SOLUBILITY DETERMINATIONS OF U. S. P. CHEMICALS.

BY W. SCHNELLBACH AND J. ROSIN.[1]

THE WATER BATH AND THE AGITATION APPARATUS USED IN SOLUBILITY DETERMINATIONS.

The constant temperature water bath used was the "Freas Automatic" type. In this bath the temperature is regulated by means of a "Freas Thermoregulator" which keeps the temperature constant within plus or minus one-twentieth of a degree Centigrade. In a water bath of this type, the switchboard is usually mounted directly over the tank occupying considerable space. The heating element sockets are attached to the bottom of the switchboard. The inconvenience of this arrangement was eliminated by removing the switchboard to a position outside of the bath and running a cable from the heating elements in the bath to the socket on the bottom of the switchboard. This rearrangement (see Fig. 1) of the water bath permitted the use of an immersed agitation apparatus and, in addition, the insertion of a copper-wire test-tube rack around the inner edge of the tank. The rack was used to allow subsidence of the excess solute. Sixteen tubes could be attached to the agitation apparatus at one time, while as many as ten tubes could be placed in the rack.

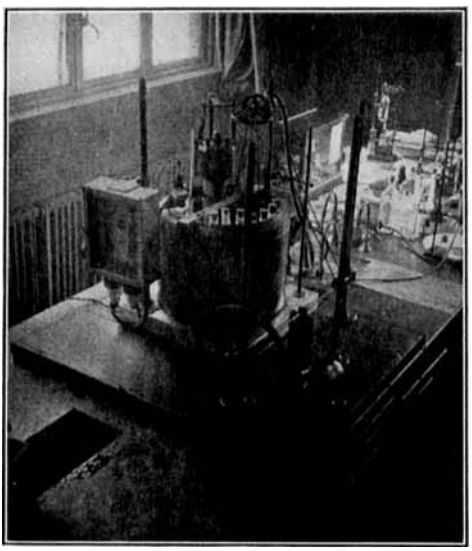

Fig. 1.

The stirrer consisted of a brass shaft carrying two brass discs. The shaft was mounted to a light frame, also made of brass. The discs were perforated so that test-tubes could be attached to both sides by rubber bands (see Fig. 2). This apparatus was entirely immersed into the water bath. A motor was used to revolve the discs at a rate which could be varied from 8 to 32 revolutions per minute by means of two cone-shaped wooden gears. The revolution of the tube, end over end, insures perfect agitation.

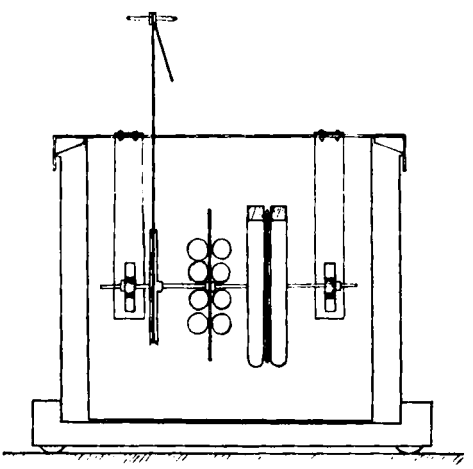

Fig. 2.

[1] Continued from JOUR. A. PH. A., 18 (1929), 762.

THE SOLUBILITY OF SODIUM SULPHATE ($Na_2SO_4.12H_2O$) IN GLYCERIN AT 25° C.

The sodium sulphate used for the solubility determination was of U. S. P. quality according to the label of the bottle and the results of the U. S. P. tests. The glycerin was also of U. S. P. quality. Its specific gravity was 1.2497 (25° C.)/(25° C.) (density = 1.246 (25° C.)/(4° C.)) which corresponds to a percentage of between 95 and 95.5 per cent of pure glycerin, the balance being water.

In determining the solubility of sodium sulphate duodecahydrate in glycerin a several-phase system is created which involves the same possibilities of change in solubility as it was the case with magnesium sulphate heptahydrate in glycerin. The aspect is discussed under solubility of magnesium sulphate (*loc. cit.*, page 770[1]). The solution of Experiment II was prepared with a small excess of sodium sulphate in order to limit the interference suspected to be caused by the water of crystallization of the excess solute. The finely crushed sodium sulphate was mixed in a proportion of 7.8 Gm. of sodium sulphate plus 92.2 Gm. of glycerin and kept at 25° C. while constantly agitated. Experiment I indicated the solubility to be close to this value. A very slight amount of solute remained undissolved after ten days. The analysis of the solution resulting from this experiment yielded results close to those of the solution prepared by the super-saturation method in Experiment I.

