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Roger Worden Lee

Prairie View State Normal and Industrial College

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THE SOLUBILITY OF METALLIC
SALTS OF SOME ORGANIC ACIDS IN A
METHYL ALCOHOL-ACETONE MIXTURE

By

ROGER WORDEN LEE

A THESIS IN CHEMISTRY SUBMITTED IN
PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR
THE DEGREE OF
BACHELOR OF SCIENCE

IN THE
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INTRODUCTION
and
DISCUSSION

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INTRODUCTION
and
DISCUSSION

The writer of this thesis is interested in the investigation of this subject because of the numerous metallic salts of the organic acids known to the chemist. These salts under investigation, including many others, are of great importance in the process of life. Moreover, salts of organic acids are important, in that, they are used in the preparation of various organic compounds and finally, a group of them belongs to those household substances which go under the common name of "soap." In both the plant and the animal kingdom salts of organic, as well as inorganic, acids are necessary. In view of this fact it is vitally important to know just how soluble these salts are; in what solvents are they most soluble, and what properties ~~de~~ they possess that influence their solubilities.

In order to get a clear idea of this piece of work it will be necessary to get a good understanding of solubility. A substance is commonly said to be soluble, or to dissolve in a liquid, when it disappears in the liquid phase; the product is called a solution, and the liquid which effects the dissolution is the solvent.

The solubility of a solid, or liquid substance, or the degree to which a substance is soluble in a given liquid, is usually expressed as the number of grams of solute which will dissolve in one hundred grams of the solvent, or the number of gram molecules of the solute which will dissolve in 100 grams of the solvent.

Many solvents are known to the chemist at present, but water is the most commonly used one by him, and also the only solvent which is of any substantial importance in the economy of nature. The mixture used in this determination as a solvent, methyl alcohol-acetone, has not been used to any great extent by the chemist. A review of scientific literature available revealed only one reference to the use of a methyl alcohol-acetone mixture as a solvent.

Henstock(4) determined the solubility of 66 metallic and ammonium salts of various organic acids in a methyl alcohol and dimethyl ketone mixture at 15 degrees, and at the boiling point of alcohol. He found that the more oxygen contained in the molecule the less was the solubility, being the opposite condition to that with water as a solvent. An exception was the

greater solubility of salicylates than benzoates, a fact attributed to the presence of the OH group in the salicylates. In general the higher the atomic weight of the metal the less the solubility of its salts in methyl alcohol, although lead acetate, mercuric acetate and mercuric cyanide were striking exceptions. The solubilities of most sodium salts were below those of potassium, yet the latter crystallized more readily. Two salts seemed to be anomalous, calcium lactate forming a more definite solvate while ammonium salicylate showed a chemical change.

In the determination of these solubilities, nine metallic salts or organic acids were used. They were: mercuric acetate, lead acetate, sodium acetate, potassium acetate, sodium oxalate, potassium oxalate, calcium lactate, sodium benzoate, and sodium salicylate. The temperatures at which the solubilities were determined were 5, 10, 15, and 25 degrees centigrade.

The procedure of the experiment was as follows: a mixture of equal quantities of methyl alcohol and acetone was used. In a small bottle a small quantity

of the finely powdered salt (about ten grams) was placed, and to this was added about forty cubic centimeters of the methyl alcohol-acetone mixture. The bottle containing the salt plus the solvent mixture was then fitted with a stirrer. The mixture was stirred vigorously for about sixty minutes. All of the undissolved salt was allowed to settle out. The mixture was adjusted to the desired temperatures by means of water bath, and the mixture allowed to come to equilibrium. At each temperature ten cubic centimeters of the supernatant liquid were withdrawn by means of a pipette, to the end of which was attached, by rubber tubing, a short glass tube filled with cotton to act as a filter. This mixture was transferred to a clean weighed weighing bottle and weighed immediately. Because the mixture is highly volatile rapid weighing was necessary.

After the bottle plus the solution had been weighed the density of the solution was calculated. The mixture was transferred to a clean evaporating dish and evaporated to dryness on a water bath. The dried solid residue was weighed and the solubility was calculated

in grams per one hundred grams of solvent. This procedure was followed for each salt.

There are many factors generally considered to influence the solubilities of the salts. Namely, the molecular weights, the atomic weights of the metals present in the salts, the influence of the percentage of the metal present and the influence of the OH group.

The molecular weights of the salts exhibit some influence on these solubilities. Those salts having the lower molecular weights were, generally, more soluble. Potassium oxalate was an exception being more soluble than sodium oxalate.

It was found that the atomic weights of the metals present in the salts had no great effect upon the solubilities, the condition being more or less opposite to that found by Henstock (4).

In noting the effect of the oxygen on the solubilities, it was found that those salts which contained more oxygen were less soluble. This condition is just the reverse when water is used as a solvent, which coincides with Henstock's conclusion.

