TIAN Shansi, LU Shuangfang , XUE Haitao, XIE Liujuan and LI Jiyuan, 2015. The Influence of Pore Throat Radius on its Internal Oil and Water Wettability. *Acta Geologica Sinica* (English Edition), 87(supp.): 166-167.

The Influence of Pore Throat Radius on its Internal Oil and Water Wettability

TIAN Shansi, LU Shuangfang, XUE Haitao*, XIE Liujuan and LI Jiyuan

China University of Petroleum (Hua Dong), Unconventional oil and gas and New Energy Research Institute, Qingdao, Shandong 266500

With the rising of energy demand and the dwindling of conventional oil and gas resources, the unconventional oil and gas resources are getting more and more attention, and has become the main contribution of global oil and gas production growth over the past five years. Compared with the North American marine tight oil, China Continental tight oil reservoir with strong heterogeneity and distribution characteristics of poor stability, and has a complex of the enrichment process, existing state and flow rules. Compared with the conventional reservoir, because of tight oil reservoir is poor and difficult to evaluate, the traditional analytical methods meet great challenge. At present, scholars have carried out a lot of research work to fine characterization of the space of tight reservoir micro pore throat system, But the study on reservoir properties of micro nano surface pore throat – wettability which has important significance in dense oil enrichment, occurrence and flow in the research of the mechanism is rare.

Before the crude oil into the reservoir, the main hydrophilic minerals in reservoir (quartz, feldspar, calcite and dolomite) after water films from forming on the surface is hydrophilic and the capillary force showed resistance in the process of crude oil into the reservoir. In the tight oil filling process, the most important resistance is the capillary force. In the process of capillary force calculation ($Pc=2\sigma\cos\theta/r$), the interfacial tension σ changes with the temperature and pressure, and the radius changes with the pore throat size，and the wetting angle usually constant. However, due to the impact of the droplet contacting solid wall curvature, the smaller the radius of pore throat, the stronger the force of the solid wall facing the liquid intermolecular.

In order to investigate the influence of pore size on the wettability angle of “oil-water -rock”, this study we selected five quartz tube of diameter size, the tube diameter were 30 μm, 25 μm, 20 μm, 15 μm, 10 μm. The standard compounds of oil including 1,3 – dimethylcycl- ohexane, cyclohexane, toluene, n-dodecane, n-octane，and the water using deionized distilled water. First, burned the surface coating of the quartz tube to ensure the light transmittance under a microscope, and then, using tweezers which verticaled quartz tube and break it into small pieces 1 cm long. Then extracting 0.1 ml of water or oil standard compounds with 1 ml syringe, with tweezers clip 1 cm quartz tube and dipped one end into the liquid, the liquid will automatically fill the quartz tube because of the quartz tube hatred gas and lyophile. Then, put the quartz tube pulled out from the liquid，standing 1 min, sealed the two section of quartz tube with 502 adhesive to prevent fluid flow within the tube (or wetting angle measured out is advancing angle). Finally, put the dealed quartz tube under a microscope the observation, first placed quartz tube vertically with ×4 times objective, followed by ×10 times, 50 times and 100 times objective (10 times for the eyepiece lens) to observe the contact angle of "liquid - gas - quartz". And imaging on the computer by high-speed cameras (CCD), save the photo about wetting angle measurement. Followed by ×20 times, ×50 times and ×100 times lens (eyepiece for ×10 times) observed contact angle of the liquid - gas - quartz, and through high speed camera (CCD) imaging on the computer, save measuring wetting angle of photo (Fig. 1).

The contact angle experiments about 1,3-dimethylcyclohexane and cyclohexane, toluene, n-dodecane, n-octane and water respectively with air in the five aperture scale quartz tube has been completed. Preliminary studies have found that 1,3-dimethylcyclohexane with air in a quartz tube, the wetting angle changes from 25.6º to 3.2º and the wetting angle has a large range. The wetting angle variation about other five reagents and air in the quartz tube showing the same rules of the smaller aperture is smaller contact angle.