The solutions were analyzed by two methods. Method I is described under "Sulphate Determination" (see first paper[2]) and Method II, based upon the determination of sodium, will be described further on.

The average of all the above results is 7.52. *Conclusion: 7.52 grams of sodium sulphate duodecahydrate are present in 100 Gm. of a glycerin solution saturated at 25° C.*

Therefore: One gram of sodium sulphate duodecahydrate is soluble in 9.87 cc. (equivalent to 12.30 Gm.) of glycerin at 25° C.

SOLUBILITY DETERMINATION OF SODIUM NITRITE IN ALCOHOL AT 25° C.

The sodium nitrite used in this determination was the granular variety of U. S. P. quality. Also the alcohol applied in this determination conformed to the U. S. P. requirements. The specific gravity was 0.810 (25° C.)/(25° C.) (equal to 0.808 (25° C.)/(4° C.)) corresponding to 94.9 per cent by volume.

The sodium nitrite assayed according to the U. S. P. method 96.66 per cent of $NaNO_2$ when taken from the bottle without previous drying. On drying over sulphuric acid at room temperature it lost 1.2 per cent of weight. In addition to the U. S. P. assay the sample was also examined for nitrate, chloride and sulphate. It showed the presence of nitrate and chloride. A ten per cent solution of sodium nitrite matched the opalescence of an 0.003 per cent solution of sodium chloride on the addition of silver nitrate. The sodium nitrite contains therefore approximately 0.03 per cent of sodium chloride.

The oxidimetric method for the determination of $NaNO_2$ as given by the U. S. P. was not suitable for the analysis of the alcoholic solution produced in solubility determination. The assay method recommended for nitrates was

[1] JOUR. A. PH. A., 18 (1929), 770.
[2] *Ibid.*, 18 (1929), 766.

therefore adopted. Accordingly the nitrite was converted into NaCl by repeated evaporation of the solution after previously acidifying with hydrochloric acid. The residue was then dissolved in water and the water evaporated repeatedly until the residue was neutral to litmus paper. The resulting sodium chloride was titrated directly with tenth-normal silver nitrate solution; $^{*}K_2CrO_4$ being used as indicator.

TABLE IV.—RESULTS OF THE SOLUBILITY DETERMINATION OF SODIUM SULPHATE (Na_2SO_4-$12H_2O$) IN GLYCERIN AT 25° C.

Stated as Percentage of Solute in Solution.

Experiment.	Method of analysis.	Time of preparing solution, days. 10.	50.	74.
I				
Prepared by supersaturation method	Sulphate determination	..	7.63	..
		..	..	..
	Sodium determination	..	7.48	7.49
		..	7.49	7.49
II				
Prepared by undersaturation method	Sulphate determination	7.67	..	..
		7.33	..	..
	Sodium determination	7.61	..	..
		..	..	..

By this method the original salt assayed a total of 98.44 per cent of $NaNO_2$ including the nitrate and chloride. The actual percentage of $NaNO_2$ may be calculated as follows: 98.41 (= 98.44 −0.03 chloride) per cent include sodium nitrite and sodium nitrate which is also calculated as nitrite. Stating the composition of the commercial sample of sodium nitrite as known from the obtained data, 0.36 per cent remain to make 100, viz.: 98.41 ($NaNO_2$ and $NaNO_3$ calculated as $NaNO_2$) + 0.03 (NaCl) + 1.20 (loss of weight on drying) = 99.84. The 0.36 per cent are obviously nitrate oxygen. The sodium nitrite analyzed contains, therefore, a percentage of nitrate which is equivalent to 0.36 Gm. of oxygen. $O : NaNO_3 = 0.36 : x$.−x = 1.91 Gm. of $NaNO_3$ which is equivalent to 1.51 Gm. of $NaNO_2$ in which form the nitrate was calculated with the analyses. The original salt contains, therefore, approximately (98.41 −1.55 =) 96.86 per cent of $NaNO_2$. This result conforms fairly close to the oxydimetric assay.

TABLE V.—RESULTS OF THE SOLUBILITY DETERMINATION OF SODIUM NITRITE IN ALCOHOL AT 25° C.

Stated as Percentage of Solute in Solution.

