THE APPROXIMATE DENSITIES OF OINTMENTS—AMMONIATED MERCURY AND ZINC OXIDE.

BY J. A. W. LUCK.

No data seem to have been published on the density of ammoniated mercury. For zinc oxide, "Landolt and Boernstein Tabellen" give data for both the crystalline and amorphous varieties. The densities of ammoniated mercury and zinc oxide will vary considerably with different specimens, depending particularly upon the manner of their preparation. Since in the computation of the density of ointments, knowledge of the approximate density of the substances is necessary, it was thought advisable to determine these values. Obviously such a determination cannot be made in water, since ammoniated mercury reacts with water in the following manner

$$2\ HgNH_2Cl + H_2O = HgO.HgNH_2Cl + NH_4Cl,$$

while in the case of zinc oxide the reaction is

$$ZnO + H_2O = Zn(OH)_2.$$

For ammoniated mercury alcohol was chosen as the displacement liquid, and benzine for the zinc oxide. The balance available for this work was sensitive to 2.5 mg., which suffices for the approximate determination of densities. The displacement weighings were made in a thin-walled glass stoppered perfume flask.

In the indirect determination of densities the following relation exists. Let

m_a = mass of substance $\quad$ d_a = its density to be determined,
m_b = mass of an equal volume of liquid $\quad$ d_b = its density,
m_c = mass of a definite volume of liquid,
m_w = mass of same volume of water, $\quad$ d_w = its density
m_k = mass of liquid + m_a.

Therefore $m_b = m_c - (m_k - m_a)$, $m_a/d_a = m_b/d_b$, $m_c/d_b = m_w/d_w$,
since $d_b = m_b/m_a \,.\, d_a = m_c/m_w \,.\, d_w$,

$$d_a = m_a/m_b \,.\, m_c/m_w \,.\, d_w. \qquad (1)$$

In the above formula d_w is the density of water at 27° C.
d_w 27°/4° C. = 0.996539.

The masses determined by weighing against brass weights in air have to be corrected, since the flask displaces a greater volume of air than the brass weights. Let

m = mass of substance in air, d_s = its density,
m_o = mass of substance in a vacuum,
d_a1 = density of air, d_b1 = density of brass,
$m/d_s \,.\, d_a1$ = mass of air occupying the same volume as the substance,
$m/d_b1 \,.\, d_a1$ = mass of air occupying the same volume as the brass weights, (2)
then $m_o = m + m/d_s \,.\, d_a1 - m/d_b1 \,.\, d_a1$.

However, since the experimental conditions were not sufficiently accurate for the application of this correction, this correction has been neglected.

The materials used were Merck's ZnO, alcohol U. S. P. grade of unknown source, $HgNH_2Cl$ source unknown and benzine commercial grade not U. S. P.

The temperature of the liquids and room were 27° C. The densities were computed at 27°/27° C., and corrected for temperature.

DATA.

m_a	$HgNH_2Cl$	0.875 Gm.	ZnO	1.295 Gm.
m_k	$HgNH_2Cl$ and alcohol	5.35 Gm.	ZnO and benzine	5.36 Gm.
m_c	Alcohol	4.6 Gm.	Benzine	4.24 Gm.
m_w	Water	5.7 Gm.	Water	5.695 Gm.
m_b		0.125 Gm.		0.175 Gm.

$HgNH_2Cl$.

m_a Gm.	m_b Gm.	m_c Gm.	m_w Gm.	d. 27°/27° C. Alcohol.	$HgNH_2Cl$.
0.875	0.125	4.6	5.7	0.807	5.65

ZnO.

				Benzine.	ZnO.
1.295	0.175	4.24	5.695	0.745	5.51

The density of alcohol has been determined accurately at various temperatures. Amorphous zinc oxide has a density of 5.42. It will be interesting to compare the densities determined in this experiment with the values given in "Landolt-Boernstein-Roth Tabellen."

