Phosphoric acid

Processing

Identification

Chemical Names phosphoric acid
Other Names: Orthophosphoric acid; also metaphosphoric acid and pyrophosphoric acid.

CAS Numbers: 7664-38-2
Other Codes:

Recommendation

Synthetic / Non-Synthetic:	National List:	Suggested Annotation:
Synthetic (consensus)	*95%+=Not allowed 50%+=Not allowed Cleanser, Sanitizer, Disinfectant=Allowed (Consensus)*	*ACS or USP grade orthophosphoric acid may be used to clean food-contact surfaces and equipment. (Consensus)*

Characterization

Composition H_3PO_4

Properties:
Phosphoric acid is a colorless, odorless solution that is about 85-87% by weight in all commercial strengths with an approximate Molarity of 14.7 to 15.2. It is further diluted to different concentrations depending upon usage applications. Strongly acidic. Corrosive to concrete, most metals, and fabrics.

How Made:
Phosphoric acid can be made in two ways, either the wet process or the thermal (furnace) process. In the wet process, mined phosphate ore is treated with sulfuric acid and then the resulting phosphoric acid is separated from the calcium sulfate crystals produced. The chemical reaction is the following:

$$(PO_4)_2Ca_3 + 3H_2SO_4 + 6H_2O \text{ --> } 3SO_4\,Ca \cdot 2H_2O + PO_4\,H_3$$

This process conserves most of the impurities found in the ore (and is therefore mostly used for fertilizer production), but the product can then be purified further for technical and food-grade phosphoric acid. Thermal acid is made from elemental phosphorus and is considerably more expensive and purer than the wet process acid. The pure phosphorus is burned in excess air and the resulting phosphorus pentoxide is then hydrated, cooled, and the acid mist is collected.

Specific Uses:
Used in cleaning operations to remove encrusted surface matter and mineral scale found on metal equipment such as boilers and steam producing equipment. Orthophosphoric acid is routinely used as a cleaning compound in its dilute form to remove oxidation from non-stainless steel surfaces, staining of stainless steel, lime and scale from heat exchangers and in Clean-in-Place (CIP) cleaning operations especially in dairy processing to remove build up of calcium and phosphate salts from processing equipment. It is also used to brighten metals and remove rust.

Additionally, orthophosphoric acid can be mixed with other detergents for process cleaning operations. It is used as an acidulent and flavoring in soft drinks--mainly colas--jellies, frozen dairy products, bakery products, candy, cheese products and in the brewing industry. It is also used as a sequestrant in hair tonics, nail polishes and skin fresheners. The concentrated form is irritating to skin and mucous membranes.

Direct food / consumer product applications are beyond the scope of this review. Only use as an equipment cleaner and sanitizer of food contact surfaces is under consideration.

Action:
The chemical reaction of phosphoric acid with minerals found in deposits makes them water soluble and thus easy to remove. Phosphoric acid is a sequestering agent that binds cations such as Fe, Cu, Ca, and Mg in fat and oil processing.

Combinations:
For cleaning purposes phosphoric acid is almost always combined with a surfactant. Usually the surfactant will be a synthetic detergent, such as derivatives of naphthalenesulfonic acid and sodium dodecylbenzene sulfonic acid. May also be combined with organic acids such as carboxylic acid, citric acid or lactic acid, or with isopropyl alchohol. See 21 CFR 178.1010 for a list of FDA approved sanitizing solutions in combination with phosphoric acid. It is also sometimes combined with a sequestrant or chelating agent, such as ethylenediaminetetraacetic acid (EDTA).

Status

OFPA
The substance is used in handing and is necessary for the handling of agricultural product because of the unavailability of wholly natural substitute products (7 USC 6517(c)(1)(A)(ii)).

Regulatory
On USDA dairy division list of cleaning aids for dairy processing operations (USDA, 1993). FDA approved for use as a cleanser, sanitizer, and disinfectant (21 CFR 178.1010).

Status among Certifiers
Generally not listed, but has been allowed for use by certified organic processors and handlers.

Historic Use
Most certification agents do not specifically regulate individual cleaning agents, except to specify that they be rinsed off food contact surfaces.

International
Not mentioned in IFOAM standards.

OFPA 2119(m) Criteria

(1) The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems. As this is a processing material, the substance is not used in organic farming systems.
(2) The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment. See processor criteria 3 below.
(3) The probability of environmental contamination during manufacture, use, misuse or disposal of such substance. This is considered below under item (2).
(4) The effect of the substance on human health. This is considered in the context of the effect on nutrition (3) below as well as the consideration of GRAS and residues (5) below.
(5) The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock. As this is not released into the agroecosystem, there is no direct effect.
(6) The alternatives to using the substance in terms of practices or other available materials. See discussion of alternatives in (1) below.
(7) Its compatibility with a system of sustainable agriculture. This is considered more specifically below in the context of organic handling in (6) below.

Phosphoric acid

Processing

Identification

Chemical Names	phosphoric acid	**CAS Numbers:**	7664-38-2
Other Names:	Orthophosphoric acid; also metaphosphoric acid and pyrophosphoric acid.	**Other Codes:**	

Recommendation

Synthetic / Non-Synthetic:	National List:	Suggested Annotation:
Synthetic (consensus)	*95%+=Not allowed 50%+=Not allowed Cleanser, Sanitizer, Disinfectant=Allowed (Consensus)*	*ACS or USP grade orthophosphoric acid may be used to clean food-contact surfaces and equipment. (Consensus)*

Characterization

Composition H_3PO_4

Properties:
Phosphoric acid is a colorless, odorless solution that is about 85-87% by weight in all commercial strengths with an approximate Molarity of 14.7 to 15.2. It is further diluted to different concentrations depending upon usage applications. Strongly acidic. Corrosive to concrete, most metals, and fabrics.

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This process conserves most of the impurities found in the ore (and is therefore mostly used for fertilizer production), but the product can then be purified further for technical and food-grade phosphoric acid. Thermal acid is made from elemental phosphorus and is considerably more expensive and purer than the wet process acid. The pure phosphorus is burned in excess air and the resulting phosphorus pentoxide is then hydrated, cooled, and the acid mist is collected.

