,
Gandhinagar, Gujarat, India.
E-mail: hazarikashankari10@gmail.com

Ajendra Singh
Pandit Deendayal Petroleum University
School of Petroleum Technology,
Gandhinagar, Gujarat, India.
E-mail: ajjusingh1989@gmail.com

Bhawanisingh G Desai
Pandit Deendayal Petroleum University
School of Petroleum Technology,
Gandhinagar, Gujarat, India.
E-mail:bhawanigd@gmail.com

SUMMARY

The present study is aimed at understanding the petrophysical properties of shale such as porosity, permeability, capillary pressure and mineralogy of fine-grained sediment. It is a common perception that tight shale formation has good source rock properties, also with current energy scenario unconventional play are being sought for shale gas prospects. In context to this the Upper Jurassic Jhuran formation which is primarily a Shale dominated facies has been investigated for unconventional aspect in the Kachchh Basin. Jhuran formation is supposedly the source rock for the Kachchh Basin. Previous studies have indicated the hydrocarbon generation potential in the offshore part of the basin which is of thermogenic nature. Therefore a number of experiments to ascertain the flow storage and migration properties are carried out which include Routine Core Analysis such as Helium Porosimetry, Liquid Permeability as well as Special Core Analysis like Spontaneous and Forced Imbibition. The higher Quartz content preserve the porosity while compaction which is validated in porosity and Permeability measurements. The Capillary pressure curve gives an indication of the randomness and inter connectivity of the sparse void spaces in the shale. Conductometric titration was used to determine Cation Exchange capacity which helps in understanding the swelling characteristics under different drilling scenario. Ultimately, critical details regarding unconvectional reservoir quality can aid in the design of better and more efficient for shale gas recovery methods.

Key words: Unconventional formation, Porosity, Permeability, Capillary Pressure, Conductometric titration.

INTRODUCTION

Shale is a sedimentary rock that is formed from the compaction of fine grained silt and clay sized mineral particles ([1] Harsh Sahani, et al. 2018) Black shales in stratigraphic records are considered as organic carbon rich sedimentary units, which are deposited in unique paleoenvironmental condition and are considered to be potential for hydrocarbon generation. Shale is a type of mudstone which has distinguished property of being fissile and laminated with average total organic content ranging from 0.8% to 2.2% ([2] Chinn et al. 1991). In recent times, most of the producing unconventional reservoirs are found to be bioturbated, contrary to the initial belief.

In recent study, Core flooding and Sponteneous imbibition technique has been found to be a powerfull method for extracting usefull petrophysical parameters information from unconventional reserv sample. This method is used to evaluate permeability and capillary pressure from shale core sample. Sample preparation requires professional, precise equipment having a high level of repeatability and accuracy regardless of sample type. A perfect outcrop core sample contains full information of permeability and capillary pressure with eletrical properties.

The permeability is associated with the presence of natural fractures in the rock which enable the flow of reservoir fluids between pore spaces. Permeability enables the flow of natural gas or oil into the borehole and their production. Permeability evaluated from gas permeameter has been used to validate permeability from the core flooding and spontenous imbibiton method. In the case of shale rocks, both permeability and porosity are highly dependent on mineral composition, organic matter distribution, quantitative (%) content of organic matter, and thermal maturity of organic matter. Hence, In the case of Shale rocks characterized by low permeability it basically prevents any unrestrained flow of hydrocarbons. Ultimately, critical details regarding unconvectional reservoir quality can aid in the design of better and more efficient for shale gas recovery methods.

METHOD AND RESULTS

A shale sample (Jara-Nirona-Ratia) of Jhuran formation was prepared and studied for petrophysical charaterization.

Figure 1. Shale core plug from outcrop of Jhuran formation.

Where Jhuran formation is overlain by Bhuj Formation with a gradational upper contact marked by first occurrence of ironstone band and last occurrence of calcareous sandstone. It consists of greenish grey sandstone, with occasional Trigonia bands, grey shale and calcareous sandstone. Jhuran Formation is present in the offshore (GK-29A-1 well), Kutch mainland and Banni graben ([3] Bhawanisingh G. Desai 2016). For estimating permeability, bioturbated shale were collected.

Imbibition is an immiscible displacement process, whereby a non-wetting fluid within a porous medium is spontaneously expelled by wetting fluid that surrounds the medium. Wetting

fluid is drawn into the medium by capillary suction. This phenomenon is caused by the differential attraction forces between the pore walls and fluids. The rate of imbibition is primarily dependent on the rock permeability, pore structure, wettability, and the interfacial tension between the resident phase and the imbibing phase. Core Flooding Systems are advanced, modular and configured for liquid permeability, water flood, water flood susceptibility and unsteady state liquid/liquid, gas/liquid relative permeability tests and other applications.

After establishing permeability from this two methods validate with gas permeameter permeability. Then electrical properties of powder form sample identified for petrophysical properties characterizing to improved shale gas recovery.

Figures and Graphs

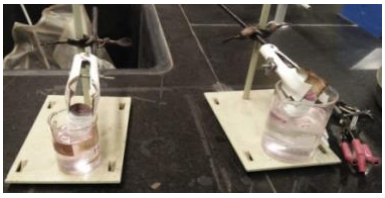
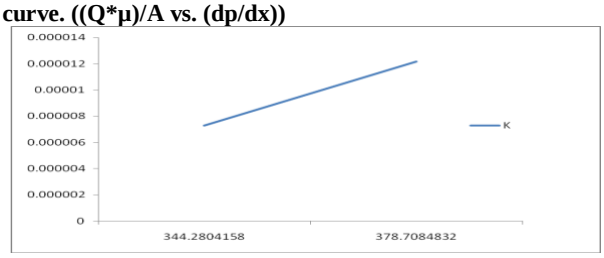


Figure 2. Spontaneous imbibitions on shale core plug in water-wet condition.

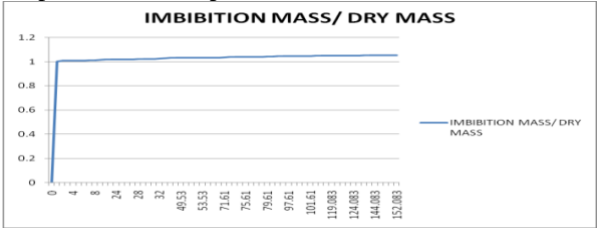
Figure 3. Shale core plug sample after spontaneous imbibition.

Figure 4. Core flooding system to establish permeability

Graph 1. Results of two methods to defined permeability curve. ((Q*μ)/A vs. (dp/dx))



Graph 2. Results of spontaneous imbibition method.



From graphical representation permeability of shale sample was reduce due to organic matter present in it which prevents any unrestrained flow of hydrocarbons.

Citation

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CONCLUSIONS

The percentage of silica is high in the Jhuran formation which indicate that shale is a better candidate for hydraulic fracture. The percentage of porosity is high as compared to permeability and by the measurement of porosity and permeability it gives the better gas storage potential in the Jhuran Shale which act as source rock for hydrocarbon rich kachchh offshore. Ultimately, critical details regarding unconvectional reservoir quality can aid in the design of better and more efficient for shale gas recovery methods.

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