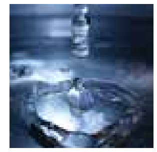
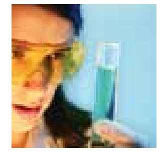
CARUS
WATER


Phosphates in Drinking Water FAQ's

PHOSPHATES

TECHNICAL INFORMATION

INTRODUCTION

Phosphates have a long history of successful application in drinking water treatment, providing both primary and secondary benefits. Phosphates are widely used by facilities to help meet regulatory rules and to produce better quality drinking water that will meet public expectations.

WHAT ARE PHOSPHATES?

Phosphates are water treatment chemicals used to solve specific water quality problems resulting from inorganic contaminants (iron, manganese, calcium, etc.) in ground water supplies and also to maintain water quality (inhibit corrosion, scale, biofilm, reduce lead and copper levels) in the distribution system. Orthophosphate and polyphosphate are two general types used in water treatment along with many different phosphate compounds that exist for use in the water treatment process. Ortho and polyphosphates work together, stabilizing water quality and minimizing color, scale, deposits, corrosion, and chlorine demand in drinking water systems.

ARE PHOSPHATES NEW CHEMICALS?

Elemental phosphorus was discovered in 1669, but commercial production of orthophosphate did not begin until about 1850 when phosphoric acid was used for fertilizer. Polyphosphate was first described in 1833, but not until 1929 was it used as a sequestering agent that formed soluble complexes with metallic ions in water. In the 1960's orthophosphate was combined with zinc salts to produce zinc orthophosphate (ZOP) corrosion inhibitor. ZOP was patented and used extensively to control corrosion in water systems. The EPA Lead and Copper Rule (1991) identified ZOP as a 'best available technology' (BAT) to minimize the leaching of lead from water lines and brass fixtures into the drinking water. Today various blends of phosphates, both orthophosphate and polyphosphate, were recognized as multi-functional chemicals used to sequester metals and inhibit corrosion.

WHAT ARE THE PROBLEMS PHOSPHATES HELP TO SOLVE?

Phosphates are used in municipal water systems to perform three broad functions: inhibit corrosion of water mains/plumbing (iron, steel, galvanized, asbestos/cement, lead, copper), sequester nuisance metals in the water supply (iron, manganese, calcium, magnesium). They can also improve the quality of water in the distribution system by removing scale deposits & tuberculation, discourage microbial film formation/regrowth, and stabilizing free chlorine disinfectant residuals.

HOW WIDELY ARE PHOSPHATES USED IN WATER SYSTEMS?

Estimates suggest that 15-20% of public and private water systems use some form of phosphate in the treatment of their drinking water. Groundwater supplies use polyphosphate to sequester iron, manganese, calcium, and magnesium, while surface plants use orthophosphates, ZOP, or blends of phosphates to inhibit corrosion in the distribution system. All systems can use phosphates to meet the EPA regulations on Lead and Copper.

ARE PHOSPHATES A CURE-ALL?

Rarely is a single treatment process or chemical additive a cure-all. Any chemical used in water treatment may have particular advantages or disadvantages. Water quality and treatment methods vary greatly. However, application of phosphates has been considered one of the most cost effective means of controlling a multitude of problems. The American Water Works Association Research Foundation (AWWARF) and the EPA have reported that corrosion control (phosphate use included) provides numerous health and consumer benefits at a rate of return much greater than the original cost of the additive. EPA Lead & Copper Rule Guidance suggest that annual expenditures of $200 million/year on corrosion inhibition yields approximately $4.3 billion in consumer benefit (20-fold increase).

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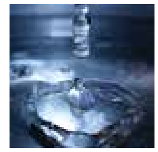

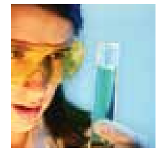

HOW DO PHOSPHATES WORK IN A WATER SYSTEM?