	Computed Values. d. 27°/27° C.	d. 27°/4° C.	Tabular Values. d. 30°/4°	d. 20°/4° C.	d. 25°/25° C.
Water		0.996539			
Alcohol	0.807	0.804	0.802	0.811	0.810
Benzine	0.745	0.742			
$HgNH_2Cl$	5.65	5.63			
ZnO	5.51	5.48		5.42	

It is apparent that the determined values compare favorably with previously published ones. The accuracy, however, includes only the first two figures, the second decimal place is doubtful.

When completely miscible substances are mixed the resulting volume is not necessarily equal to the sum of the individual volumes of which the mixture is composed. This is particularly true of aqueous solution, the resulting volume is less in most cases, but in a few cases greater than the sum of the volumes of the constituents.

For substances which are closely related it has been found that the physical properties are additive.

Thus, if $v_1, v_2, v_3, \ldots\ldots\ldots\ldots v_x$ are the volumes which upon mixing have a total volume V, this volume will be found to be equal to the sum of the individual volumes, *i. e.*,

$$V = \Sigma (v_1, v_2, v_3, \ldots\ldots\ldots\ldots v_x). \quad (3)$$

Substances which are not closely related show the greatest deviation from this relation. Under "closely related" are meant substances which have similar structures as the organic compounds C_nH_{2n+2}, C_nH_{2n}, C_nH_{2n-2}, etc., substances which have similar physical properties, fats, oils, etc.

Since ointment bases belong to the latter group, little or no volume changes occur upon mixing two or more of these, and, since with few exceptions no chemical reactions take place between the ointment bases and the solids which enter into their composition, the density of these mixtures can be readily determined from their individual densities. A convenient method is the graphical solution of this problem, if we construct a diagram of two related quantities, plotting one as the ordinate the other as the abscissa, for closely related substances such a plot should be a straight line. Care must be taken to choose the correct quantities as a simple calculation will show. If we consider the equation

$$VD = v_1d_1 + v_2d_2,$$

and for the sake of convenience choose 1 cc as the total volume, we may write this equation,

$$D = v_1d_1 + (1 - v_1)d_2 = v_1(d_1 - d_2) + d_2,$$

and if we plot the two variables v_1 as abscissa and D as ordinate a straight line will result. On the other hand, the equation

$$M/D = m_1/d_1 + m_2/d_2$$

will produce a curve if plotted in a similar manner. Assuming the total mass to be 1 Gm., we may write the equation

$$1/D = m_1/d_1 + (1 - m_1)/d_2, \text{ or}$$
$$1/D = [m_1d_2 + (1 - m_1)d_1]d_1d_2 \therefore D = d_1d_2[d_1 + m_1(d_2 - d_1)]$$

this is an equation of a curve (see Fig. 1).

A simple relation exists between the percentage by volume and percentage by weight and the corresponding density.

If we consider v_a the % volume of mass m_a and density d_a,
v_b the % volume of mass m_b and density d_b,
V the total volume of a mass M and density D,
$m_a = v_ad_a$, $m_b = v_bd_b$, $M = VD$.
$100 : \%m_a :: VD : v_ad_a$ or
$\% m_a = 100v_ad_a/VD$.