Specific Uses:
Used in cleaning operations to remove encrusted surface matter and mineral scale found on metal equipment such as boilers and steam producing equipment. Orthophosphoric acid is routinely used as a cleaning compound in its dilute form to remove oxidation from non-stainless steel surfaces, staining of stainless steel, lime and scale from heat exchangers and in Clean-in-Place (CIP) cleaning operations especially in dairy processing to remove build up of calcium and phosphate salts from processing equipment. It is also used to brighten metals and remove rust.

Additionally, orthophosphoric acid can be mixed with other detergents for process cleaning operations. It is used as an acidulent and flavoring in soft drinks--mainly colas--jellies, frozen dairy products, bakery products, candy, cheese products and in the brewing industry. It is also used as a sequestrant in hair tonics, nail polishes and skin fresheners. The concentrated form is irritating to skin and mucous membranes.

Direct food / consumer product applications are beyond the scope of this review. Only use as an equipment cleaner and sanitizer of food contact surfaces is under consideration.

Action:
The chemical reaction of phosphoric acid with minerals found in deposits makes them water soluble and thus easy to remove. Phosphoric acid is a sequestering agent that binds cations such as Fe, Cu, Ca, and Mg in fat and oil processing.

Combinations:
For cleaning purposes phosphoric acid is almost always combined with a surfactant. Usually the surfactant will be a synthetic detergent, such as derivatives of naphthalenesulfonic acid and sodium dodecylbenzene sulfonic acid. May also be combined with organic acids such as carboxylic acid, citric acid or lactic acid, or with isopropyl alchohol. See 21 CFR 178.1010 for a list of FDA approved sanitizing solutions in combination with phosphoric acid. It is also sometimes combined with a sequestrant or chelating agent, such as ethylenediaminetetraacetic acid (EDTA).

Status

OFPA
The substance is used in handing and is necessary for the handling of agricultural product because of the unavailability of wholly natural substitute products (7 USC 6517(c)(1)(A)(ii)).

Regulatory
On USDA dairy division list of cleaning aids for dairy processing operations (USDA, 1993). FDA approved for use as a cleanser, sanitizer, and disinfectant (21 CFR 178.1010).

Status among Certifiers
Generally not listed, but has been allowed for use by certified organic processors and handlers.

Historic Use
Most certification agents do not specifically regulate individual cleaning agents, except to specify that they be rinsed off food contact surfaces.

International
Not mentioned in IFOAM standards.

OFPA 2119(m) Criteria

(1) The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems. As this is a processing material, the substance is not used in organic farming systems.
(2) The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment. See processor criteria 3 below.
(3) The probability of environmental contamination during manufacture, use, misuse or disposal of such substance. This is considered below under item (2).
(4) The effect of the substance on human health. This is considered in the context of the effect on nutrition (3) below as well as the consideration of GRAS and residues (5) below.
(5) The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock. As this is not released into the agroecosystem, there is no direct effect.
(6) The alternatives to using the substance in terms of practices or other available materials. See discussion of alternatives in (1) below.
(7) Its compatibility with a system of sustainable agriculture. This is considered more specifically below in the context of organic handling in (6) below.

NOSB Processing Criteria

A SYNTHETIC PROCESSING AID OR ADJUVANT may be used if;

1. An equivalent substance cannot be produced from a natural source and has no substitutes that are organic ingredients.
   The most common use for phosphoric acid in the food processing industry is as an equipment cleaner. Other acids which involve less environmental impact and/or human health hazard are organic acids such as citric, gluconic, tartaric, or acetic acids; these materials must also be used with care though, some more than others, depending on their respective concentrations. Such alternatives may or may not be as effective as phosphoric acid.

   Other strong acid agents used for cleaning operations include hydrochloric (muriatic), hydrofluoric, sulfamic, sulfuric, and nitric acids. Nitric and sulfuric acids are so corrosive that they are not generally used as cleaners. Hydrofluoric acid is very unstable and dangerous to handle and also extremely corrosive. Hydrochloric acid is very effective at descaling metals but produces highly toxic fumes in the form of hydrogen chloride gas. Phosphoric acid is preferred because it is the lowest in corrosiveness at the low concentrations which are effective and is compatible with many surfactants (Marriott, 1994). Organic acids such as citric, tartaric, and gluconic are effective in some situations, especially removing mineral deposits formed as a result of using alkaline cleaning compounds or other cleaners. They are not as corrosive or irritating to the skin and they are good water softeners and rinse easily. They can be irritating to the eyes, cost more, and do not work as well on metals.

   Phosphoric acid is sometimes used in the food processing industry as a disinfectant or microbial control for fresh produce, by addition of it to flume or rinse water such as in the processing of oranges and other citrus fruits). In this case, there may or may not be traces of the material entering into the final food product, depending on the care with which it is used in the processing line. The acidulating action is the mechanism of microbial control here; there are alternatives to this, in the form of organic acids like those mentioned above. Other ways to treat water, such as filtration, ozonolysis, ultraviolet radiation, and chlorination vary as to how much they are in line with organic production principles. It is hard to imagine a case where phosphoric acid is the best possible strategy for such biocidal purposes in an organic processing system.

   As a food additive, phosphoric acid is used as an acidulating agent, to which there are several natural an/or organically-produced alternatives.

   Alkaline cleaning agents have different functions and would not be considered alternatives to acids, but would be used as a separate step in a thorough cleaning program. Synthetic detergents are also effective cleaning agents but do not replace by themselves the specific uses that require an acid cleaning agent.

2. Its manufacture, use and disposal does not contaminate the environment.
   There are many environmental consequences from the manufacture, misuse and disposal of phosphates in general and these cannot be separated out for phosphoric acid in particular. In figures from world phosphorus consumption in 1980, about 90% of phosphate consumption is for fertilizer, while 4.5% is for all detergents including other cleaners such as trisodium phosphate (Becker, 1989). There are extreme environmental impacts from mining of phosphate ore which occurs in many parts of the world. Worker safety is of prime concern in the wet-process acid and elemental phosphorous used in the thermal process because of high acidity, heat released upon neutralization and toxic gases released. Plants will be equipped with proper safety procedures and equipment to deal with these issues.

   The issues of phosphate pollution from disposal are discussed above but in general the dilution of the phosphoric acid will minimize disposal problems in the food processing or livestock facility.

