# Study of The Correlation Between Contact Angle Values with The Polarity of Liquids

Muhammad Alwi Syahara[1], Fredy Kurniawan[1], Wahyu Anggriawan[1]

***Abstract* – Contact angle measurement is a technique which can be used to determine the surface properties of a substance and observe the interaction of surfaces. When polar liquid dropped on a non-polar solid, it will make an interaction that can observed from the contact angle. In simple way, the different polarity of the solid and the liquid sample will affect to the contact angle obtained. In this work the value of contact angle will be correlated to the polarity of the sample. The results showed that the plot between polarity parameter with contact angle on polytetrafluoroethylene substrat has a correlation which formed a sigmoidal curve with $R^2$=0,954. It means the polarity of liquids can be determined by the contact angle values.**

***Index Terms* – Contact angle measurement, polar molecule, polarity parameter, surface properties.**

## INTRODUCTION

Contact angle (θ) is the angle between the solid surface and a liquid droplet surface intersection of the lines at the contact point between [1]. Contact angle can be defined in different ways; determining the angle of droplets through the goniometer telescope (sessile drop method), captive bubble method, tilting plate method, Wilhelmy balance method, and the capillary rise method [2]. Sessile drop method is the most popular determination of contact angle, the reason is because this method requires a fairly easy stage and less of liquids and solids [3]. Generally, Contact angle measurements can be used to determine the surface tension [4][5][6], but the contact angle measurements can also be used to study the properties of molecular interactions solids-liquid (ion-dipole, dipole-dipole, and Van der Waals forces) [5]. From the molecular interaction can be taken a hypotheses that contact angle can be related with polarity of liquids.

Determination of polarity can be defined in several ways; determination of the dipole moment and dielectric constant that require experimentation and mathematical calculation through Onsager equation [7] [8] and using the solvathochromic method that using dyes and resulting polarity parameter ($E_T^N$) [9] [10]. Both of the methods seems difficult and not simple to do, so we need a breakthrough that is easy to determine the polarity of liquids by using the contact angle measuring device.

[1]Muhammad Alwi Syahara, Fredy Kurniawan, Wahyu Anggriawan are with Department of Chemistry, Faculty of Mathematics and Science, Institut Teknologi Sepuluh Nopember, Surabaya. Email: syah_azeez@yahoo.com; fredy@chem.its.ac.id; wahyuanggriawan.wa.@gmail.com.

## METHOD

### A. *Preparation of Polymer Substrat*

Polymer Substrat (polytetrafluoroethylene) must first be washed with detergent and then sonicated for 30 minutes to clean the surfaces. Then substrat dried in oven at 45 ºC for 15 minutes. Polymer substrat stored in a desiccator for 6 hours before use.

### B. *Contact Angle Measurement of Liquids*

Ten liquids with different polarity ($E_T^N$ = ± 0 - 1) was used. Polymer substrat that has been prepared, placed in the goniometer and position of the subtrat adjusted to the appearance from each camera, then the liquid dripped by syringe 25µl. Droplets that appear on each camera will be photographed. Images obtained from the camera will be processed with the software ImageJ, and its contact angle is determined by the plugin Low Bond-Axisymmetric Drop Shape Analysis.

### C. *Correlating Contact Angle Values with Polarity Parameter*

Results of contact angle measurements will be recorded and compared with the data of polarity parameter of liquids ($E_T^N$). The data obtained will be plotted to get contact angle as the function of polarity of liquid. From the plote will be drawn conclusions the relationship between contact angle and polarity parameter of liquids.

## RESULT

The polymer substrat was succesfully prepared, it was cleaned and stored at desiccator. Image of the droplets was succesfully captured and the contact angle values was measured. The image showed that droplet form varying due to the polarity of liquids (Figure 1). The lower contact angle obtained was from n-hexane ($E_T^N$ = 0,09) that is 0º and the higher contact angle obtained was from water ($E_T^N$ = 1) that is 118º.

