THE REACTION OF SODIUM CHLORIDE IF ADDED TO A SOLUTION OF LITMUS AND MERCURIC CHLORIDE[1]

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It has been known for many decades that an aqueous solution containing either equivalent amounts of mercuric chloride and sodium chloride or sodium chloride in excess, does not change the color of blue or violet litmus, whereas a solution of corrosive sublimate alone has an acid reaction. I was indeed able to convince myself that red, violet or blue litmus did not react in any way with a solution containing mercuric chloride and sodium chloride, if the latter was present in an equivalent proportion or in excess to mercuric chloride.

This phenomenon has been explained on the ground that chloride of sodium and bichloride of mercury form a double salt, $HgCl_2.NaCl.H_2O$, the reaction of which is neutral. For this reason further study and experimentation will be required to find an adequate explanation for the reaction to be described in the following.

It has been of great convenience to me in the course of my researches that I found a method which enabled me to obtain, whenever needed, a standard violet solution of litmus. By dissolving in a diluted solution of blue litmus some sulfate of zinc, we obtain a liquid which has exactly the same violet color as the best neutral tincture of litmus (for example, Kahlbaum's of the same dilution).[2] If the blue solution of litmus is not too concentrated, and if the sulfate of zinc has not been used too much in excess, no precipitate will form. By recurring to this method it will be made possible for every laboratory to use neutral solutions of litmus, possessing exactly the same shade of color.

In order to carry out successfully the reaction which forms the subject-matter of this communication, the following requisites should be kept ready on hand:

1. Two test-tubes of small caliber (about 1 cm. in diameter), each containing about 5 cc. of water.
2. A saturated solution (15–20°) of chloride of sodium.
3. A small measuring cylinder containing about 1.25 cc. of this saturated sodium chloride solution.
4. A filtered solution of 2 g. of blue litmus in 30 cc. of water. It is advisable to dissolve the litmus in warm water (50°).
5. Crystallized sulfate of zinc.
6. A solution of 1 drop of concd. hydrochloric acid in 40 cc. of water.

[1] From a paper read before the Chemical Society of Leningrad, on March 4 and April 1, 1926.

[2] I do not know whether this fact is known to chemists or not.

7. A 2% aqueous solution of bichloride of mercury.
8. Neutral violet litmus paper of the best sort.

Care must be taken that the chloride of sodium which is used here should be of absolutely neutral reaction, so that its saturated solution does not change the color of neutral litmus paper one way or the other. It sometimes happens that even "pure" sodium chloride shows a slightly alkaline reaction if tested with violet litmus paper. In such cases a saturated solution of the salt must be mixed, drop by drop, with a solution of one drop of hydrochloric acid in 40 cc. of water until sensitive neutral litmus paper, when moistened with the liquid, does not assume a tint of blue.

The reaction itself is carried out in the following manner. Five cc. of water is mixed first with 1–2 drops of the blue litmus solution, and then with some crystallized sulfate of zinc. We thus obtain a standard violet solution of litmus. Now we add to another 5 cc. of the diluted blue litmus solution, drop by drop, the above-mentioned solution of one drop of hydrochloric acid in 40 cc. of water, until the two liquids possess exactly the same color. The second 5 cc. of the neutral violet litmus solution is now mixed with 4–5 drops of a 2% aqueous solution of bichloride of mercury, whereupon the mixture at once becomes reddish. On quickly adding to this reddish liquid about 1 cc. of a saturated sodium chloride solution, the mixture, against all expectation, does not assume its original violet color, *but turns blue.*[3]

For properly estimating the shades of color of these various liquids it is necessary to use test-tubes of a small caliber and to hold them above the level of the eyes, so that the sky shines through the liquid. It need hardly be mentioned that this reaction must be carried out by daylight, the use of artificial light being very misleading.

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Supplementary Note on the Reaction of Sodium Chloride with a Solution of Litmus and Mercuric Chloride.—Using the same quantities of the two solutions, sodium chloride and mercuric chloride, as in the original experiment, it makes no difference whether the mercuric chloride is added to the sodium chloride, or the sodium chloride to the mercuric chloride, as long as the litmus is added *last.* In both cases the solutions exhibit a neutral reaction.

If the original experiment is modified by varying the time allowed for the interaction of litmus and mercuric chloride from nearly zero minutes to several hours, the solution, on adding sodium chloride in excess, turns just as blue as in the original reaction. Even when the liquid containing litmus and five drops of the 2% solution of mercuric chloride was boiled for a few seconds the characteristic blue reaction with sodium chloride did not fail to take place.

[3] After a few seconds the liquid gradually turns violet.

Only the best kind of litmus should be used, a diluted solution of which has a genuine blue color. It must be mentioned that the degree of blue produced by the sodium chloride is a shade less intense than that produced by adding potassium hydroxide to a neutral violet solution of litmus.

An adequate explanation of the *modus operandi* of the reaction between sodium chloride and litmus + mercuric chloride must account for the following facts.

1. The reaction takes place only if *first* the mercuric chloride has come in contact with the litmus.

2. The blue color produced by the sodium chloride is not lasting; in a few minutes the liquid assumes a violet color.

3. The blue color of the reaction is a shade less deep than the one produced by potassium hydroxide; the solution possesses a tint of lilac, which is not noticed if potassium hydroxide is used instead of sodium chloride.

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THE CRYSTAL STRUCTURES OF MERCURIC AND MERCUROUS IODIDES

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Introduction

Since the determinations of the crystal structures of the mercury iodides here described were completed (in the summer of 1925) other investigators, as shown below, have published x-ray analyses of these substances, their conclusions being substantially in accord with our own. It seems desirable, nevertheless, to publish in brief form our measurements and deductions as they afford an independent confirmation of the results obtained, as our methods of obtaining and utilizing the data differ from those employed by the others, and as our structure determinations are more nearly unique.

This research was carried on while the senior author was a National Research Fellow at the California Institute of Technology. Some of the apparatus used was bought with the aid of a grant to Dr. A. A. Noyes from the Carnegie Institution of Washington. We wish to express our thanks for this aid and also to thank Dr. R. G. Dickinson for the use of apparatus designed by him and for personal instruction in methods of crystal-structure analysis.