3. If the nutritional quality of the food is maintained and the material itself or its breakdown products do not have any adverse effect on human health.
   Undiluted phosphoric acid is a hazard to living organisms, and as such, must be handled with caution. Phosphoric acid is extremely corrosive and should not come into contact with skin or eyes. The acid can

produce corrosive toxic gases when heated and care should be taken to provide ventilation and protective clothing for workers. Inorganic phosphates are not hazardous to ingest and are in fact essential mineral nutrients.

At low concentrations ingestion is not a health hazard. There could be minor nutritional benefit from low-level ingestion of this material, although the actual commercial formulation in which it is found (i.e. in combination with other materials) may negate such benefit. Assuming that basic GMP's are followed, phosphoric acid would not appear in foodstuffs in a concentration which would be deleterious to human health.

4. Is not a preservative or used only to recreate/improve flavors, colors, textures, or nutritive value lost during processing except in the latter case as required by law.
   The use of phosphoric acid as a food ingredient or pH adjuster to retard spoilage is beyond the scope of the review.

5. Is Generally Recognized as Safe (GRAS) by FDA when used in accordance with Good Manufacturing Practices (GMP), and contains no residues of heavy metals or other contaminants in excess of the tolerances established by FDA.
   The final report to the FDA of the Select Committee on GRAS Substances indicated in 1980 that it should continue its GRAS status with no limitations other than GMP's (Winter, 1989). See 21 CFR 178.1010 for proper use as a sanitizer of food handling equipment. Some technical grades of phosphoric acid can have impurities related to their recovery processes. When properly used with GMPs as a sanitizer, the product will not leave residues.

6. Is compatible with the principles of organic handling.
   Since proper cleaning and sanitation is a key component of any organic management program, and phosphoric acid appears to be among the best and safest of the acid cleaning agents, this material seems to be compatible with an organic production and processing system.

7. There is no other way to produce a similar product without its use and it is used in the minimum quantity required to achieve the process.
   While there are other sanitizers, there may be cases when phosphoric acid is indeed the best possible choice of material as an equipment cleaner.

Discussion

Condensed Reviewer Comments

Reviewer 1
As in the discussion section it is stated that proper cleaning and sanitation is critical to organic programs and phosphoric acid appears to be the product of choice, it seems compatible.

Reviewer 2
Sulfuric, nitric, hydrochloric, and other such stronger acids are less favorable alternatives to phosphoric acid, and would fail OFPA criteria 2119(m)3 and 2119(m)4, and NOSB criteria # 2 and # 3, perhaps more so than would phosphoric acid.

In many if not all cases there may be an alternative to using phosphoric acid, namely more intensive manual labor in cleaning, at least in cases where surfaces to be cleaned are not enclosed or are reachable by human hands and/or tools. This, combined with materials (such as scouring compounds, enzymatic cleaners, detergents, alkaline cleaners, colloids, and sequestrating/chelating agents) which more ideally satisfy the OFPA and NOSB criteria on environmental effects of manufacture, misuse, and disposal, might likely suffice. Cost should not necessarily play an influential role in deciding which materials are suitable for organic systems, but overall environmental impact should. In summary, compared to the full spectrum of alternatives, phosphoric acid is a reasonable middle ground, but alternatives definitely exist in most cases, which may better fit the principles of organic production.

List phosphoric acid as a synthetic material, REGULATED for use in organic processing systems. Annotation should read: As an equipment cleaner only, and only when it is demonstrated that methods and materials which involve less overall environmental impact are not adequate.

Reviewer 3
Based on how orthophosphoric acid is manufactured, it is clearly synthetic. I have added additional information regarding types and uses of phosphoric acid. I agree with the technical information as presented in the NOSB database. It is also important to recognize that three types of phosphoric acid exist and only the orthophosphoric acid form of phosphoric acid is being reviewed.

After extensive review of all commercially available strong and weak acids, it is clear that there are no competitive alternatives to orthophosphoric acid. In reviewing 2119(m)6 alternatives to substance, I found the information to be technically accurate. There is not a suitable alternative that meets criteria with respect to safety, compatibility to agro systems and environmental impact issues.

I would propose that orthophosphoric acid be added to the National List of Allowed Synthetics. I base this decision on compatibility with sustainable agriculture, OFPA status, and the fact that there are no clear alternatives with less compromise of organic integrity.

I also would like to propose the following annotation: "Only the orthophosphate form of phosphoric acid may be used for livestock use as an equipment cleaner. Additionally, orthophosphoric acid must be of the highest purity and meet the ACS or USP criteria for purity when used in the dilute form, or as an added ingredient in equipment cleaning formulations.

Conclusion

Acid cleaning compounds are necessary for removing encrusted surface materials and dissolving mineral scale deposits on metal equipment, both in livestock production such as milking equipment, and in food processing uses. A thorough review of cleaning agents should also address alkaline cleaning compounds and detergents as well as scouring compounds, colloids, sequestrants, enzymatic cleaners, and auxiliary compounds used in cleaners. Until the review of this very large group of cleaning materials is acheived, the very limited yet very essential uses of phosphoric acid cleaners should be considered for both livestock and processing applications.

References

Becker, P. 1989. Phosphates & Phosphoric Acid - Raw Materials, Technology & Economics of the Wet Process, 2nd edition. Marcel Dekker, Inc.

Block, S.S. 1991. Disinfection, Sterilization, and Preservation. Philadelphia: Lea & Febinger.

Kirk-Othmer Encyclopedia of Chemical Technology, 3rd. edition, 1982. New York: John Wiley & Sons.

Marriott, N.C. 1984. Principles of Food Sanitation, 3rd edition. Chapman & Hall. 421 pp.

Ockerman. H.W. 1978. Source Book for Food Scientists. Westport, CT: AVI Publishing Co.

Troller, J.A. 1993. Sanitation in Food Processing, 2nd edition. New York: Academic Press.

USDA, Food Safety Inspection Service. 1993. List of Proprietary Substances and Non-food Compounds. Washington, DC: US Government Printing Office.

Winter, R. 1994. A Consumer's Dictionary of Food Additives. New York: Crown Trade Paperbacks.

