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Interfacial Tension between Soap Water and Vegetable Oil

Inside a bulk liquid, intermolecular forces act on all sides of a molecule. Under static conditions, the net force acting on this molecule is zero; the forces are balanced out in all directions. At the interface of the liquid and immiscible gas, liquid or solid, the intermolecular forces are not balanced in all directions. This imbalance of forces result in excessive cohesive force and/or energy for the molecules at the interface and it is called interfacial tension. In the case of a liquid-air interface, the interfacial tension is called surface tension. In some applications, a high interfacial tension is not desirable. For these applications, adding surfactants to the solution often the best of choice. Surfactants are composed of two parts: a hydrophilic head and a hydrophobic tail. This combination of hydrophilic and hydrophobic components causes the surfactants to gather at the liquid interface to reduce the interfacial tension.

One method to measure the interfacial tension between two immiscible liquids is through the Wilhelmy Plate technique. The Wilhelmy Plate operates similar to the du Noüy Ring, but differs in geometry and is preferred for ease of use and increased accuracy. For interfacial tension measurements with the Wilhelmy Plate, the plate starts in the top liquid after being wetted with the bottom liquid. The plate then goes through the top liquid and approaches the bottom liquid. When the base of the plate reaches the liquid interface, the interfacial force acting on the plate is recorded.

With the force measured, the interfacial tension is determined through the following equation:

$$Eq. 1 \quad \gamma = \frac{F}{L \cos \theta}$$

Where F is the measured force, L is the perimeter around the base of the plate and θ is the contact angle between the plate and liquid. Normally, the process of pre-wetting the plate surface with the bottom liquid and the plate design satisfactorily bring the contact angle to zero. With a contact angle of zero, the interfacial tension is dependant only on the measured force and the known perimeter of the plate.

Two common immiscible liquids are vegetable oil and water. In this application study, the effectiveness of surfactant/detergent in reducing the interfacial tension of vegetable oil and water is demonstrated. The interfacial tension between vegetable oil and water solutions of different concentrations of dishwashing detergent were measured with a Wilhelmy Plate technique on a DY-700 Surface Tensiometer (Kyowa Interface Science Co. Ltd., Japan). The DY-700 has the capability to utilize either the Wilhelmy Plate or du Noüy Ring technique for surface tension or interfacial tension measurements, but as mentioned before, the Wilhelmy plate is preferred.



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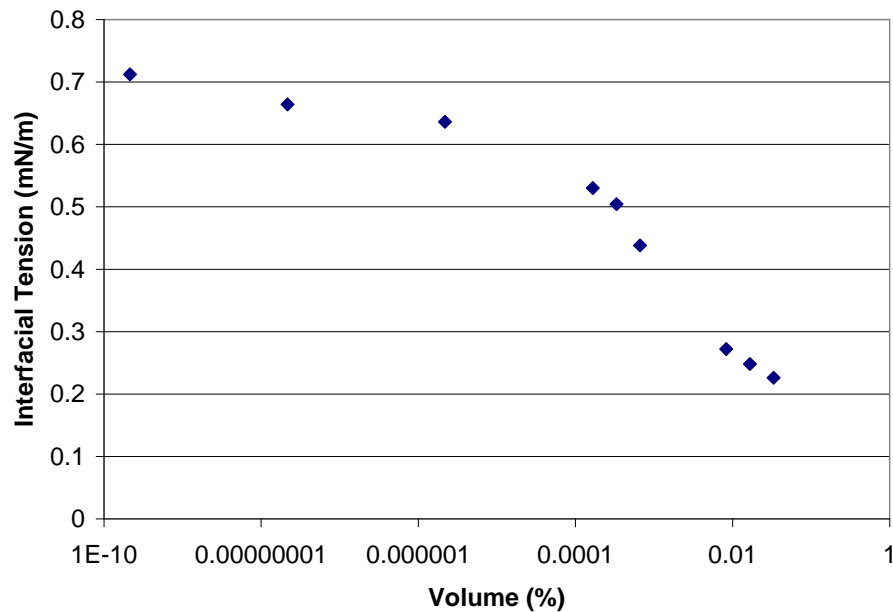


Figure 1. Interfacial tension between vegetable oil and water solutions with different concentrations of dishwashing detergent.

As can be seen from Figure 1, surfactant/detergent is effective in reducing the interfacial tension between the vegetable oil and water. Even small amounts have a considerable impact on the interfacial tension between vegetable oil and water, which is really desired for cleaning dishes after use.