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THE EFFECT OF TEMPERATURE VARIATIONS ON THE DETERMINATION OF SPECIFIC GRAVITY OF GLASS FRAGMENTS

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(Here is an interesting little study of the effect of temperature variations in respect to determination of specific gravity of glass fragments. Dr. Beeman is a staff member of the University of Oregon Medical School and is affiliated with the Crime Detection Laboratory of the Oregon State Police Department.—EDITOR.)

Glass fragments obtained as evidence in criminal investigations may often yield information of value when their physical and chemical properties are compared with a suspected source in automobile accidents, burglaries, assaults and similar enterprises. One useful physical property is specific gravity.[1,2,3,4.] The most accurate method of determining specific gravity of relatively gross samples consists in weighing them in air and water at a given temperature and computing their specific gravity; the method is not applicable with small fragments. The flotation method, easily performed with small samples, consists in immersing the fragment in a medium whose density can be varied by addition of one of its components until the fragment neither sinks nor floats; the specific gravity of the medium is then determined by means of the pyknometer or Westphal balance. Besides the determination of specific gravity, comparison of this property can be made between several samples simultaneously in the same container.

The flotation methods described in the more recent literature do not stress the importance of rigid temperature control of the solutions. Tryhorn[2] states: "In making rough comparisons by this method, changes of temperature must be reduced to a minimum. This is conveniently done by immersing the test tube in a larger vessel of water at room temperature." It is our purpose to point out the magnitude of errors which are made possible by relatively slight changes of temperature.

The usual solutions used in the flotation methods cover the range of Sp. Gr. 2.0—3.2 which is sufficient for most glasses encountered in criminal investigations. Three common such media are Thoulets solution (a mixture of mercuric iodide and potassium iodide in water) having a specific gravity of about

[1] Winchell, A. N.: The Microscopic Characters of Artificial Inorganic Substances of Artificial Minerals, John Wiley and Sons, New York, 1931, page 37.

[2] Tryhorn, F. C.: J. Crim. Law & Criminol., 30, 404, 1939-1940.

[3] Gamble, L., Burd, D., and Kirk, P.: J. Crim. Law & Criminol., 33, 416, 1943.

[4] Kirk, P., and Russel, R.: Crim. Law & Criminol., 32, 118, 1941.

3.0 and diluted with water; s-tetrabromoethane (Sp. Gr. 2.9) diluted with kerosene, and methylene iodide (Sp. Gr. 3.3) diluted with ethyl acetate. The specific gravity of the above mixtures was determined by weighing them in a 10 ml pyknometer at varying temperature increments; the results when plotted approximated a straight line curve. With Thoulets solution, the loss in specific gravity was 0.001+ per degree centigrade; with s-tetrabromoethane and methylene iodide, the loss was 0.002+ per degree centigrade. When the determination of specific gravity is performed in test tubes, handling of the tubes will result in a rise in temperature of one to two degrees centigrade, depending upon the original temperature and the size of the container; this may cause a possible variation of 0.001 to 0.004 in the specific gravity of the medium. Since glass samples from similar sources (as in the same lot of bottle glass from the same manufacturer) may vary from each other only in the specific gravity in the third or fourth decimal place, definite temperature control becomes a necessity if absolute specific gravity is to be reported. For comparison of glass samples in the same container, such temperature control is unnecessary. We have found the use of a thermostatically controlled water bath at 25°C. to be convenient.

In order to avoid the tedium of carefully adding small amounts of a diluent to the medium when comparing glass samples in the same container, we have found it more rapid to roughly dilute the solution until it is slightly heavier than the fragments, and warm the container in the hand until the desired specific gravity is obtained. We do not feel that sufficient precision can be reached by applying temperature correction factors to report absolute specific gravity by this method.

In comparing glass fragments we have noted an influence of particle size to apparent specific gravity when determined by flotation methods, even when fragments from a single small source are used. A 5 mm square of microscopic slide glass, strain free by observation in polarized light, was placed in a flotation medium of the same specific gravity at a constant temperature. Fragments of the same particle were crushed, washed, and dried in vacuuo, and again placed in the medium; the particles tended to group themselves roughly according to size with no particular relationship of size to a higher or lower specific gravity. When the specific gravity of the medium was changed by addition of a diluent and returned to its original state by addition of the second component, apparent specific gravity differences in the particles of an order of about +0.001 was observed. An adequate explanation for this phenomenon requires further investigation. For this reason, we feel that the fragments being compared should be of the same approximate size.

SUMMARY

[1] In determining the specific gravity of glass fragments by flotation methods, rigid temperature control is desirable, as the common flotation media have appreciable changes in their specific gravity due to temperature variation.

[2] In comparing the specific gravity of glass fragments by flotation methods, comparable fragment sizes should be used.