Phosphoric acid

Livestock

Identification

Chemical Names	phosphoric acid	**CAS Numbers:**	7664-38-2
Other Names:	Orthophosphoric acid, metaphosphoric acid, pyrophosphoric acid	**Other Codes:**	

Recommendation

Synthetic / Non-Synthetic:	National List:	Suggested Annotation:
Synthetic (consensus)	*Allowed as a equipment cleaner and facility disinfectant (consensus).*	*ACS or USP grade orthophosphoric acid only. For use only as a equipment cleaner and facility disinfectant. Direct contact with organic livestock or land is prohibited. (Consensus)*

Characterization

Composition H_3PO_4

Properties:
Strongly acidic. Corrosive to concrete, most metals, and fabrics.

How Made:
Phosphoric acid can be made in two ways, either the wet process or the thermal (furnace) process. In the wet process, mined phosphate ore is treated with sulfuric acid and then the resulting phosphoric acid is separated from the calcium sulfate crystals produced. The chemical reaction is the following:

$$(PO_4)_2Ca_3 + 3H_2SO_4 + 6H_2O \text{ --> } 3SO_4\,Ca \cdot 2H_2O + PO_4\,H_3$$

This process conserves most of the impurities found in the ore (and is therefore mostly used for fertilizer production), but the product can then be purified further for technical and food-grade phosphoric acid. Thermal acid is made from elemental phosphorus and is considerably more expensive and purer than the wet process acid. The pure phosphorus is burned in excess air and the resulting phosphorus pentoxide is then hydrated, cooled, and the acid mist is collected.

Specific Uses:
Used in cleaning operations to remove encrusted surface matter and mineral scale found on metal equipment such as boilers and steam producing equipment. Also used to brighten metals and remove rust.

Action:
Chemical reaction of the acid with minerals found in deposits makes them water soluble and thus easy to remove. Phosphoric acid is a sequesting agent that binds cations such as Fe, Cu, Ca, and Mg in fat and oil processing.

Combinations:
For cleaning purposes phosphoric acid is almost always combined with a surfactant. Usually the surfactant will be a synthetic detergent. It is also sometimes combined with a sequestrant or chelating agent.

Status

OFPA
In processing this would be considered a processing aid. For livestock use it would be considered an equipment cleaner in the exempt categories in 6517(1)(B)(i).

Phosphoric Acid Class: Processing

Chemical Name: Orthophosphoric Acid
H_3PO_4

Introduction

Phosphoric Acid (H_3PO_4) is the orthophosphoric acid form of three types of phosphoric acid generally described in the literature. Additionally, there is the metaphosphoric (HPO_3) form and the pyrophosphoric acid ($H_4P_2O_7$) form. This review will focus only on the orthophosphoric acid form. However, it is important to recognize there are two other forms of phosphoric acid and review will focus on orthophosphoric acid (H_3PO_4) which is the most common form of phosphoric acid. (1)

Phosphoric acid is a colorless, odorless solution that is about 85-87% by weight in all commercial strengths with an approximate Molarity of 14.7 to 15.2. It is further diluted to different concentrations depending upon usage applications. It is a sequestering agent (i.e., binds cations such as Fe, Cu, Ca, and Mg) in fat and oil processing. It is used as an acidulent and flavoring in soft drinks (mainly colas e.g. Pepsi, Coke), jellies, frozen dairy products, bakery products, candy, cheese products and in the brewing industry. It is also used as a sequestrant in hair tonics, nail polishes and skin fresheners. The concentrated form is irritating to skin and mucous membranes. The final report to the FDA of the Select Committee on GRAS Substances indicated in 1980 that it should continue its GRAS status with no limitations other than GMP's. (2)

Orthophosphoric acid is routinely used as a cleaning compound in its dilute form to remove oxidation from non-stainless steel surfaces, staining of stainless steel, lime and

scale from heat exchangers and in CIP cleaning operations especially in dairy processing to remove build up of calcium and phosphate salts from processing equipment. Additionally, orthophosphoric acid can be mixed with other detergents for process cleaning operations.

Overall Recommendation

Based on how orthophosphoric acid is manufactured, it is clearly synthetic. I have added additional information regarding types and uses of phosphoric acid. I agree with the technical information as presented in the NOSB database. It is also important to recognize that three types of phosphoric acid exist and only the orthophosphoric acid form of phosphoric acid is being reviewed.

After extensive review of all commercially available strong and weak acids, it is clear that there are no competitive alternatives to orthophosphoric acid. In reviewing 2119(m)6 alternatives to substance, I found the information to be technically accurate. There is not a suitable alternative that meets criteria with respect to safety, compatibility to agro systems and environmental impact issues.

I would propose that orthophosphoric acid be added to the National List of Allowed Synthetics. I base this decision on compatibility with sustainable agriculture, OFPA status, and the fact that there are no clear alternatives with less compromise of organic integrity.

I also would like to propose the following annotation: "Only the orthophosphate form of phosphoric acid may be used for hard surface cleaning and CIP (clean in place) process cleaning operations and the orthophosphoric acid used either as a stand alone cleaner or as a component of a detergent/cleaner formulation. It must be used in ACS or USP standards of purity and may not be used in technical grade forms (i.e. less pure than ACS or USP)."

I have no commercial or financial interest in any form of phosphoric acid.

References:

1. H.W. Ockerman. (1978) *Source Book for Food Scientists*. AVI Publishing Co. Westport, CT. p.205.
2. R. Winter. (1994) *A Consumer's Dictionary of Food Additives*. Crown Trade Paperbacks. NY, NY. P. 311.

TECHNICAL ADVISORY PANEL
REVIEW FOR
PHOSPHORIC ACID (PROCESSING)

NATURAL VERSUS SYNTHETIC:

Phosphoric acid, in all existing forms, is a synthetic material. It is most commonly derived either by reaction of rock phosphate with sulfuric acid, or by combustion of phosphorus in air (followed by hydration).

CRITERIA:

2119(m)(1) - Chemical interactions in organic farming systems:
Not applicable

2119(m)(2) - Toxicity and persistence in the environment:
Phosphoric acid does not in and of itself persist in the environment in any way which necessarily implies detriment. The phosphate component can be readily assimilated into life systems. Problems may arise when excessive amounts of the material is deposited in a given area, usually because this results in unaccustomedly high growth of algae, thereby negatively competing with other species. The amount of phosphate contributed to such imbalances by phosphoric acid as opposed to other forms of phosphate such as detergents, fertilizers, etc., is likely to be difficult if not impossible to determine in many cases.

