

Chemistry. — *The salting out of gelatin sols by salt mixtures.* By E. H. BÜCHNER and G. POSTMA. (Communicated by Prof. F. A. H. SCHREINEMAKERS.)

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Some time ago, the salting out of agar sols by mixtures of two salts was studied.¹⁾ It was now thought necessary to carry out an analogous investigation of the behaviour which gelatin sols would show in this respect. It is the object of the present communication merely to put on record the results obtained, which will be more fully treated in Mr. POSTMA's thesis.

In principle, the same experimental method was followed as in the previous communication. A solution of sodium sulphate and a solution of an other sodium salt, both of which had a known concentration, were mixed and so much water was added as necessary to make up to 7 cc. The whole was given to 3 cc of a gelatin sol, made by dissolving 1 gram of commercial gelatin in 100 cc water. Several mixtures with varying proportion of the salts having been made, the mixture was noted, which caused immediately the appearance of an opalescence in the gelatin sol as well as that which exactly failed to do so. The difference in composition between these two mixtures did not exceed 0,1 cc or 0,03 mol Na₂SO₄. As it was necessary to use the strongest solutions possible, the measurements were made at 40°. With the view to easily preparing the mixtures of the two salt solutions, some of which would have crystallised out on cooling, two burettes were placed within a wide glass tube, that could be heated above 40° by an electric current flowing through a wire that was wound externally round the tube.

Although the p_H of the mixture has been shown to have a great influence on the salting out of the gelatin,²⁾ no special measures were taken to make all experiments at the same p_H . All solutions being prepared with the ordinary distilled water of the laboratory and the same gelatin being used, it may be safely assumed that, at least in the experiments with strictly neutral salts, the p_H was approximately equal. In a few cases, it was determined and found to be about 6.

The results obtained are represented in the accompanying diagram in the same way as was previously done with the agar sols. The only difference is that the points in the present diagram represent the mixtures which exactly failed to cause the opalescence. This, however, is quite

¹⁾ BÜCHNER and KLEYN, *These Proceedings*, **30**, 740, 1927.

²⁾ BÜCHNER, *Rec. Trav. Chim.* **49**, 1150, 1930.

irrelevant, if only general conclusions about the effect of salts on agar and gelatin are sought.

When comparing the results with those obtained by BÜCHNER and KLEYN, it is at once seen, that the sequence of the salts is exactly the

