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Determination of Contact Angle of Various Fluids In oil Industry

Mohsen Aldobiani[1], Hashem Mohammed Al-mahaqeri[1], Ali Saleh Mareai[1], OsamahAlgeredi[1], Purabhi Bora[2], Dr.A.Rajesh Kanna[3]
[1]*Undergraduate students, Petroleum Department, Lords Institute of Engineering and Technology, India*
[2] *Assistant Professor, Petroleum Department, Lords Institute of Engineering and Technology, India*
[3]*Head of the Petroleum Department, Lords Institute of Engineering and Technology, India*
Corresponding Author: Mohsen Aldobiani[1]

Abstract: Contact Angle measurement is a classical method widely used in chemical engineering to derive the wettability in three-phase system (gas/liquid/solid, or liquid/liquid/solid). The method was introduced into petroleum engineering more than 50 year ago. This method is used to determine reservoir formation wettability. The imaging method is easily carried out in the laboratory and gives you a clear understanding of wetting mechanism in oil-water-rock system.
Generally, sandstone formation and carbonate formation are represented by small polished quartz and carbonate blocks, respectively. A small drop (2-3mm) of water is laid on the smooth surface of rock which has previously been submerged in an oil-filled transparent cell. Then, the enlarged image of the water drop is obtained by photographing. The dimensions of the drop image are used to calculate the contact angle in the system.
Keywords: Contact angle, Wettability, Imaging method, Quartz, Photographing

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I. INTRODUCTION

When a liquid is brought into contact with a solid surface, the liquid either expand over the whole surface or form small drops on the surface. In the first case the liquid will wet the solid completely, whereas in the later case a contact angle >0 will develop between the surface and the drop. When two immiscible fluids contact a solid surface, one of them tends to spread or adhere to it more so than the other. Adhesion tension, which is a function of the interfacial tension, determines which fluids preferentially wet the solid. Ideally, the shape of a liquid droplet is determined by the surface tension of the liquid. In a pure liquid, each molecule in the bulk is pulled equally in every direction by neighboring liquid molecules, resulting in a net force of zero. How-ever, the molecules exposed at the surface do not have neighboring molecules in all directions to provide a balanced net force. Instead, they are pulled inward by the neighboring molecules, creating an internal pressure. As a result, the liquid voluntarily contracts its surface area to maintain the lowest surface free energy.

The significance of contact angle hysteresis has been extensively investigated, and the general conclusion is that it arises from surface roughness and/or heterogeneity. For surfaces that are not homogeneous, there exist domains that present barriers to the motion of the contact line.

II. METHODOLOGY

Contact Angle measurement is a classical method widely used in chemical engineering to derive the wettability in three-phase system (gas/liquid/solid, or liquid/liquid/solid).The method was introduced into petroleum engineering more than 50 year ago. This method is used to determine reservoir formation wettability. The imaging method is easily carried out in the laboratory and gives you a clear understanding of wetting mechanism in oil-water-rock system. Generally, sandstone formation and carbonate formation are represented by small polished quartz and carbonate blocks, respectively. A small drop (2-3mm) of water is laid on the smooth surface of rock which has previously been submerged in an oil-filled transparent cell. Then, the enlarged image of the water drop is obtained by photographing. The dimensions of the drop image are used to calculate the contact angle in the system.

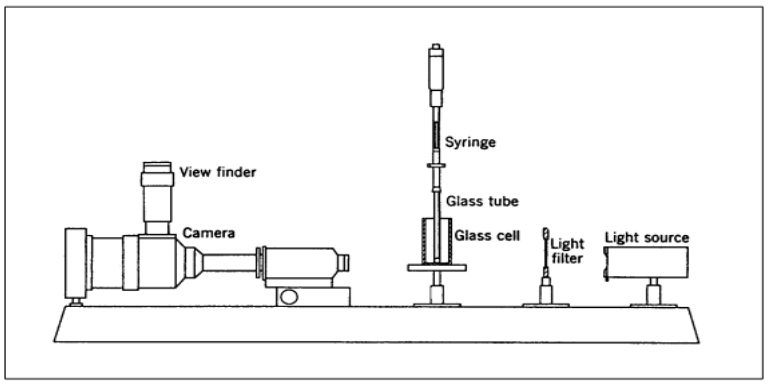


Fig. 8.4: The image system set-up.

Fig: Image of water drop in glass with reflection below

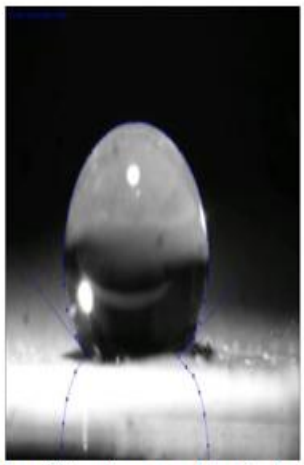


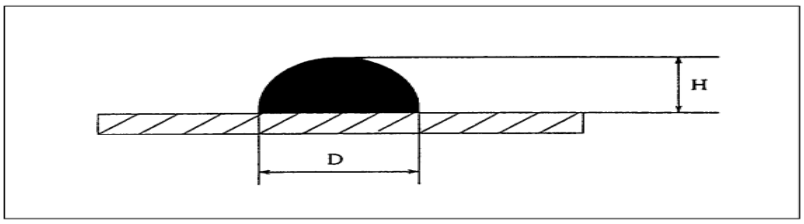
Fig: Water drop on a lotus leaf surface at angle approximately 147<

1. Fill the cell with oil phase and then put polished quartz or carbonate cube into the cell.
2. Carefully inject several water drops onto the cube surface with a medical syringe.
3. Adjust the imaging system until a drop is in focus (a clear
4. outline of the image appears on the screen)
5. Take image picture and measure the dimension of the drop image.
6. Press the capture option in the software to take the image of the drop.
7. Press the line point option and click at the both ends of the drop.
8. Then click on the drop point option point 3 to 4 points on both end surfaces of the drop.
9. Click the "find angle icon "in the software to get the contact angles.

Equation:

$$\theta = 2\tan^{-1}\left(\frac{2H}{D}\right)$$

$\theta < 62^0$-----water-wet, $\theta = 62^0$-133^0-----intermediate-wet, $\theta > 133^0$-----oil-wet



III. RESULTS AND DISCUSSIONS

The left contact angle of water is 71.323 deg. and right contact angle is 80.34 deg. The left contact angle of petrol is 29.31 deg. and right contact angle is 30.6 deg. The left contact angle of kerosene is 29.31 deg. and right contact angle is 30.69 deg

S.NO	SAMPLE	CONTACT ANGLE	
		LEFT	RIGHT
1	WATER	71.323	80.34
2	PETROL	29.31	30.6
3	KEROSENE	29.31	30.69

IV. CONCLUSION

The contact angle of water is more when compared to other fluid samples and it is more wettability than other fluids. The water present in petroleum reservoirs are much solid wet than other fluids. This is mainly due to change in their density.

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