Orthophosphate based additives are classified as corrosion inhibitors and as such react with dissolved metals (e.g. Ca, Mg. Zn, etc.) in the water to form a very thin metal-phosphate coating or they react with metals on a pipe surface to form a microscopic film on the inner surface of the pipe that is exposed to the treated water. Polyphosphate type chemicals react with soluble metals (iron, manganese, calcium, magnesium, etc.) by sequestering (bind-up) the metals to maintain their solubility in water. The phosphate sequestering process minimizes the risk of discoloration, staining, scaling, taste/odor and other water quality complaints.

HOW EFFECTIVE ARE PHOSPHATES AT CONTROLLING COLOR?

Color in a water system may be the result in the precipitation of soluble iron/manganese when they react with dissolved oxygen, chlorine disinfectant, and other oxidizing agents during water treatment. Polyphosphates bind-up the Fe/Mn, keeping them in solution and preventing the color from initially forming. Another source of color is the natural release of soluble iron by-products that appear to be 'bleeding' from the scale deposits (tuberculation) inside water pipes. Polyphosphates bind with soluble iron before it turns color (precipitates), while orthophosphates react with the pipe surface to slow down pipe corrosion and the release of corrosion particulates. Blended mixtures of ortho/polyphosphates control both sources of potential color at the water supply and in the distribution system.

DO PHOSPHATES AFFECT TRIHALOMETHANE (THM) FORMATION?

The primary cause of THMs is pre-oxidation, with chlorine, of raw water that contains organic precursors. The presence of biological regrowth (biofilm) inside water pipes is another source of organic precursors. After chlorine reacts with organic material, THMs may form. Alternative disinfectants or treatment adjustments will often reduce THM formation. However, phosphates also contribute to lowering system THMs. Phosphates inhibit corrosion effectively in a lower pH (7-7.5) range. THM formation potential is significantly reduced when water is chlorinated at a lower pH (< 8.0). Phosphate inhibitors/sequestering agents minimize corrosion by-product scale formation inside the pipe, thereby keeping the pipes cleaner and free of the biofilm that may generate additional organic precursors if left uncontrolled.

WHAT OTHER BENEFITS OF PHOSPHATE TREATMENT EXIST?

Phosphates easily adapt to any pre-existing water quality without changing the water chemistry. Referred to as inhibitors (ortho), sequestrants (poly), or blends (ortho/poly), phosphates have a selective function, yet wide range of performance. Primary treatment benefits include: corrosion control, lead/copper control, sequestration of iron/manganese, control of calcium carbonate scale, and water softening, etc. Many secondary benefits develop, such as: reduced chlorine demand due to corrosion inhibition and sequestration of Fe/Mn, lower color and turbidity in the distribution system, less staining, removal of system scale deposits, control of biofilm regrowth, lower TOC, fewer system coliform violations, increased C-factors and hydraulic flow rates in system, reduced electrical demand, fewer main breaks, better valve operation, improved meter accuracy, increased revenue, reduced hydrant flushing frequency, less wasted water during flushing, less maintenance and service expenditures, fewer complaint calls, and overall improved consumer satisfaction.

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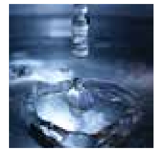
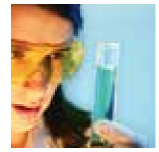


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ARE PHOSPHATES SAFE AND APPROVED FOR WATER SYSTEMS?

Various forms and purity grades of phosphates exist. Most dry powders and liquid concentrates are safe to handle and store, except for the standard precautions required for orthophosphate acids and zinc orthophosphate solutions. All Carus phosphate additives are either food quality grade or certified to ANSI/NSF Standard 60 Drinking Water Treatment Chemicals as approved for use in potable drinking water. Safety Data Sheets (SDS) are available for all Carus products.

HOW MUCH PHOSPHATE IS REQUIRED TO PROVIDE EXPECTED RESULTS?