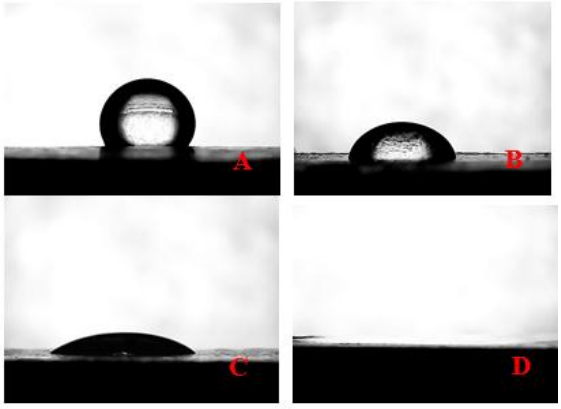


**Figure 1.** Image of liquids droplet, (A) droplet of water, (B) propylene glycol, (C) ethanol, (d) n-hexane.

The contact angle values that was obtained then compared with the data of polarity parameter ($E_T^N$) and plotted into a curve. The curve between the contact angle values and the liquids polarity parameter showed that it has a correlation. It formed a sigmoidal curve which $R^2$ is 0,954 that shown in Figure 2.

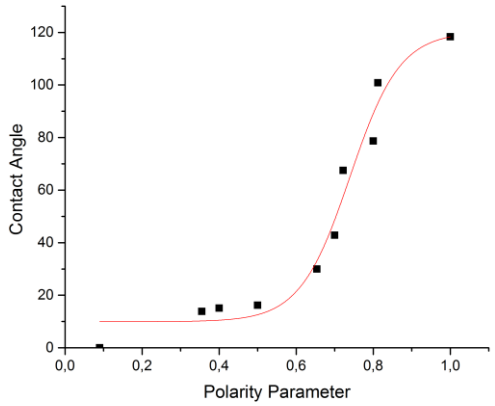


**Figure 2.** Graphic curve between contact angle (θ) values versus polarity parameter ($E_T^N$). Conclusion

The scheme of SMS fiber structure is potential for the vibration sensor which offers inexpensive and simple configuration. It was shown that the frequency measurement of 20 Hz vibration source can be carried out in a range of 0 to 30 cm with an error frequency 0.1 Hz.

## CONCLUSION

From the result known that contact angle values has a correlation with polarity parameter. The correlation can imply that the polarity of liquid can be determined using contact angle values. So that, it can be improved to be a new method to determining polarity of liquid.

## ACKNOWLEDGEMENTS

We acknowledge Ministry of Research Technology and Higher Education for the financial support. We also would like to thanks Instrumental and Analytical Sciences Laboratory of Institut Teknologi Sepuluh Nopember for providing contact angle measurement.

## REFERENCES

[1] Dionísio, M., and Sotomayor, J., "A Surface Chemistry Experiment Using an Inexpensive Contact Angle Goniometer", *Journal Chemical Education*, vol. 77, no. 1, pp. 59, 2000.

[2] Yuan, Y., and Lee, T.R., "Contact Angle and Wetting Properties", in *Surface Science Techniques*, Bracco, G., Holst, B. (Eds.), Springer Series in Surface Sciences, pp. 3–34, 2013.

[3] Chini, S.F., and Amirfazli, A., "A method for measuring contact angle of asymmetric and symmetric drops", *Colloids Surface Physicochem. Eng. Asp*., vol 388, pp. 29–37, 2011.

[4] Li, D., and Neumann, A.W., "Contact angles on hydrophobic solid surfaces and their interpretation", *J. Colloid Interface Sci*, vol. 148, pp. 190–200, 1992.

[5] Kabza, K.G., et.al. "Contact Angle Goniometry as a Tool for Surface Tension Measurements of Solids, Using Zisman Plot Method. A Physical Chemistry Experiment", *J. Chemical Education*, vol 77, pp. 63, 2000.

[6] Soon, C.F., et.al., "A Bespoke Contact Angle Measurement Software and Experimental Setup for Determination of Surface Tension", *Procedia Technol., 4th International Conference on Electrical Engineering and Informatics, ICEEI* 2013 vol. 11, pp. 487–494, 2013.

[7] Makosz, J.J., "Dipole moment of molecules determined from dielectric measurements in very dilute solutions of a dipole liquid in a nondipole liquid", *Journal Molecule. Liquid*, vol. 59, pp. 103–113, 1994.

[8] Włodarska, M., "Dipole moment calculation in solution for some liquid crystalline molecules", *J. Molecule Structure*, vol. 1059, pp. 44–50, 2013.

[9] Reichardt, C., "Solvatochromic Dyes as Solvent Polarity Indicators", *Chemical Review*, vol. 94, pp. 2319–2358, 1994.

[10] Katritzky, et.al. "Quantitative Measures of Solvent Polarity", *Chemical Review*, vol. 104, pp. 175–198, 2004.