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STUDY OF SURFACE ROUGHNESS EFFECTS TO LIQUID CONTACT ANGLE ON SOLID SURFACE

MOHD SHAHRIR ASHRAF BIN ABDUL WAHAB

Report submitted in partial fulfillment of the requirements
for the award of the degree of
Bachelor of Engineering in Manufacturing Engineering

Faculty of Manufacturing Engineering
UNIVERSITI MALAYSIA PAHANG

June 2016

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ABSTRACT

This thesis deals with measurement of liquid contact angle with different surface roughness. The objective of this thesis is to measure the contact angle on different material of solid surfaces and to measure the effect of surface roughness to the shape of liquid drop from above view. Sessile drop method is used in this paper to determine the contact angle and drop shape of a liquid. The result is trustful and easy to apply. With this method, the intersection of three interface line and contact angle that state in Young's equation can be achieved. This method also has been shown to improve the contact angle measurement. The material used is mild steel with four different roughness, 0.321µm, 0.635µm, 2.325µm and 3.353µm. The surface roughness is very important to determine the contact angle. The increase the roughness of the surface, the larger the contact angle meanwhile the wetting properties become lower. As a result, liquid contact angle increased with increasing plate surface roughness and liquid dropped on higher roughness presents smaller diameter with more edge curve.

ABSTRAK

Tesis ini berkaitan dengan pengukuran sudut permukaan cecair dengan kekasaran permukaan yang berbeza. Objektif projek ini adalah untuk mengukur sudut permukaan pada bahan yang berbeza dan untuk mengukur bentuk titisan cecair dari pandangan atas. Kaedah sessile drop digunakan dalam kertas kerja ini untuk menentukan sudut kenalan dan titisan bentuk cecair. Kaedah ini sangat mudah dan bacaan data yang diperolehi sangat tepat. Dengan kaedah ini juga, persilangan garis tiga antara muka dan sudut permukaan cecair dalam persamaan Young dapat dicapai. Kaedah ini juga telah ditunjukkan dapat meningkatkan ukuran sudut permukaan. Bahan yang digunakan adalah empat keluli lembut yang berbeza kekasarannya, 0.321μm, 0.635μm, 2.325μm dan 3.353μm. Kekasaran permukaan sangat penting untuk menentukan sudut permukaan cecair. Semakin besar peningkatan kekasaran permukaan, semakin besar sudut permukaan cecair. Sementara sifat kebolehbasahan menjadi lebih rendah. Hasilnya, sudut permukaan cecair meningkat dengan peningkatan kekasaran permukaan dan titikan cecair pada kekasaran tinggi menyebabkan diameter lebih kecil dengan banyak lengkungngan.

CHAPTER 1

PROJECT BACKGROUND

1.1 INTRODUCTION

In our daily life, there are various phenomena of liquid droplet such as rain droplet, fingering pattern and splashing on solid surface. In industrial field, it application can be found in printing, adhesion, paints, textile processing, static dissipation, water and stain repellency, laundering and fuel injecting [3,4].

In recent years, the studies of wettability have become very important and interesting to study due to its application in producing hydrophilic surface and hydrophobic surface materials. The study of wettability is including the measurement of contact angle as the primary data. Contact angle can be defined as the angle with of a small drop of liquid that cause it to meet the surface. According to the theory, the small contact angle that mean bigger than 90° is correspond to low wettability and the surface is unfavorable, while large contact angle smaller than 90° is correspond to high wettability and the surface is favorable [4].

The contact angle of liquid droplet has some information about surface properties, wettability and surface energy. Usually, contact angles consist of two types of angle which are advancing and receding contact angle but contact angle hysteresis will

appear between two main of the contact angle that state before. Figure 1.1 shows that the advancing and receding contact angle [2]. Figure 1.2 shows three balance phases of contact angle; solid, liquid and vapor that founded by Thomas Young without surface roughness consideration.

The surface roughness can be the major effect of the contact angle measurement. There is also new method and equation proposed by Wanzel to make a correction factor on rough surface which is known as Wanzel equation. He states that the surface roughness may increase the interfacial area between the interfaces but he assumes that there is no air trapping [1]. Then, another model is built, as known as Cassie and Baxter model to measure contact angle on rough surface. However, this time a measurement on the air trapping based on the droplet is considered and also following the Young's equation. Figure 1.3 shows the contact angle on different roughness as stated by Cassie and Baxter.

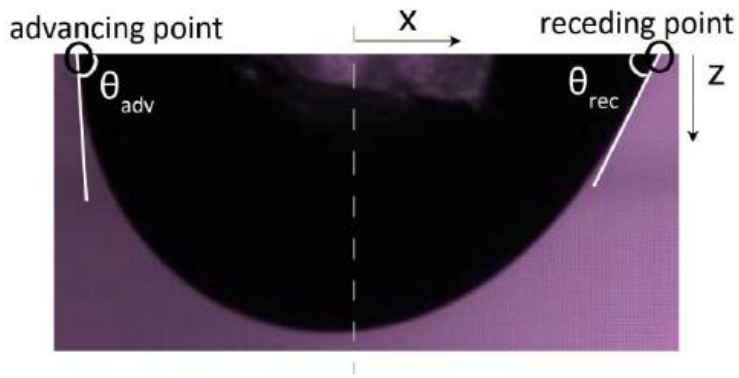

Figure 1.1: Illustration of advancing and receding angle from a droplet.

Source: [2]

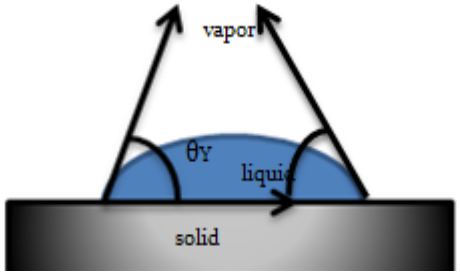

Figure 1.2: Young's contact angle.

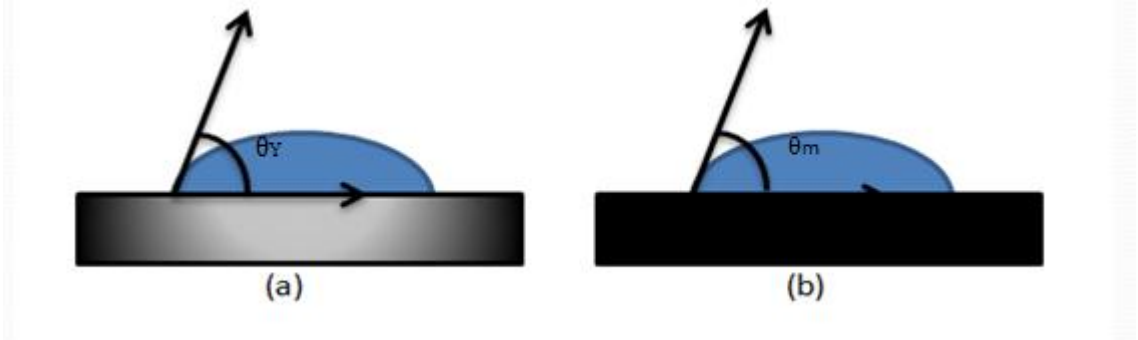

Figure 1.3: Description of contact angle on different roughness on (a) ideal surface (b) roughness surface.

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