ALCOHOL, WATER AND POTASSIUM NITRATE

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In the investigation here recorded we have determined the concentration-temperature curve for two liquid layers in mixtures of alcohol and water, in the presence of an excess of potassium nitrate. A serious experimental difficulty was encountered. If to a mixture of two consolute liquids a constituent soluble in one of them be added, then at some temperature there will be a separation of the two liquids into distinct layers. And usually the point at which this separation takes place can be detected with considerable accuracy by the clear solution clouding suddenly. In the case we are describing this "clouding" did not take place readily, and the temperature would frequently be carried far beyond the proper point, when two liquid layers would be found to exist without its being possible to say at what precise temperature the separation took place. It was necessary to make many determinations and with great caution; to use a large bath, to heat up the mixture very slowly, and to keep them at each temperature for a considerable time. In each case the lowest temperature noted, at which clouding took place, was selected as the true value. The determinations for one set of concentrations were made by one of us, and for the remaining set by the other. They were subsequently verified by us conjointly. Owing to the great difficulty of determining the point at which clouding took place, we do not feel justified in claiming great accuracy for our results, but do not believe that in any case the possible error amounts to 0.5° .

The alcohol was distilled from lime, and then kept in contact with dehydrated copper sulfate for several weeks, decanted and distilled with a Hempel column. It all distilled constantly, but the first and last portions were discarded. The water used

was prepared by taking about three liters of the distilled water of the laboratory, adding about 2 g potassium permanganate, and distilling. The first 500 cc was discarded; the next 500 cc was used to rinse out the receiver, a 2-liter glass-stoppered bottle which had previously been washed out with ether and alcohol. About a liter of the water was then distilled, and carefully kept until used. The potassium nitrate was recrystallized repeatedly until no traces of other salts or impurities could be detected. It was then dried, pulverized in an agate mortar and kept in a glass-stoppered reagent bottle until used.

The determinations were all made in sealed tubes, about 1.5 cm in diameter and about 20 cm in length, and terminated by a long capillary tube. These tubes were never more than one-third filled by the mixture used for the investigation. The upper part of the tube was always relatively cool, and the danger of the tube bursting reduced to a minimum. The desired temperature was obtained by immersion in a beaker containing about 2 liters of water. The thermometer was rigidly supported in the water which was constantly agitated by using the sealed tube as a stirrer. Temperatures above 100° were obtained by adding calcium chlorid to the water, until a solution with the right boiling-point was obtained. We found this a most convenient and satisfactory method for controlling the temperature. Some care must be exercised in its use, however, and if it be desired to raise the boiling-point, the salt should be carefully added, in small quantities at a time. It seems scarcely necessary to say that under no circumstances should water be added to the solution while hot.

Our tabulated results follow. The first column contains the percentage by weight of alcohol in the aqueous alcohol, the second the number of reacting weights of alcohol per hundred reacting weights of aqueous alcohol, and the third column the temperature at which the solution clouded.

pct Alc	pct R. W. Alc	Temp	pct Alc	pct R. W. Alc	Temp
13.1	5.57	106.0°	57.8	34.89	86.0°
24.9	11.48	82.5°	64.7	41.76	91.0°
35.1	17.24	80.0°	74.9	53.86	105.0°
44.8	24.10	80.5°	84.9	68.75	144.0°

On the accompanying chart the curve to the left is plotted

for molecules per 100 molecules in solution, the curve to the right for percentages by weights. From the curves it would appear that the minimum temperature at which a separation into two liquid layers would occur is 79.5°–80°, and the composition of the solution which would cloud at this point is about 39 percent by weight or 20 reacting weights of alcohol per 100 reacting weights of aqueous alcohol, the amount of potassium nitrate in solution being of course unknown.

It has seemed desirable to study the effect of an excess of two substances on a solution of two consolute liquids. We have not been able to complete our investigation in this respect for lack of time, but the following preliminary experiment indicates the desirability of further study. At what temperature a solution containing 35 percent alcohol will cloud in the presence of an excess of potassium chlorid we do not know. Certainly it

will not below 140°C as we have found by experiment.¹ But this same solution with an excess of both potassium nitrate and potassium chlorid (carefully purified) clouded at 65.5° . This point will be further investigated. Thus the addition of potassium chlorid to a mixture of aqueous alcohol saturated with respect to potassium nitrate lowers the temperature, at which this solution clouds, some 15° in spite of the fact that potassium chlorid by itself has very little effect in causing aqueous alcohol to form two liquid layers. The experimental work described in this paper has been carried on under the supervision of Dr. Frank K. Cameron.

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¹ Cf. also Snell. Jour. Phys. Chem. **2**, 457 (1898).