Experiments.	Time of preparing solution, days. 2.	4.	9.
I	1.398	1.398	...
Prepared by undersaturation method	(1.420)	(1.420)	...
	1.408	1.401	...
	(1.430)	(1.423)	...
II	1.485	1.460	1.403
Prepared by supersaturation method	(1.509)	(1.483)	(1.425)
	1.434	1.444	...
	(1.457)	(1.467)	...

The average of the results of Experiments I (2 and 4 days) and II (9 days) is 1.424. *Conclusion: 1.424 grams of sodium nitrite (of the above stated composition) are present in 100 Gm. of U. S. P. alcohol solution saturated at 25° C.*

Therefore: One gram of sodium nitrite (of the above stated composition) is soluble in 85.43 cc. (equivalent to 69.03 Gm.) of U. S. P. alcohol at 25° C.

The results of solubility determination shown in Table V were calculated based on the argentometric analyses of the original salt. The values in parenthesis represent the corresponding amount of sodium nitrite of the above stated composition, 98.44 Gm. of $NaNO_2$ found argentometrically being equal to 100 Gm. of the commercial sodium nitrite.

SOLUBILITY DETERMINATION OF ARSENIC TRIOXIDE IN WATER AND GLYCERIN AT 25° C.

The arsenic trioxide used for this determination was of U. S. P. quality. It was in the form of a fine powder appearing crystalline under the microscope. On drying over sulphuric acid the loss was negligible. Two methods were used in analyzing the solutions obtained in the solubility determinations. The first method was used for the aqueous solutions only. It consisted in evaporating the solution and drying the residue to constant weight at 100° C. The second method was the titration with tenth-normal iodine solution. This method was used for both the aqueous and the glycerin solution. The tenth-normal iodine solution was standardized against a tenth-normal arsenic trioxide solution prepared from arsenic trioxide analytical chemical.

SOLUBILITY IN WATER.

The rate of solubility in water is rather slow even at first, but a constant increase of the concentration is observable. The difference in concentration between 32 and 131 days is very small indicating that the point of saturation was practically attained. A definite saturation point, however, has not been reached. Based upon the figure obtained from the last analysis, after 131 days, the solubility may be stated approximately as follows: *1.99 grams of arsenic trioxide are present in 100 Gm. of an aqueous solution, nearly saturated at 25° C.*

Therefore: One gram of arsenic trioxide is soluble in somewhat less than 49.4 cc. (equivalent to 49.3 Gm.) of water at 25° C.

TABLE VI.—RESULTS OF THE SOLUBILITY DETERMINATION OF ARSENIC TRIOXIDE IN WATER AT 25° C.

Stated as Percentage Solute in Solution.

Experiment.	Method of analysis.	Time of preparing solution, days. 27.	30.	36.	131.
Prepared by undersaturation method	Iodometrically	1.439	...	1.901	1.986
		1.446	...	...	...
	Dried at 100° C.	...	1.725	1.923	...
		...	...	...	...

SOLUBILITY IN GLYCERIN.

Solution in this solvent is also slow. The excess solute turned slightly gray after remaining in contact with the solvent for six months. After eight months contact with frequent shaking the solution was kept for several weeks in the rack

to allow subsidence of the excess solute. The solution remained quite strongly opalescent and did not become clear on repeated filtration. It was suspected that part of the solute was suspended in the solution in a finely divided form. This assumption is supported by the high analytical result obtained from this solution. In extrapolating the curve which is obtained on plotting the analytical result after 27 and 93 days and after 3 months, a concentration of nearly 18 per cent is to be expected for a period of 8 months, but the result was 23.37 per cent. This result was not included in the calculation. The concentration found after six months and the extrapolated value for an eight months' period both show no evidence to represent saturation, but they are evidently very close to this point. They illustrate the slow solution of arsenic trioxide in glycerin.

TABLE VII.—RESULTS OF THE SOLUBILITY DETERMINATION OF ARSENIC TRIOXIDE IN GLYCERIN AT 25° C.

Stated as Percentage of Solute in Solution.

	Time of preparing solution.			
	Days.		Months.	
Experiment.	27.	39.	6.	8.
Prepared by undersaturation method	10.18	13.95	16.88	23.39
	10.21	13.70	15.89	23.32
	...	13.62	...	23.42
	...	13.67	...	...

The solubility may be approximately stated as follows: *15.88 grams of arsenic trioxide are present in 100 Gm. of a glycerin solution nearly saturated at 25° C. Therefore: One gram of arsenic trioxide is soluble in somewhat less than 3.9 cc. (equivalent to 4.8 Gm.) of glycerin*[1] *at 25° C.*

THE QUANTITATIVE DETERMINATION OF SODIUM.

