

A Study of Physical Properties Relationship for Binary Mixtures of Methyl and Ethyl Alcohols

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The objective of this study was to obtain graphical representations of physical properties vs. composition for the binary system of methyl and ethyl alcohols and to do this in such a manner as to reveal similarities of linear relationships or deviations from linear relationships for the physical properties of the binary solutions. Data for a temperature of 25 degrees centigrade were accumulated from literature for the properties: density, refractive index, surface tension, vapor pressure, heat capacity, and viscosity.

It is well known by many that vapor pressure and boiling point graphs for binary solutions show relationships which are described as linear or deviations from linearity. These deviations may be to such extent that maxima or minima may be present. It is also known that similar relationships occur for other properties of solutions. The author became curious as to the nature of the relationships for the other properties of the same solutions. If linear relationships existed for one property, was such a relationship to be expected for some other properties? In order to make a comparison of properties it was considered essential to obtain properties data for the same solutions at the same temperature. The properties of the same molecular aggregate would hence be compared.

Method of Graphical Representation

The method for graphing data is similar to that for vapor pressure or boiling point vs. composition relationships for binary systems. The composition is represented on the abscissa axis with the pure components represented at the two ends and the compositions of the mixtures proportionately in between. The ordinate axis is used for the physical property variable and is spotted at two fixed points. These points are the same on all graphs for the system and represent the physical property value for each of the pure components. A linear relationship will be represented by a straight line between these points.

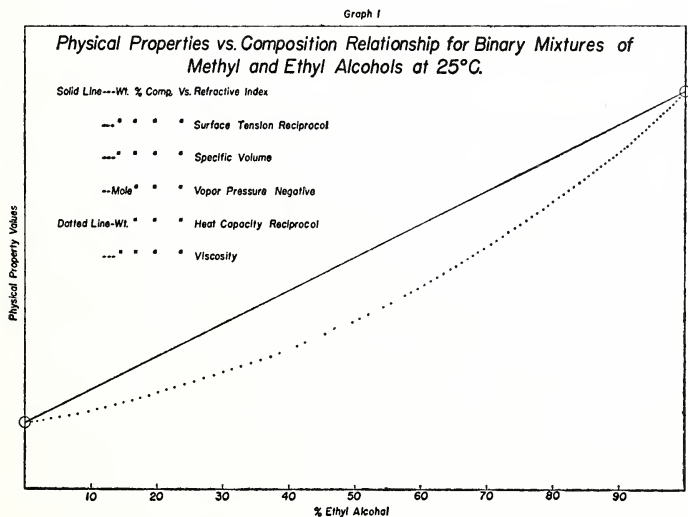
In order to obtain graphs which had the same general slope, it was found necessary to sometimes plot a function of the physical property in place of the property itself. This made it possible to have values increase in magnitude reading upward on the graph. Reciprocal and negative functions were used in this study.

Literature data gave composition values in different units. It was hence decided to leave the composition axis general in nature and indicate the composition unit by means of a solid line, dotted line, etc. Weight per cent and mole per cent units were used in this work.

Results

Data were taken from references as indicated in "Literature Cited" given at the end of this report. Refractive index values were taken from an unpublished master's thesis by Larson. The weight per cent composition

vs. refractive index relationship was linear. Surface tension data at 25°C. were interpolated from data by Morgan and Scarlett. Values for 0°C., 30°C., and 50°C. were given. The change of surface tension with temperature was found to be linear and hence extrapolation for temperature of 25°C. was valid. A plot of weight per cent composition vs. surface tension reciprocal gave a linear relationship of same slope as for refractive index relationship. Density data were obtained from reference of Herz, and Herz and Kuhn. A plotting of weight per cent composition vs. density reciprocal (specific volume) gave a linear relationship. Vapor pressure data were obtained from reference by Schmidt. Values for 25°C. were calculated from data given at other temperatures. A plot of mole per cent composition vs. vapor pressure negative gave a linear relationship. Viscosity data were obtained from references by Herz and by Bingham, White, Thomas and Cadwell. Heat capacity data were obtained from reference by Bose. It was found that a plot of weight per cent composition vs. viscosity in one case and heat capacity reciprocal in the other case, gave identical curves which were not linear but had a negative deviation from linearity.



These results may be condensed into one graph. This is shown in Graph 1 where the solid line represents the linear relationship for 1) wt. per cent comp. vs. refractive index, 2) wt. per cent comp. vs. surface tension reciprocal, 3) wt. per cent comp. vs. specific volume, and 4) mole per cent comp. vs. vapor pressure negative. The dotted line represents the relationship for 5) wt. per cent comp. vs. heat capacity reciprocal and 6) wt. per cent comp. vs. viscosity.

Conclusion

The binary system of methyl and ethyl alcohols shows linear relationships for the properties refractive index, surface tension, density or spe-

cific volume when related to weight per cent composition and also for vapor pressure when related to mole per cent composition. Heat capacity and viscosity show a small departure from linearity when related to weight per cent composition. The graphical method presented serves well for the study of deviations of the properties of solutions from linearity and also enables a condensation of data into one graph.

Literature Cited

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