THE SOLUBILITY AND REVERSION OF CALCIUM AND POTASSIUM METAPHOSPHATES
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Since the passage of the Tennessee Valley Authority Act of 1933, authorizing improvements in fertilizer production, the Authority has produced, along with other fertilizers, considerable quantities of concentrated fertilizers, containing over 50% \( \text{P}_2\text{O}_5 \), presenting a decided advantage to farmers in that they have three to four times more plant nutrients per ton than ordinary commercial superphosphate. Thus, the costs of handling, bagging, storing, shipping, and spreading are greatly reduced.

Field yield comparison tests of the new metaphosphate fertilizers have been conducted on a wide scale, but the physical and chemical properties of the metaphosphates have not received much attention. This is due primarily to the fact that the metaphosphates have a strong tendency to polymerize into complex products with high molecular weights and their commercial importance did not warrant the necessary research. However, in recent years the use of metaphosphates as fertilizers, water conditioners, emulsifying agents, and detergents has stimulated new interest in these materials (2, 3, 9, 10).

With most metaphosphate compounds, the product formed is dependent on the method and conditions of production and on the subsequent treatment of the product. Consequently, various polymerized products with entirely different properties can be readily prepared (1, 2, 3, 9, 10). For this reason, much of the earlier work on metaphosphates reported in the literature presents conflicting results or is fragmentary in scope.

The preparation and some of the chemical and physical properties of potassium metaphosphate have been studied by Madorsky and Clark (9). They report a melting point of 806.8° C and a solubility of 0.0041 gram per 100 ml of water at 25° C for the crystalline potassium metaphosphate produced by the reaction of \( \text{KCl} \) with phosphoric acid at high temperatures.

The production and some of the chemical and physical properties of calcium metaphosphate have been investigated recently by several workers (1, 2, 3, 4, 8). Maclntire, et al. (8) reported that quenching the calcium metaphosphate melt results in greater solubility and accelerated hydrolytic transition.

It was the purpose of this investigation to study the solubility of potassium and calcium metaphosphates in water and weak salt solutions and to follow the reversion of the metaphosphate to the orthophosphate form by this treatment, i.e.,

\[
\text{MPO}_3^+ + \text{AgNO}_3 \rightarrow \text{AgPO}_3 + \text{MNO}_3
\]

\[
\text{MH}_2\text{PO}_4 + \text{AgNO}_3 \rightarrow \text{Ag}_{2}\text{PO}_4 + \text{MNO}_3
\]

\[
\text{HNO}_3 + \text{NaOH} \rightarrow \text{NaNO}_3 + \text{H}_2\text{O}
\]

The solution was then cooled, neutralized to cresol green endpoint with strong \( \text{NaOH} \), and titrmetrically to \( \text{pH} 4.6 \) with dilute \( \text{NaOH} \) or \( \text{HNO}_3 \). Excess of \( \text{AgNO}_3 \) and the amount of 0.0592N \( \text{NaOH} \) required to bring the solution to \( \text{pH} 5.5 \) determined. Each M.E. of \( \text{NaOH} \) was equivalent to 0.0153 gram of phosphorus in some orthophosphate form, i.e.,

\[
\text{PO}_3^- + \text{H}_2\text{O} \rightarrow \text{H}_2\text{PO}_4^-
\]

The solution was then cooled, neutralized to cresol green endpoint with strong \( \text{NaOH} \), and titrmetrically to \( \text{pH} 4.6 \) with dilute \( \text{NaOH} \) or \( \text{HNO}_3 \). Excess of \( \text{AgNO}_3 \) and the amount of 0.0592N \( \text{NaOH} \) required to bring the solution to \( \text{pH} 5.5 \) determined. Each M.E. of \( \text{NaOH} \) was equivalent to 0.0153 gram of phosphorus in some orthophosphate form, i.e.,

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