

Ceramics

Numerous phosphates are used in the processing of various ceramic products from whiteware to refractory products to specialty cements to specialty glasses to ceramic glazes and enamels. Phosphates are used as both processing aids in the manufacture of many of these products and to provide key functional properties that improve the final product characteristics of the ceramic and its end-use performance. Most notably, phosphates provide for the bonding phase in many ceramic systems.

Polyphosphates as a product family are principally used as processing aids in the manufacture of many of the starting raw materials/minerals used in ceramics, and then subsequently, in the preparation of ceramic product formulations that go through a liquid phase during manufacture. Sodium Hexametaphosphate (SHMP) and Sodium Tripolyphosphate (STPP) are characteristically used as deflocculants in the mining and processing of clay minerals and then again as dispersants in preparing slurries for whiteware, glaze, and enamel manufacture. Other polyphosphates sometimes used to help control ceramic product slurry viscosity, dependent upon the matrix minerals present, are Tetrasodium Pyrophosphate (TSPP), Tetrapotassium Pyrophosphate (TKPP), and Potassium Tripolyphosphate (KTPP). The use of polyphosphates for slurry viscosity control is also sometimes supplemented by the use of orthophosphates as Disodium Phosphate (DSP) and Trisodium Phosphate (TSP) as buffering agents to help control slurry pH and improve slurry stability. Wet process cements use STPP as a dispersant to aid when they are mixed with water to improve their pump-ability and to reduce the attendant water requirements.

Many orthophosphates are used to provide functional properties to ceramic product systems. Acidic orthophosphates are commonly used in the manufacture of various refractory systems because of their ability to provide low temperature chemical bonding that when subsequently exposed to high temperatures form higher strength ceramic bonds. Phosphoric Acid is used as the bonding phase in the manufacture of many high alumina based refractory systems. For specialty cast or rammed aluminosilicate refractory systems, liquid Aluminum Phosphate, 50% acid solution (LAP), is also used. Monopotassium Phosphate (MKP) is used for the manufacture of monolithic magnesia refractories as used for steel manufacture. Monoammonium Phosphate (MAP) has been used in the manufacture of cordierite refractory systems. Phosphate bonded refractories have very good resistance to molten metals and related slags. Phosphoric acid and LAP are used for bonding silica to produce molds used for metal castings. As noted above for whiteware ceramic systems, polyphosphates are also used in manufacture of slurried refractory products as a viscosity control agent and, then subsequently become part of the high temperature bonding phase.

Specialty cements take advantage of the room temperature chemical bond formed when acid phosphates react with alkaline earth based minerals such as those containing lime and magnesia. Solid acidic phosphates including MAP, Diammonium Phosphate (DAP), and MKP are used in the manufacture of specialty magnesia cements known for their very fast setting times and high strength properties. These acid orthophosphates are also used in making calcium, aluminum, and zinc phosphate specialty cements. TKPP is used to retard the setting of Portland cements to provide for additional working time.

Orthophosphates are commonly used to formulate various specialty glass and ceramic glazes. Phosphates are used to provide fluxing properties and to provide unique optical property characteristics. Monocalcium Phosphate (MCP), Dicalcium Phosphate (DCP), and Tricalcium Phosphate (TCP) are used in the formulation of opal glasses and high quality porcelain glazes and enamels. DCP and TCP are used for the manufacture of many bioceramic materials as used for bone replacement and prosthesis. The sodium, potassium, and ammonium orthophosphates are used in the manufacture of optical glass filters and rare earth laser glasses. Specialty (metal-metal) sealing glasses use these orthophosphates in formulating the base glass matrix. Here phosphates are used because of their fluxing properties and the matching thermal expansion properties of the glass to metals.