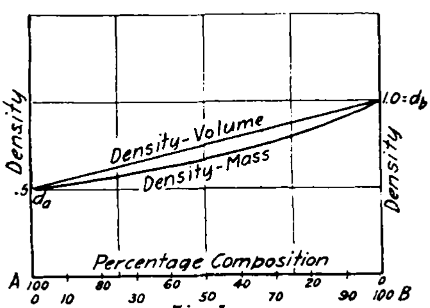


Fig. 1

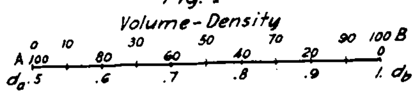
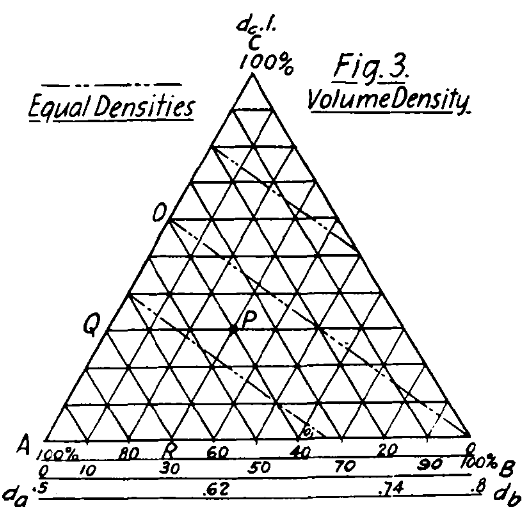


Fig. 2



A simplification in the graphical analyses of two component systems may be introduced for the percentage volume-density plots. If we plot the difference in the densities of the two components and the percentage by volume along the same straight line, Fig. 2, any point along that line will show the density of the mixture represented by that point directly, if the extremities of the line represent the densities of the pure substances.

For three component systems we may make use of the triangular diagrams introduced by Gibbs, which have been used extensively for temperature and composition diagrams of ternary alloys by Tammann and others. These diagrams are equilateral triangles, the corners represent pure substances, the sides mixtures of two components, and a point inside the triangle mixtures of three components.

Roozeboom and others have used such diagrams ruled with lines drawn parallel to the sides of the triangle. Thus in Fig. 3, a point, P, denotes a mixture of OC% of A, AR% of B, AQ% of C.

It is self-evident that lines can be drawn through the area of the triangle, each point representing mixtures having the same density. For a percentage composition by volume and density diagram it is necessary to proceed as in the two component systems. Densities may then be read off directly.

Equation 3 may be written as follows:

$$M/D = \Sigma(m_a/d_a,\ m_b/d_b,\ m_c/d_c \ldots\ldots\ldots\ldots m_x/d_x)$$

from which D may be computed for any number of components.

Using this method, the densities for ointments were calculated. The necessary data were taken from the U. S. P., U. S. Dispensatory and "Landolt and Boernstein Tabellen."

DENSITY OF OINTMENTS.

Unguentum Acidi Borici	0.86	Unguentum Aquae Rosae	0.94
Unguentum Hydrarg. Amm.	0.90	Unguentum Sulphuris	1.00
Unguentum Hydrarg Flav.	0.97	Unguentum Zinci Oxidi	1.23
Unguentum Hydrarg. Dil.	1.12	Unguentum Belladonnae	0.95
Unguentum Hydrargyrum	1.76	Unguentum Strammonii	0.95
Unguentum Iodi	1.03	Unguentum Gallae	0.93
Unguentum Iodoformi	1.01	Unguentum Acidi Tannici	0.95
Unguentum Phenolis	0.94	Unguentum Chrysarobini	0.93
Unguentum	0.93	Unguentum Picis Liquidi	0.99

In addition to the references given in this text the following sources have been used in compiling the data, "Hagers Handbuch," "Chemiker Kalender," "Olsen's Annual" and the YEAR BOOK.

SUMMARY.

Methods have been described to compute the densities of ointments and the approximate densities of nearly all official ointments have been calculated.

The density of ammoniated mercury has been determined to be 5.63 at the temperature 27°/4° C.

LONG ISLAND CITY, N. Y.

THE PREPARATION OF BENZYL BENZOATE OF HIGH PURITY.

BY W. F. KAMM AND A. O. MATTHEWS.

Benzyl benzoate has been proposed as an antispasmodic and although it is still too early to determine to what extent it is actually efficient and to what extent we may be misled by the natural enthusiasm for a new therapeutic agent, it nevertheless seemed of importance to investigate the various methods of preparation of this compound and to examine also the specifications for purity that are accepted at the present time.