2119(m)(3) and NOSB processing criterion #2 - Consequence of manufacture, misuse, disposal:
Environmental impact from manufacture, misuse, and disposal of phosphoric acid can have serious consequences, but the degree to which this occurs is subject to the particulars of any given situation. As far as use and disposal of phosphoric acid itself (i.e. the end product) is concerned, there is generally less negative impact than that caused by the initial mining and manufacturing phases involved to make the product. If phosphoric acid is used with good manufacturing and handling practices, problems with use of the material itself are minimized.

Whether or not the OFPA and NOSB criteria on this point are met is open to question, as it cannot be safely said that non-contamination of the environment is certain, especially on the production end of this material. Technically, phosphoric acid might then be more likely to fail the respective OFPA or NOSB criterion.

2119(m)(4) and NOSB processing criterion #3 - Effect on human health:
Undiluted phosphoric acid is a hazard to living organisms, and as such, must be handled with caution. At low concentrations ingestion is not a health hazard. There could be minor nutritional benefit from low-level ingestion of this material, although the actual commercial formulation in which it is found (i.e. in combination with other materials) may negate such benefit. Assuming that basic GMP's are followed, phosphoric acid would not appear in foodstuffs in a concentration which would be deleterious to human health.

2119(m)(5) - Agroecosystem biology:
Not applicable

2119(m)(6) and NOSB processing criteria #1 - Alternative substances, specific uses:
The most common use for phosphoric acid in the food processing industry is as an equipment cleaner. Other acids which involve less environmental impact and/or human health hazard are

organic acids such as citric, gluconic, tartaric, or acetic acids; these materials must also be used with care though, some more than others, depending on their respective concentrations. Such alternatives may or may not be as effective as phosphoric acid. Sulfuric, nitric, hydrochloric, and other such stronger acids are less favorable alternatives to phosphoric acid, and would fail OFPA criteria 2119(m)3 and 2119(m)4, and NOSB criteria #2 and #3, perhaps more so than would phosphoric acid.

In many if not all cases there may be an alternative to using phosphoric acid, namely more intensive manual labor in cleaning, at least in cases where surfaces to be cleaned are not enclosed or are reachable by human hands and/or tools. This, combined with materials (such as scouring compounds, enzymatic cleaners, detergents, alkaline cleaners, colloids, and sequestrating/chelating agents) which more ideally satisfy the OFPA and NOSB criteria on environmental effects of manufacture, misuse, and disposal, might likely suffice. Cost should not necessarily play an influential role in deciding which materials are suitable for organic systems, but overall environmental impact should. In summary, compared to the full spectrum of alternatives, phosphoric acid is a reasonable middle ground, but alternatives definitely exist in most cases, which may better fit the principles of organic production.

Phosphoric acid is sometimes used in the food processing industry as a disinfectant or microbial control for fresh produce, by addition of it to flume or rinse water (e.g. in processing of oranges and other citrus fruits). In this case, there may or may not be traces of the material entering into the final food product, depending on the care with which it is used in the processing line. The acidulating action is the mechanism of microbial control here; there are alternatives to this, in the form of organic acids (such as those mentioned above). Other ways to treat water, such as filtration, ozonolysis, ultraviolet radiation, and chlorination vary as to how much they are in line with organic production principles. It is hard to imagine a case where phosphoric acid is the best possible strategy for such biocidal purposes in an organic processing system.

As a food additive, phosphoric acid is used as an acidulating agent, to which there are several natural an/or organically-produced alternatives.

2119(m)(7) and NOSB processing criterion #6: Compatibility:
Adequate sanitation in food processing operations is extremely important. Acidic compounds are useful for these purposes, and as such, phosphoric acid is a reasonable choice. However, it should be stated that if this material is used in organic production/processing systems, this allowance should only be made when it is demonstrated by the operation in question that cleaning methods and materials which are otherwise more in line with the ideals of organic production are not effective enough. Use as a disinfecting agent in water treatment (i.e. flumes, rinses, etc., as mentioned above), or as a food additive, is not compatible with the principles of organic food production.

NOSB Processing Criterion #4 - Preservative, restorer of nutritional/sensory properties:
Not applicable. Although it appears as an additive to certain processed foods, phosphoric acid is not used for these purposes.

NOSB processing criterion #5 - GRAS, residues:
If phosphoric acid were to somehow enter into a food product formulation, residues per se would not be found.

NOSB Processing Criterion #7 - Essential need, minimum quantity:
The NOSB Materials Database for this material states that ,"As a processing aid this question is not applicable." I do not agree with this statement, especially when reading the NOSB criteria for acceptance of materials used in processing, which states, "A synthetic processing aid or adjuvant

may be used if:..." Nonetheless, there may be cases when phosphoric acid is indeed the best possible choice of material as an equipment cleaner.

SUMMARY AND RECOMMENDATION:
List phosphoric acid as a synthetic material, REGULATED for use in organic processing systems. Annotation should read: As an equipment cleaner only, and only when it is demonstrated that methods and materials which involve less overall environmental impact are not adequate.

COMMERCIAL/FINANCIAL INTEREST:
I unequivocally claim that I have no personal, commercial, or financial interest whatsoever in the this material or the decisions regarding it.

20 August, 1999

Response
Reviewer Name: Anonymous

Substance: **Phosphoric acid** Livestock/Processing

Is the substance synthetic or non-synthetic (natural)?**Synthetic.**

_Synthetic Allowed ___Prohibited Natural

The information provided about properties, uses and sources of the material is:
_Complete __Incomplete __Other

Criteria Section:
As in the discussion section it is stated that proper cleaning and sanitation is critical to organic programs and phosphoric acid appears to be the product of choice, it seems compatible.

I do not have a commercial or financial interest in this material.

Identification

Common Name: Phosphoric acid

Class: Processing

Other Names: Orthophosphoric acid

Code #: CAS: 7664-38-2

Chemical Name:

Code #: Other:

MSDS: yes

Characterization

Composition: H_3PO_4

Properties: Strongly acidic. Corrosive to concrete, most metals, and fabrics.

