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METHOD OF PRODUCING CONDENSED PHOSPHORIC ACIDS

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2 Claims. (Cl. 204—103)

This invention relates to a novel method for producing condensed phosphoric acids.

It has now been found that phosphoric acids can be condensed electrolytically. More particularly, it has been found that more highly condensed phosphoric acids can be produced from less highly condensed phosphoric acids by electrolyzing the less highly condensed acids, thereby producing the more highly condensed acids and evolving hydrogen and oxygen.

All phosphoric acids can be represented stoichiometrically as combinations of H_2O and P_2O_5. The mole ratio of H_2O to P_2O_5 can be utilized to characterize the degree of condensation of such acids—the lower the ratio, the greater the degree of condensation. For example, orthophosphoric acid (the least condensed of any of the acids) has a mole ratio of H_2O/P_2O_5 equal to 3, pyrophoric acid a ratio of 2, tripolyphosphoric a ratio of 5/3, the metaphosphoric acids (both linear and cyclic) a ratio of 1, and the ultraphosphoric acids ratios between 1 and 0. The limiting case of highly condensed acids is that of pure phosphorus pentoxide, which has an H_2O/P_2O_5 ratio of 0. The present invention deals with the production of phosphoric acids (including mixtures thereof) having lower H_2O/P_2O_5 ratio, from acids having higher H_2O/P_2O_5 ratios.

The present process can be carried out in a simple and straightforward manner by inserting electrodes into the phosphoric acid to be electrolyzed and passing a direct current between the electrodes. The process can be operated over a wide range of current densities, varying from infinitesimal to extremely high values such as 1000 amperes per square foot. Selection of a particular current density will depend primarily upon economic considerations, but in general current densities falling between about 1 and about 200 amperes per square foot of cathode surface will be found most practical.

Preferred electrolytes for the present invention are those made up of essentially 100 percent phosphoric acid (or acids). Thus, the electrolyte will be one in which the mole ratio of H_2O/P_2O_5 is equal to three or less—i. e., not greater than 3. Aqueous solutions of

phosphoric acids can be utilized, but in such a case there will be a preliminary period in which only the aqueous solvent will be electrolyzed to produce essentially 100 percent phosphoric acid before the electrolysis of the acid will take place. Non-aqueous solutions can also be utilized, provided the decomposition potential of the solvent is substantially higher than that of water.

In the case of electrolysis of orthophosphoric acid, the principal electrolytic reaction may be represented as follows:

$$2H_3PO_4 \rightarrow H_4P_2O_7 + H_2 + \tfrac{1}{2}O_2$$

In general, the present electrolysis process will produce a mixture of condensed phosphoric acids, which can be resolved into its various components if the individual species are desired in more pure form.

The following example will serve to illustrate the electrolytic process of the present invention:

Example

Two platinum electrodes (each of 0.00625 square foot surface area) were immersed in 100% orthophosphoric acid at room temperature, and direct current passed between the electrodes through the electrolyte for a period of about ten hours. During this time the current density was varied between 1000 amperes per square foot (of cathode surface) and 30 amperes per square foot, the average current density being somewhat in excess of 200 amperes per square foot. During this period the average chain length of the acid increased from 1 phosphorous atom per molecule to about 3.5 phosphorus atoms per molecule. In order to determine if any substantial reduction had taken place along with the condensation, the electrolyte was analyzed for trivalent phosphorus before and after the electrolysis. It was found that the ratio of trivalent phosphorus to pentavalent phosphorus had only increased from 0.0143 to 0.0228.

This application is a continuation-in-part of my earlier copending application Serial No. 542,500, filed October 24, 1955, now abandoned.

I claim:

1. The method of preparing a condensed phosphoric acid by passing a direct current between non-reactive electrodes through a less condensed phosphoric acid having a mole ratio of H_2O/P_2O not greater than 3.

2. The method of preparing polyphosphoric acids from orthophosphoric acid, which method comprises passing a direct current between non-reactive electrodes through said orthophosphoric acid in an electrolyte having a mole ratio of H_2O/P_2O_5 not greater than 3.

References Cited in the file of this patent

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