The solubilities of the salts tend to decrease with

a decrease in the percentage of the metal in the molecule, sodium acetate being an exception.

Comparing sodium benzoate and sodium salicylate, sodium salicylate possessed a much greater solubility than the former due to the presence of the OH group in the salicylate. This conclusion also coincides with that of Henstock.

On the following pages will be found the tables ~~and graphs~~ showing the solubilities of the salts at the designated temperatures determined in grams per one hundred grams of solvent.

SUMMARY CHART

Reliability per 100 Grams of Sample

Densities of the methyl alcohol-acetone mixture were determined for the temperatures used in this investigation using the Westphal balance.

Results are shown below.

TEMPERATURES	DENSITIES
5 degrees centigrades	-----.7552
10 " "	-----.7542
15 " "	-----.7532
25 " "	-----.7440

SUMMARY CHART

Solubility per 100 Grams of Solvent

NAME OF SALT	TEMPERATURE			
	5°C.	10°C.	15°C.	25°C.
Mercuric Acetate	5.07	5.20	5.42	5.91
Lead Acetate	3.33	3.36	3.38	3.66
Sodium Acetate	7.66	7.67	7.69	8.54
Potassium Acetate	1.28	1.31	1.45	1.45
Sodium Oxalate	.026	.044	.043	.067
Potassium Oxalate	54.16	55.08	56.70	56.83
Calcium Lactate	.254	.274	.349	.392
Sodium Benzoate	3.23	3.38	3.59	3.63
Sodium Salicylate	35.16	35.42	41.00	46.83

SAMPLE DATA SHEET AND CAL-
CULATION

TEMPERATURE	5°C	10°C	15°C	25°C
Volume of Solution	10cc	10cc	10cc	10cc
Weight of bottle plus solution	18.8303	18.7904	18.7261	18.7880
Weight of bottle	10.5291	10.5291	10.5291	10.5291
Weight of solution	8.3012	8.2613	8.1970	8.2589
Weight of dish plus residue	2.1684	2.1764	2.1897	2.2287
Weight of dish	1.7674	1.7674	1.7674	1.7674
Weight of residue	0.4010	0.4090	0.4223	0.4613
Weight of solution minus weight of residue	7.9002	7.8523	7.7747	7.7976
Weight of residue	5.07	5.20	5.42	5.91
Weight of mixture				

SUMMARY CHART

NAME OF SALT	MOLECULAR WEIGHT	SOLUBILITY 25°	ATOMIC WEIGHT OF METAL	OXYGEN (PERCENT)
Lead Acetate	379.3	3.66	207.22	16.9
Mercuric Acetate	318.7	5.91	200.61	20.0
Calcium Lactate	219.08	0.392	40.08	43.82
Potassium Oxalate	184.2	56.83	39.1	38.47
Sodium Salicylate	160.1	46.83	22.997	29.9
Sodium Benzoate	144	3.63	22.997	22.22
Sodium Acetate (.3H ₂ O)	136.1	8.54	22.997	58.77
Sodium Oxalate	134	0.067	22.997	47.75
Potassium Acetate	98.1	1.45	39.1	32.6

SUMMARY AND CONCLUSION

1. The solubilities of various metallic salts of organic acids in a methyl alcohol-acetone mixture have been determined at 5, 10, 15, and 25 degrees centigrade.

2. According to this investigation there is a decrease in solubility with an increase in oxygen content. An exception is that of sodium acetate, probably due to the presence of the OH group in the form of water in the hydrated molecule.

3. Apparently the atomic weights of the metal in the salt has no effect upon the solubility.

4. The solubility of the salts tends to decrease with a decrease in the percentage of the metal in the molecule. A possible exception would be the case of sodium acetate.

The greater solubility of the salicylate, ^{COMPARED} to that of the benzoate is due to the presence of the OH group.

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BIOGRAPHY

Roger Worden Lee, son of Mr and Mrs. Lamar Lee, born September 9, 1900 in Oakland, Colorado County, Texas. He entered school in the Oakland Public school at the age of seven years. After finishing the Oakland Public School it became necessary for him to remain out of school for a period of seven years, And during this period his desire for higher learning did not decrease.

In September 1923 he entered Prairie View State Normal and Industrial College as Junior Academy. He finished Senior Academy in May 1925. Again there came an interruption in his quest for learning, and he had to discontinue his study for two years. He returned to the same college in September 1927. It was during this school year that he began his study of chemistry in which he became interested.

In September 1928 he became a teacher in the Okland Public School and returned to Prairie View in June 1929, where he met Miss Josie Arnita Porche whom he married in May 1930. He has continued his study through the summer sessions in Prairie View State Normal and Industrial College.

Accepted
7/30/37