How Made: Phosphoric acid can be made in two ways, either the wet process or the thermal (furnace) process. In the wet process, mined phosphate ore is treated with sulfuric acid and then the resulting phosphoric acid is separated from the calcium sulfate crystals produced. The chemcial reaction is the following:

$$(PO_4)_2Ca_3 + 3H_2SO_4 + 6H_2O \rightarrow 3SO_4\,Ca \cdot 2H_2O + PO_4\,H_3$$

This process conserves most of the impurities found in the ore (and is therefore mostly used for fertilizer production), but the product can then be purified further for technical and food-grade phosphoric acid. Thermal acid is made from elemental phosphorus and is considerably more expensive and purer than the wet process acid. The pure phosphorus is burned in excess air and the resulting phosphorus pentoxide is then hydrated, cooled, and the acid mist is collected.

Specific Use(s): Used in cleaning operations to remove encrusted surface matter and mineral scale found on metal equipment such as boilers and steam producing equipment. Also used to brighten metals and remove rust.

Action: Chemical reaction of the acid with minerals found in deposits makes them water soluble and thus easy to remove.

Combinations: For cleaning purposes phosphoric acid is almost always combined with a surfactant. Usually the surfactant will be a synthetic detergent. It is also sometimes combined with a sequestrant or chelating agent.

Status

OFPA: In processing this would be considered a processing aid. For livestock use it would be considered an equipment cleaner in the exempt categories in 6517(1)(B)(i).

Regulatory Status: On USDA dairy division list of cleaning aids for dairies.

Historic Use: Most certification agents do not specifically regulate individual cleaning agents, except to specify that they be rinsed off food contact surfaces.

International: unknown

Existing Restrictions:

Proposed Annotation:

OFPA Criteria for Processing

2119(m)1: chemical interactions Not Applicable

2119(m)2: toxicity & persistence

The acid will dilute quickly in the environment and there are no toxicity issues directly from its breakdown products. To the contrary, the well-known problems with excess phosphate polluting water with excessive algae growth are because of the nutritive value of the material to algae, but this causes environmental consequences to higher life forms in the water. It is impossible to judge how much of this phosphate pollution would come from phosphoric acid as a cleaner and how much from household laundry detergents, sewage-borne phosphates and other sources.

NOSB Processing Criteria #2 2119(m)3: manufacture & disposal consequences

There are many environmental consequences from the manufacture, misuse and disposal of phosphates in general and these cannot be separated out for phosphoric acid in particular. In figures from world phosphorus consumption in 1980, about 90% of phosphate consumption is for fertilizer, while 4.5% is for all detergents (which would include other cleaners such as tridsodium phosphate)(Becker, 1989). There are extreme environmental impacts from mining of phosphate ore which occurs in many parts of the world. Worker safety is of prime concern in the wet-process acid and elemental phosphorous used in the thermal process because of high acidity, heat released upon neutralization and toxic gases released. Plants will be equipped with proper safety procedures and equipment to deal with these issues.

The issues of phosphate pollution from disposal are discussed above but in general the dilution of the phosphoric acid will minimize disposal problems in the food processing or livestock facility.

NOSB Processing Criteria #3 - 2119(m)4: effect on human health
Also "Nutritional quality of the food is maintained."

Inorganic phosphates are not hazardous to ingest and are in fact essential mineral nutrients.
The phosphoric acid is extremely corrosive and should not come into contact with skin or eyes.
The acid can produce corrosive toxic gases when heated and care should be taken to provide ventilation and protective clothing for workers.

2119(m)5: agroecosystem biology Not Applicable

NOSB Processing Criteria #1 2119(m)6: alternatives to substance

Other strong acid agents used for cleaning operations include hydrochloric (muriatic), hydrofluoric, sulfamic, sulfuric, and nitric acids. Nitric and sulfuric acids are so corrosive that they are not generally used as cleaners. Hydrofluoric acid is very unstable and dangerous to handle and also extremely corrosive. Hydrochloric acid is very effective at descaling metals but has a real hazard with toxic fumes of hydrogen chloride gas. Phosphoric acid is preferred because it is the lowest in corrosiveness at the low concentrations which are effective and is compatible with many surfactants. (Marriott, 1994). Organic acids such as citric, tartaric, and gluconic are effective in some situations, especially removing mineral deposits formed as a result of using alkaline cleaning compounds or other cleaners. They are not as corrosive or irritating to the skin and they are good water sofenters and rinse easily. They can be irritating to the eyes, cost more, and do not work as well on metals.

Alkaline cleaning agents have different functions and would not be considered alternatives to acids, but would be used as a separate step in a thorough cleaning program. Synthetic detergents are also effective cleaning agents but do not replace by themselves the specific uses that require an acid cleaning agent.

NOSB Processing Criteria #6 2119(m)7: Is it compatible?

Since proper cleaning and sanitation is a key component of any organic management program, and phosphoric acid appears to be among the best and safest of the acid cleaning agents, this material seems to be compatible with an organic production and processing system.

NOSB Criteria for Processing

NOSB Proc Criteria #4: Preservative?

not applicable

NOSB Proc Criteria #5: GRAS & residues?

It would not leave residues in the food.

NOSB Proc Criteria #7: Essential & Minimum?

As a processing aid this question is not applicable.

Discussion

Acid cleaning compounds are necessary for removing encrusted surface materials and dissolving mineral scale deposits on metal equipment, both in livestock production such as milking equipment, and in food processing uses. A thorough review of cleaning agents should also address alkaline cleaning compounds and detergents as well as scouring compounds, colloids, sequestrants, enzymatic cleaners, and auxiliary compounds used in cleaners. Until the review of this very large group of cleaning materials is acheived, the very limited yet very essential uses of phosphoric acid cleaners should be considered for both livestock and processing applications.

Becker, Pierre. 1989. Phosphates & Phosphoric Acid - Raw Materials, Technology & Economics of the Wet Process, 2nd edition. Marcel Dekker, Inc.

Kirk-Othmer Encyclopedia of Chemical Technology, 3rd. edition, 1982. John Wiley & Sons.

Marriott, N.C. 1984. Principles of Food Sanitation, 3rd edition. Chapman & Hall. 421 pp.