The most effective dosage rate is determined by running a complete water analysis to determine the total demand of the finished water and the consumption rate of the distribution system. The ANSI/NSF Standard #60 authorized listing of all certified drinking water treatment chemicals has limited the application of inorganic phosphates at 10 mg/L as total phosphate ion. In most cases, this is not a health related or safety limitation, but a practical guideline for the maximum required quantity of phosphate typically applied in drinking water. Most ground and surface water supplies contain naturally occurring phosphate at low levels. However, additional phosphate chemicals (1-5 mg/L) are added to control most Fe/Mn, scale or corrosion concerns. There are 20 distinct phosphate species listed by ANSI/NSF Standard 60 for use in drinking water with many more proprietary phosphate blends available on the market. Carus Corporation is a leading manufacturer of 80 types of generic and blended phosphates for use in food processing and drinking water. Carus Laboratory staff provide analytical services, feasibility studies, and dosage evaluations for your water system.

HOW ARE PHOSPHATES FED?

Phosphate based corrosion inhibitors are injected via a chemical metering pump into finished water separate from other chemical additives (chlorine, fluoride, caustic soda, etc.). They selectively react with iron, copper, lead, zinc, and calcium to form an insoluble protective film of metallic-phosphate that passivates new or pre-corroded piping surfaces in the distribution system.

Sequestering agents are injected via a chemical metering pump at the well head prior to other chemical additives (chlorine, fluoride, caustic soda, etc.), or, if permissible, down the well casing to mix with groundwater at the pump intake. Carus polyphosphates selectively react with Fe, Mn, Ca, and Mg ions to maintain a color-less soluble molecule that resists precipitation caused by aeration, disinfection, oxidation, storage and transmission of finished water. Carus Technical Service staff provide on-site evaluations, water testing, and treatment recommendations.

HOW ARE PHOSPHATE DOSAGES CONTROLLED?

Since phosphates do not change water chemistry, measuring phosphate in the raw and finished water is necessary to monitor the dosage rate. Orthophosphate ion ($PO4^{-}$) is the most common species used to measure the initial and total quantity of phosphate in the water. Orthophosphate can be measured on a cold-water sample, while the total phosphate requires a digestion step to break down all other forms of phosphate to the ortho form. Simple field test kits or laboratory analytical equipment can be used to monitor all forms. Subtracting the initial orthophosphate quantity from the total phosphate yields the quantity of polyphosphate present in the finished water (Total-Ortho=Poly).

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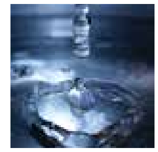
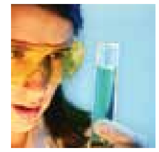


WHAT HAPPENS IF PHOSPHATE IS OVERFED?

An overdose of phosphate is difficult to detect immediately unless orthophosphate is being monitored in the finished water. Too much orthophosphate typically will not result in a water quality problem unless calcium hardness reacting with the phosphate begins to form a slight turbidity during the film formation process inside the system. Excessive polyphosphate dosage may result in an accelerated cleaning of scale and tuberculation from the pipe surface, resulting in colored water, turbidity or suspended solids.

HOW IS PHOSPHATE PACKAGED AND SHIPPED?

Dry powder, granular or crystalline phosphates are packaged in plastic lined paper bags (50 lb.) or HDPE pails to minimize caking. Carus liquid phosphates are packaged in HDPE pails (5 gallon) and drums (15, 30, 55 gallon) or shipped in food quality stainless steel tanker trucks (3000-4000 gallons).

WHERE DO I OBTAIN MORE INFORMATION ON PHOSPHATE?

Phosphate product standards are available from AWWA in Denver, Colorado.

Carus phosphates are listed with ANSI/NSF Standard 60 the accepted health-effect standard for drinking water additives. Information is available from the National Sanitation Foundation in Ann Arbor, Michigan.

Application information is available from the local regulatory agencies, local chemical distributors, and consulting engineers or directly from Carus Corporation, producer of the AQUA MAQ® blended phosphates, CALCIQUEST® water treatment chemicals, and CARUS™ water treatment chemicals.

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