In determining the sodium content of a salt or a solution the method of Barber and Kolthoff[2] was applied. This method is based upon the precipitation of sodium as sodium-zinc-uranyl acetate. The reagent is made up from two solutions, *A* and *B*. Solution *A* contains 10 Gm. of uranyl, acetate dihydrate, 6 Gm. of a 30 per cent acetic acid, and sufficient water to make 65 Gm. Solution *B* contains 30 Gm. of zinc acetate trihydrate, 3 Gm. of a 30 per cent acetic acid, and sufficient water to make 65 Gm. The chemicals are dissolved in the solvents with the aid of heat, the solutions then mixed and allowed to stand for 24 hours, and finally filtered.

The solutions to be analyzed should contain not more than 8 mg. of Na in 1 cc. To effect complete precipitation of the sodium, 10 cc. of reagent is added to each cc. of the solution, and the mixture allowed to stand for half an hour. In the case of glycerin a longer time is required as is shown subsequently. The precipitate is collected on a pledget of cotton[3] in a "cup funnel"[4] attached to a suction

[1] The glycerin was the same sample used in the solubility determination of sodium sulphate.

[2] *Jour. Am. Chem. Soc.*, 50 (1928), 1625.

[3] The previous treatment of the cotton with the reagent and the washing solutions in the order followed in washing the precipitate, was found to be necessary, for the weight of the cotton increased by about 5 per cent, evidently by absorption of reagent. Alundum-crucible filters are suggested to overcome this trouble.

[4] For description of the "cup funnel" see under "Sulphate Determination," *loc. cit.*, 766.

pump, washed five to ten times with 2-cc. portions of the reagent then with 95 per cent alcohol previously saturated with sodium-zinc-uranyl acetate. Finally the alcohol is removed by washing with ether and the precipitate dried by drawing air through the funnel. The precipitate is weighed after standing for ten minutes in the balance case.

One milligram of sodium yields 66.88 mg. of sodium-zinc-uranyl acetate. The weight of the precipitate, multiplied by 0.01495 (= (1/66.88)) represents the quantity of sodium (Na) present.

In analyzing the solution resulting from the determination of the solubility of sodium sulphate in glycerin it was found, that the sodium-zinc-uranyl acetate was not completely precipitated after standing for half an hour. Glycerin evidently retards the precipitations. The following data illustrate the retarding effect of a 20 per cent aqueous glycerin:

Time in minutes.	30	40	45	80	180
Gm. of precipitate obtained from equal amounts of solution	0.1823	0.1899	0.1909	0.1914	0.2010 0.2007

COMMENTS ON THE U. S. P. X TEST FOR RHAPONTIC RHUBARB.*

BY R. A. KONNERTH AND R. E. SCHOETZOW.

A lot of Rhubarb which macroscopically closely resembled the Rhapontic variety recently was brought to our attention.

The U. S. P. X test for Rhapontic Rhubarb was applied with negative results. The same determination was made on a sample of true Rhapontic Rhubarb and much to our surprise this also failed to produce a positive reaction.

The German Pharmacopœia was then consulted and by following the technic therein described, crystalline precipitations were obtained in the Rhapontic as well as in the sample under examination.

We wish to point out that the U. S. P. X test for Rhapontic Rhubarb is not reliable.

The U. S. P. sets a time limit of 24 hours. We found that by the U. S. P. X test, Rhapontic Rhubarb requires more than 24 hours for the crystallization of Rhaponticin. Under certain conditions no crystallization occurs. The container in which the test is set aside for observation should be described since the reaction may be overlooked if allowed to take place in a separatory funnel. Crystallization is more readily detected when the test is run in a (1 x 8") test-tube.

We urgently recommend the U. S. P. adoption of the method given in the German Pharmacopœia: "Deutsches Arzneibuch," 6 Ausgabe (1926), 584.

Below are given the two methods for the detection of Rhapontic Rhubarb as outlined in their respective pharmacopœias:

GERMAN PHARMACOPŒIA.

Five grams of powdered Rhubarb are refluxed on the steam bath for 15 minutes with 22 cc. alcohol (68% vol.), filter to exhaustion and wash residue with 22 cc. hot alcohol (68% vol.).

* Scientific Section, A. PH. A., Rapid City meeting, 1929.