Troller, J.A. 1993. Sanitation in Food Processing, 2nd edition. Academic Press. 478 pp.

Phosphoric acid

Livestock

Identification

Chemical Names	phosphoric acid	**CAS Numbers:**	7664-38-2
Other Names:	Orthophosphoric acid, metaphosphoric acid, pyrophosphoric acid	**Other Codes:**	

Recommendation

Synthetic / Non-Synthetic:	National List:	Suggested Annotation:
Synthetic (consensus)	*Allowed as a equipment cleaner and facility disinfectant (consensus).*	*ACS or USP grade orthophosphoric acid only. For use only as a equipment cleaner and facility disinfectant. Direct contact with organic livestock or land is prohibited. (Consensus)*

Characterization

Composition H_3PO_4

Properties:
Strongly acidic. Corrosive to concrete, most metals, and fabrics.

How Made:
Phosphoric acid can be made in two ways, either the wet process or the thermal (furnace) process. In the wet process, mined phosphate ore is treated with sulfuric acid and then the resulting phosphoric acid is separated from the calcium sulfate crystals produced. The chemical reaction is the following:

$$(PO_4)_2Ca_3 + 3H_2SO_4 + 6H_2O \text{ --> } 3SO_4\,Ca \cdot 2H_2O + PO_4\,H_3$$

This process conserves most of the impurities found in the ore (and is therefore mostly used for fertilizer production), but the product can then be purified further for technical and food-grade phosphoric acid. Thermal acid is made from elemental phosphorus and is considerably more expensive and purer than the wet process acid. The pure phosphorus is burned in excess air and the resulting phosphorus pentoxide is then hydrated, cooled, and the acid mist is collected.

Specific Uses:
Used in cleaning operations to remove encrusted surface matter and mineral scale found on metal equipment such as boilers and steam producing equipment. Also used to brighten metals and remove rust.

Action:
Chemical reaction of the acid with minerals found in deposits makes them water soluble and thus easy to remove. Phosphoric acid is a sequesting agent that binds cations such as Fe, Cu, Ca, and Mg in fat and oil processing.

Combinations:
For cleaning purposes phosphoric acid is almost always combined with a surfactant. Usually the surfactant will be a synthetic detergent. It is also sometimes combined with a sequestrant or chelating agent.

Status

OFPA
In processing this would be considered a processing aid. For livestock use it would be considered an equipment cleaner in the exempt categories in 6517(1)(B)(i).

Regulatory
On USDA dairy division list of cleaning aids for dairies.

Status among Certifiers
Generally not mentioned.

Historic Use
Most certification agents do not specifically regulate individual cleaning agents, except to specify that they be rinsed off food contact surfaces.

International
Not mentioned in IFOAM standards.

OFPA 2119(m) Criteria

(1) The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.

Phosphoric acid itself combines readily with many other chemicals, but there are no known detrimental interactions within the organic farming system.

(2) The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.

The acid will dilute quickly in the environment and there are no toxicity issues directly from its breakdown products. To the contrary, the well-known problems with excess phosphate polluting water with excessive algae growth are because of the nutritive value of the material to algae, but this causes environmental consequences to higher life forms in the water. It is impossible to judge how much of this phosphate pollution would come from phosphoric acid as a cleaner and how much from household laundry detergents, sewage-borne phosphates and other sources.

(3) The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.

There are many environmental consequences from the manufacture, misuse and disposal of phosphates in general and these cannot be separated out for phosphoric acid in particular. In figures from world phosphorus consumption in 1980, about 90% of phosphate consumption is for fertilizer, while 4.5% is for all detergents, including other cleaners such as tridsodium phosphate (Becker, 1989). There are extreme environmental impacts from mining of phosphate ore which occurs in many parts of the world. Worker safety is of prime concern in the wet-process acid and elemental phosphorous used in the thermal process because of high acidity, heat released upon neutralization and toxic gases released. Plants will be equipped with proper safety procedures and equipment to deal with these issues.

The issues of phosphate pollution from disposal are discussed above but in general the dilution of the phosphoric acid will minimize disposal problems in the food processing or livestock facility.

(4) The effect of the substance on human health.

Inorganic phosphates are not hazardous to ingest and are in fact essential mineral nutrients. Undiluted phosphoric acid can be very hazardous and should be handled with caution. The phosphoric acid is extremely corrosive and should not come into contact with skin or eyes. The acid can produce corrosive toxic gases when heated and care should be taken to provide ventilation and protective clothing for workers.

(5) The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.

If stored, used, and disposed of properly, phosphoric acid utilized as a cleaning agent for livestock equipment and facilities will not interact very much with the agroecosystem and will not come into direct contact with livestock.

(6) The alternatives to using the substance in terms of practices or other available materials.

Other strong acid agents used for cleaning operations include hydrochloric (muriatic), hydrofluoric, sulfamic, sulfuric, and nitric acids. Nitric and sulfuric acids are so corrosive that they are not generally used as cleaners. Hydrofluoric acid is very unstable and dangerous to handle and also extremely corrosive. Hydrochloric acid is very effective at descaling metals but produces highly toxic fumes in the form of hydrogen chloride gas. Phosphoric acid is preferred because it is the lowest in corrosiveness at the low concentrations which are effective and is compatible with many surfactants (Marriott, 1994). Organic acids such as citric, tartaric, and gluconic are effective in some situations, especially removing mineral deposits formed as a result of using alkaline cleaning compounds or other cleaners. They are not as corrosive or irritating to the skin and they are good water softeners and rinse easily. They can be irritating to the eyes, cost more, and do not work as well on metals.

Alkaline cleaning agents have different functions and would not be considered alternatives to acids, but would be used as a separate step in a thorough cleaning program. Synthetic detergents are also effective cleaning agents but do not replace by themselves the specific uses that require an acid cleaning agent.

In many if not all cases there may be an alternative to using phosphoric acid, namely more intensive manual labor in cleaning, at least in cases where surfaces to be cleaned are not enclosed or are reachable by human hands and/or tools. This, combined with materials (such as scouring compounds, enzymatic cleaners, detergents, alkaline cleaners, colloids, and sequestrating/chelating agents) which more ideally satisfy the OFPA criteria on environmental effects of manufacture, misuse, and disposal, might likely suffice. Cost should not necessarily play an influential role in deciding which materials are suitable for organic systems, but overall environmental impact should. In summary, compared to the full spectrum of alternatives, phosphoric acid is a reasonable middle ground, but alternatives definitely exist in most cases, which may better fit the principles of organic production.