References

Barber, A.H., Cohen, S.R., and Wagner, H.D., 2005. External and internal wetting of carbon nanotubes with organic liquids.

* Corresponding author. E-mail: sea1999101@sina.com

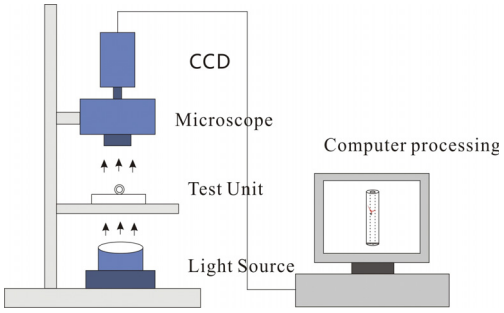

Fig. 1. The schematic of measuring device about wetting angle in quartz tube.

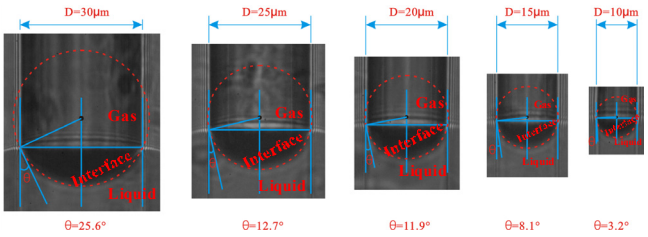

Fig. 2. The measurements results of 1,3-dimethylcyclohexane - air wetting angle in different diameter of quartz tube under 1000 times magnification.

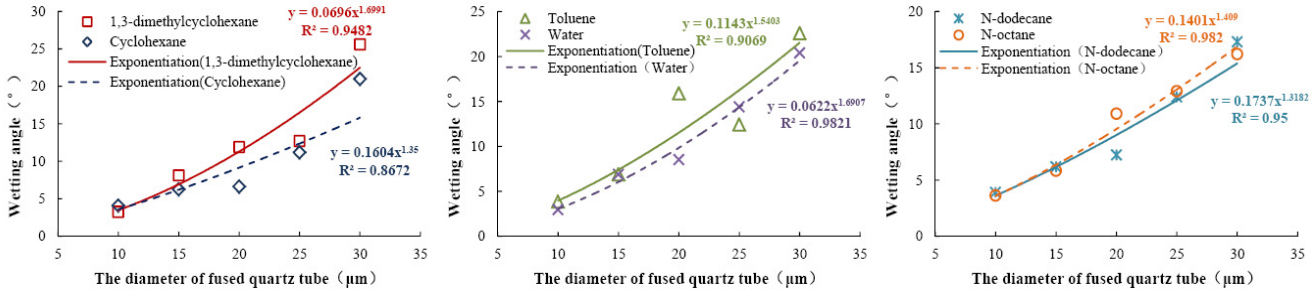

Fig. 3. The wetting angle measurements results of six kinds of reagents and air in different diameter of quartz tube.

Physical Review B, 71: 115443.

Churaev, N.V., 2003. Surface forces in wetting films. *Advances in Colloid and Interface Science*, 103(3): 197-218.

Jia Chengzao, Zheng Min and Zhang Yongfeng, 2014. Four important theoretical issues of unconventional petroleum geology. *Acta Petrolei Sinica*, 35(1): 1-10.

Zhang Hong, Zhang Shuichang and Liu Shaobo, 2014. A theoretical discussion and case study on the oil-charging throat threshold for tight reservoirs. *Petroleum exploration and development*, 41(3): 367-374.

Zou Caineng, Zhu Rukai and Wu Songtao, 2012. Types, characteristics, genesis and prospects of conventional and un conventional hydrocarbon accumulations: taking tight oil and tight gas in China as an instance . *Acta Petrolei Sinica*, 33(2): 173-187.