A Turbidimeter for the Measurement of the Solubility of Slightly Soluble Liquids[1]

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The measurement of the solubility of slightly soluble liquids presents some experimental difficulties. This is particularly true if the interfacial tension of the system is small and, hence, the formation of dispersions of some stability is favored.

A possible method for such determinations is the measurement of the relative intensity of light scattered by the solution under investigation as a function of the amount of solute added. As long as the solute is molecularly dispersed, only a slight degree of turbidity is observed. At the appearance of droplets, however, a sharp increase of the scattered intensity should result. Thus, a plot of scattered intensity versus the amount of solute added should show a sharp break at the solubility limit. This is evidenced by the measurements made on a mixture of toluene and water which are represented graphically in Fig. 1.

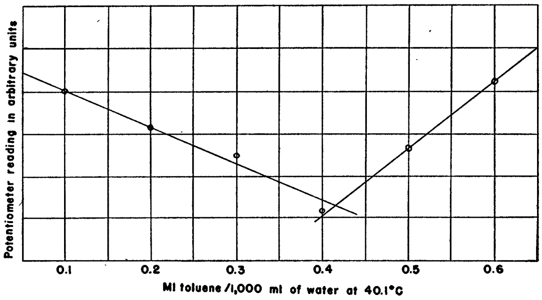

Fig. 1. Plot of the ratio of the intensities of the scattered light and the transmitted primary beam versus the volume of toluene added.

Although several turbidimeters are described in the literature (*1–4*), an apparatus of special design, illustrated in Figs. 2 and 3, was used in our experiments.

The flask selected was a 1-liter, three-necked flask. To prevent the inclusion of air bubbles, stirring was accomplished from the bottom by means of a modified 10-ml hypodermic syringe. The end of the barrel of the latter was cut off and sealed to the bottom of the flask. To the inner end of the piston of the syringe a glass propeller was fused. The outer end of the piston was drawn out and connected to the shaft of a variable-speed motor by means of a length of rubber tubing.

The heater was made by winding 7′ of Nichrome wire around a form of asbestos and inserting it into a ½″ × 6″ test tube. A variable transformer controlled the rate of heating, while a mercury thermoregulator controlled the temperature of the solution to within ± 0.1° C.

The assembly was enclosed in a wooden box, the inside of which was painted with a suspension of carbon black in lacquer in order to reduce the effect of light reflected from the walls. The primary and secondary photoelectric cells were mounted on the left side and back of the box, respectively.

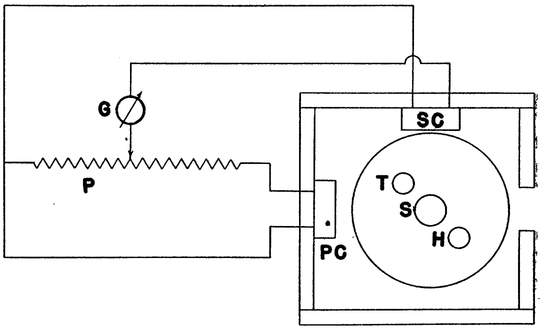

Fig. 2. Schematic representation of the electrical circuit. G, mirror galvanometer; P, potentiometer; PC, primary cell; SC, secondary cell; T, thermoregulator; S, opening for solute; H, heater.

The light source was a microscope lamp. Focusing and cooling of the light beam was accomplished by a 500-ml Florence flask filled with water.

The solute was measured and introduced through an opening in the top of the box with a 1-ml Mohr pipette.

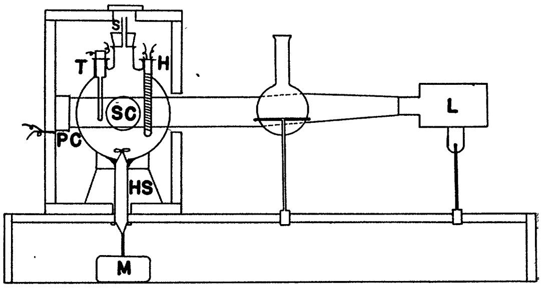

Fig. 3. Side view of the turbidimeter. S, opening for solute; T, thermoregulator; H, heater; PC, primary cell; SC, secondary cell; HS, hypodermic syringe stirrer; M, variable-speed motor; L, light source.

For the measurement of the scattered intensity a potentiometer was employed, the voltage of the photoelectric cell illuminated by the primary beam being used as a standard with which the voltage of the cell placed at right angles to it and illuminated by the scattered radiation was compared (Fig. 2).

While this turbidimeter can certainly be improved, it has proven satisfactory so far for the rapid determination of the solubilities of monomers in water and dilute soap solutions.

References

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