BUTYL "CARBITOL" AS AN IMMERSION LIQUID

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ABSTRACT

Butyl "carbitol" [2 (butoxyethoxy) ethanol] has the following properties which make it desirable as the low index end-member of a series of immersion liquids prepared by mixing it with 1-chloronaphthalene: (1) low dispersion, (2) low temperature coefficient, (3) very stable, (4) colorless and nearly odorless. Graphs are presented showing variation of dispersion with index of refraction, and variation of index of refraction with temperature, for butyl "carbitol"—1-chloronaphthalene liquids.

INTRODUCTION

The optical properties of ideal immersion liquids have been discussed by Buerger (1933), who points out that the most desirable constituents for a set of immersion liquids should have the following properties in common: (1) equal dispersion, (2) equal temperature coefficients. It is desirable also that they have equal vapor pressures at ordinary temperatures, and good keeping qualities.

It is impossible to attain the goal of an ideal series of liquids. However, the ideal may be most closely approached if a series of liquids is prepared by mixing two miscible end-members of as widely different index as possible, provided the end-members have the necessary properties mentioned above. If the set of liquids is made by mixing only two end-members, then even though they do not have equal temperature coefficients and dispersion, these two properties will vary continuously from one end of the set to the other.

Many substances have been proposed for preparing a set of immersion liquids to cover the refraction range between 1.45 and 1.66. Butyl "carbitol"[1] [2 (butoxyethoxy) ethanol; diethylene glycol mono-butyl ether] has several properties that make it highly desirable as the low index end-member of a series of liquids in the intermediate range. A set of liquids prepared by using butyl "carbitol" and 1-chloronaphthalene (α-monochlornaphthalene) as end-members has been in use for the past three years in the Yale Mineralogical Laboratory. It has proved to be more satisfactory than any previously used.

DESCRIPTION OF PROPERTIES

Butyl "carbitol" and 1-chloronaphthalene are miscible in all proportions and when used as end-members provide a continuous series from 1.43 to 1.63. 1-bromonaphthalene would serve equally well as the higher

[1] Manufactured by the Carbide and Carbon Chemicals Corporation, 30 East 42nd Street, New York, N. Y.

end-member of the series, and its use would extend the set of liquids to 1.66.

The properties of a set of immersion liquids prepared with butyl "carbitol" and 1-chloronaphthalene are described below.

Dispersion. The dispersion of the two end-members and several intermediate members of the set was measured with an Abbé refractometer. A graph of these values (Fig. 1) shows that there is a straight line relation between dispersion and index of refraction. From Fig. 1 the dispersion of any intermediate member of the set of immersion liquids may be found.

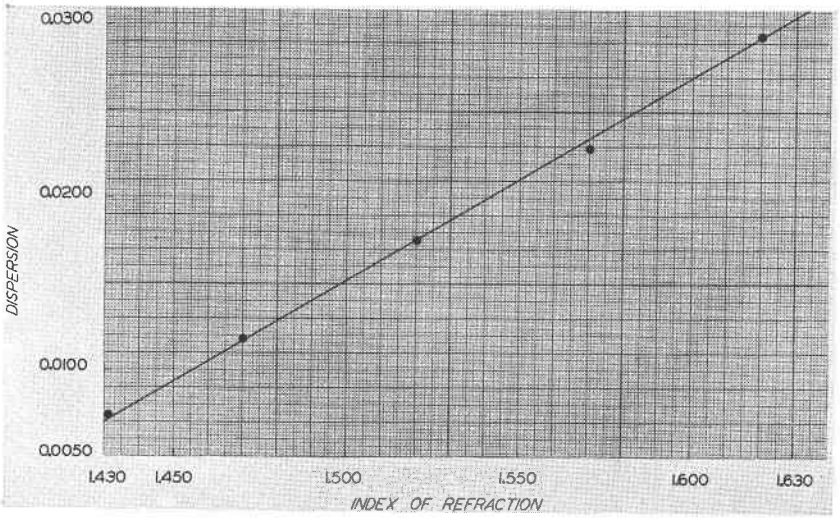

FIG. 1. Dispersion ($n_F - n_C$), plotted against index, n_D, for butyl "carbitol"—1-chloronaphthalene liquids.