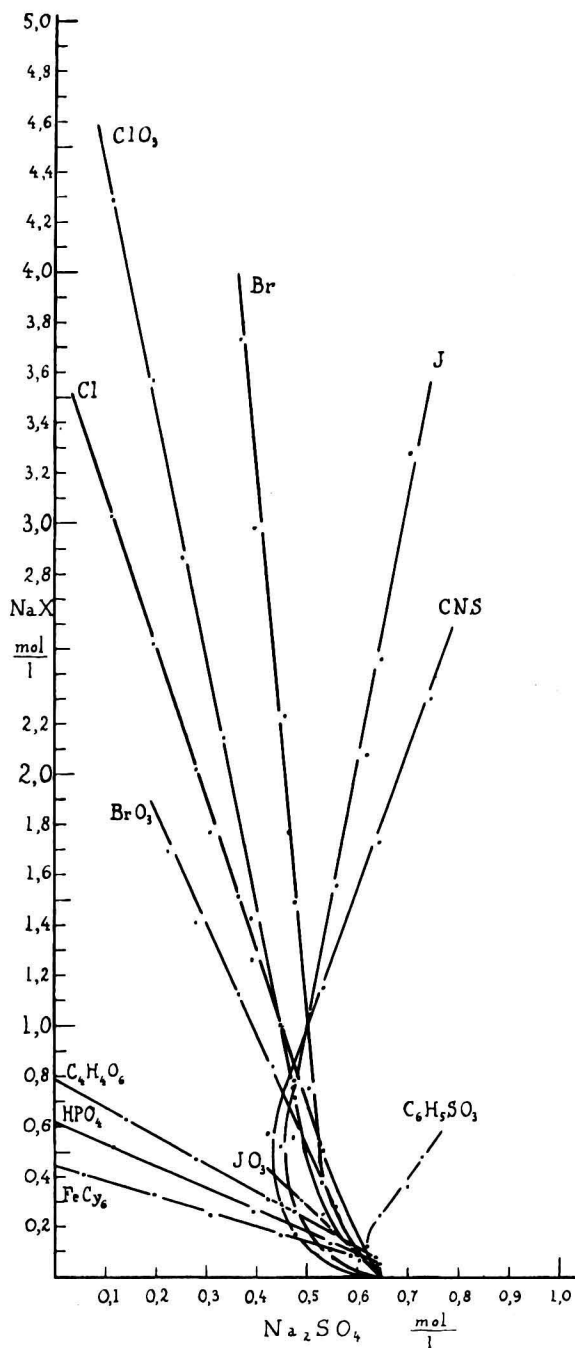


Fig. 1.

same, and that the additive behaviour of the more concentrated solutions observed with the agar sols exhibits itself also in the present case ¹⁾. It may be said, therefore, that a determined quantity of sodium sulphate may be replaced by a definite quantity of another sodium salt, but the relation between these quantities appears to differ, when different colloids are taken. So with agar sols, 0,1 mol of sodium sulphate may be replaced by 0,15 mol of tartrate, whilst with gelatin sols 0,1 mol of sulphate is equivalent to 0,11 mol of tartrate. Still greater differences are encountered, if the lines for the chloride and all salts lying in the diagram on the right side of the chloride are taken in comparison. Whereas these salts counteracted the sodium sulphate in the case of the agar sols, most of them act in the same sense as the sulphate with gelatin sols. In the latter case, only the iodide, the thiocyanate and the benzenesulphonate show the antagonistic effect noted for so many salts with the agar sols. Therefore, the conclusion as to the existence of two groups of salts, that was suggested by BÜCHNER and KLEYN, wants to be modified; when passing from one colloid to another, a salt also may pass from the anti-group to the salting out group. This is the more surprising as it was shown that the groups as distinguished with the agar sols, almost exactly agreed with those found in swelling experiments with gelatin ²⁾. It had therefore been expected that the agreement would have been complete when the salting out effect on gelatin sols was measured.

On the other hand the different directions of the lines for NaBr and for NaI are in agreement with the fact, that according to previous observations gelatin can be salted out by NaBr, but cannot by NaI. Another interesting result, which showed itself already with the agar sols, is confirmed with the gelatin sols and is here even more distinctly and generally to be seen. The curves which are at the higher concentrations of the second salt straight lines, are, when only small quantities of the second salt are present, curved and, very curiously, in different senses for the salts with a strong salting out power and for those having a small or even contrary effect. As is seen from the diagram, the first three curves are concave to the x-axis; the following ones are convex and show a stronger curvature as their salting out power decreases. In connexion herewith, attention may be drawn to the curious fact that a salt like thiocyanate which exhibits at higher concentrations an antagonistic effect, has at very small concentration the strongest salting out effect of all salts tried. Consequently, the lyotropic series is at small concentrations, at least partially, reversed, as has already been observed by others ³⁾,

¹⁾ An excellent proof of this fact is given by the experiments with ferrocyanide, phosphate and tartrate, the salting out power of which could be determined separately with the pure salts.

²⁾ BÜCHNER, *Rec. Trav. Chim.* **46**, 439, 1927.

³⁾ HÖBER, *Physik. Chem. der Zelle*, 5th ed., 324; LENK, *Biochem. Zschr.* **73**, 15 and 58 (1916).

but it is very curious that this phenomenon occurs equally distinctly when the salts are dissolved in water, and so to say, in a solution of an electrolyte. The latter one appears to have no specific influence on the behaviour of the other salts; its effect consists only in diminishing the quantity necessary for salting out the gelatin.

Attention may also be drawn to a few special points. In connexion with the desire of comparing the halides and the halogenates, the iodate, which was not used in the former investigation, was also tried. Although this salt is not very soluble, it is seen that the sequence of the halogenates is exactly the reverse of the order of the halides, the difference between the extreme terms being smaller in the former case. This may perhaps be explained by considering that the halogen atom in the halogenate is to a certain measure enveloped by the oxygen atoms, the properties of the halogen atom being thereby more or less masked.

The benzenesulphonate was investigated as this salt is known to exhibit a remarkably great influence on the swelling of gelatin. In agreement with its promoting effect on swelling, it was found to have a very great antagonistic effect on the salting out.

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