Temperature coefficient. The temperature coefficient, dn/dt, was determined for the two end-members and four intermediate members of the set of index liquids. In Fig. 2 the temperature coefficient is plotted against index of refraction. From this graph dn/dt may be determined for any liquid of the set.

Stability. Butyl "carbitol" and 1-chloronaphthalene have boiling points of 231.2°C. and 281.1°C., respectively. Thus at room temperatures they must both have relatively low vapor-pressures. To test their differential rate of evaporation five cc. of several liquids of the set were placed in 75 mm. watch glasses and allowed to stand for 70 hours at room temperature. The maximum change in index of refraction was 0.003. Thus for the ordinary period of time during which immersion liquids are used on a microscope slide (during which time they are covered with a cover slip) the change in index due to differential evaporation would be negligible.

The set of butyl "carbitol"—1-chloronaphthalene immersion liquids being used by the writer has been in constant use for three years. At the time this set of liquids was prepared they were calibrated to ± 0.001. Recalibration at the end of three years has revealed a maximum change in index of 0.001, and in most cases less than this. The liquids have been stored in standard double-stoppered bottles.

Other properties. Butyl "carbitol" is a colorless, almost odorless, slightly viscous liquid. Immersion liquids prepared by mixing butyl "carbitol" and 1-chloronaphthalene are colorless and remain that way indefinitely.

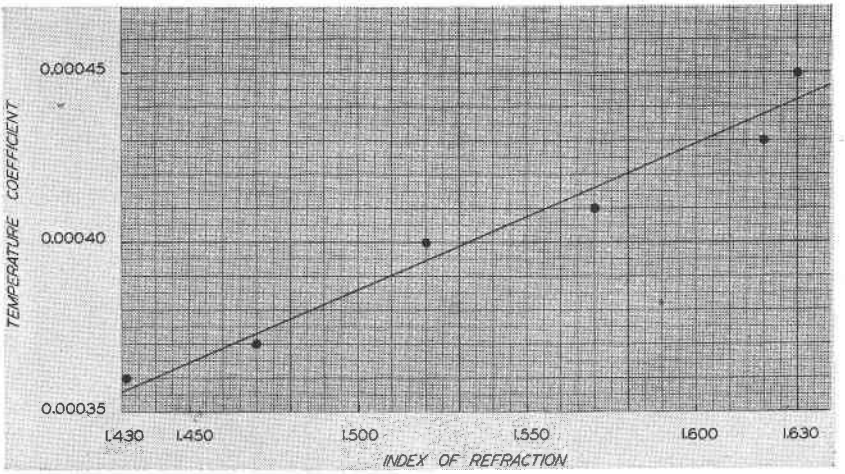

FIG. 2. Temperature coefficient, dn/dt, plotted against index, n_D, for butyl "carbitol"—1-chloronaphthalene liquids.

Butyl "carbitol" is miscible in all proportions with water. Hence by using water and butyl "carbitol" as end-members a series of liquids may be readily prepared to cover the range between 1.34 and 1.43. Liquids prepared in this way are quite stable, and very satisfactory in most respects. Unfortunately their use is limited by the fact that most minerals in this range are water-soluble.

ACKNOWLEDGMENTS

The writer learned of the possibilities of butyl "carbitol" as an immersion liquid through Dr. Harry Berman of Harvard University. Its use was suggested to Dr. Berman by Dr. C. D. West, of the Polaroid Corporation, Cambridge, Mass. Grateful acknowledgment is due Dr. West and Dr. Berman for permission to prepare this paper.

REFERENCE

BUERGER, M. J., The optical properties of ideal solution immersion liquids: *Am. Mineral.*, **18**, 325–334 (1933).