(7) Its compatibility with a system of sustainable agriculture.

Since proper cleaning and sanitation is a key component of any organic management program, and phosphoric acid appears to be among the best and safest of the acid cleaning agents, this material seems to be compatible with an organic production and processing system.

Discussion

Condensed Reviewer Comments

None of the reviewers have a direct commercial or financial interest in phosphoric acid.

Reviewer 1
As in the discussion section it is stated that proper cleaning and sanitation is critical to organic programs and phosphoric acid appears to be the product of choice, it seems compatible.

Reviewer 2
Adequate sanitation is extremely important in the management of organic food production systems. Acidic compounds are useful for these purposes, and as such, phosphoric acid is a reasonable choice. However, it should be stated that if this material is used in organic systems, this allowance should only be made when it is

demonstrated by the operation in question that cleaning methods and materials which are otherwise more in line with the ideals of organic production are not effective enough.

SUMMARY AND RECOMMENDATION:
List phosphoric acid as a synthetic material, REGULATED for use in organic livestock systems. Annotation should read: As an equipment cleaner only, and only when it is demonstrated that methods and materials which involve less overall environmental impact are not adequate.

Reviewer 3
Based on how orthophosphoric acid is manufactured, it is clearly synthetic. I have added additional information regarding types and uses of phosphoric acid. I agree with the technical information as presented in the NOSB database. It is also important to recognize that three types of phosphoric acid exist and only the orthophosphoric acid form of phosphoric acid is being reviewed.

After extensive review of all commercially available strong and weak acids, it is clear that there are no competitive alternatives to orthophosphoric acid. In reviewing 2119(m)6 alternatives to substance, I found the information to be technically accurate. There is not a suitable alternative that meets criteria with respect to safety, compatibility to agro systems and environmental impact issues.

I would propose that orthophosphoric acid be added to the National List of Allowed Synthetics. I base this decision on compatibility with sustainable agriculture, OFPA status, and the fact that there are no clear alternatives with less compromise of organic integrity.

I also would like to propose the following annotation: "Only the orthophosphate form of phosphoric acid may be used for livestock use as an equipment cleaner. Additionally, orthophosphoric acid must be of the highest purity and meet the ACS or USP criteria for purity when used in the dilute form, or as an added ingredient in equipment cleaning formulations."

Conclusion

Acid cleaning compounds are necessary for removing encrusted surface materials and dissolving mineral scale deposits on metal equipment, both in livestock production such as milking equipment, and in food processing uses. A thorough review of cleaning agents should also address alkaline cleaning compounds and detergents as well as scouring compounds, colloids, sequestrants, enzymatic cleaners, and auxiliary compounds used in cleaners. Until the review of this very large group of cleaning materials is acheived, the very limited yet very essential uses of phosphoric acid cleaners should be considered for both livestock and processing applications.

References

Becker, Pierre. 1989. Phosphates & Phosphoric Acid - Raw Materials, Technology & Economics of the Wet Process, 2nd edition. Marcel Dekker, Inc.

Kirk-Othmer Encyclopedia of Chemical Technology, 3rd. edition, 1982. John Wiley & Sons.

Marriott, N.C. 1984. Principles of Food Sanitation, 3rd edition. Chapman & Hall. 421 pp.

Troller, J.A. 1993. Sanitation in Food Processing, 2nd edition. Academic Press. 478 pp.

TECHNICAL ADVISORY PANEL
REVIEW FOR
PHOSPHORIC ACID (LIVESTOCK)

NATURAL VERSUS SYNTHETIC:

Phosphoric acid, in all existing forms, is a synthetic material. It is most commonly derived either by reaction of rock phosphate with sulfuric acid, or by combustion of phosphorus in air (followed by hydration).

CRITERIA:

2119(m)(1) - Chemical interactions in organic farming systems:
Phosphoric acid reacts with a wide variety of compounds, but the products of said reactions, from a chemical standpoint, do not imply negative interactions with other components of an organic farming/production system.

2119(m)(2) - Toxicity and persistence in the environment:
Phosphoric acid does not in and of itself persist in the environment in any way which necessarily implies detriment. The phosphate component can be readily assimilated into life systems. Problems may arise when excessive amounts of the material is deposited in a given area, usually because this results in unaccustomedly high growth of algae, thereby negatively competing with other species. The amount of phosphate contributed to such imbalances by phosphoric acid as opposed to other forms of phosphate such as detergents, fertilizers, etc., is likely to be difficult if not impossible to determine in many cases.

2119(m)(3) - Consequence of manufacture, misuse, disposal:
Environmental impact from manufacture, misuse, and disposal of phosphoric acid can have serious consequences, but the degree to which this occurs is subject to the particulars of any given situation. As far as use and disposal of phosphoric acid itself (i.e. the end product) is concerned, there is generally less negative impact than that caused by the initial mining and manufacturing phases involved to make the product. If phosphoric acid is used with good handling practices, problems with use of the material itself are minimized.

Whether or not the OFPA criterion on this point is met is open to question, as it cannot be safely said that non-contamination of the environment is certain, especially on the production end of this material. Technically, phosphoric acid might then be more likely to fail the OFPA criterion.

2119(m)(4) - Effect on human health:
Undiluted phosphoric acid is a hazard to living organisms, and as such, must be handled with caution. At low concentrations ingestion is not a health hazard. There could be minor nutritional benefit from low-level ingestion of this material, although the actual commercial formulation in which it is found (i.e. in combination with other materials) may negate such benefit. Assuming that basic safety practices for this material are followed (per instructions given by its MSDS), phosphoric acid can be used in a way which is not directly deleterious to livestock or human health.

2119(m)(5) - Agroecosystem biology:
If stored, used, and disposed of properly, phosphoric acid should not have much if any direct interactions with soils, plants, or livestock. Its use here is being considered as a cleaning agent, and as such, is not to be considered for direct contact with soils, plants, or animals.

2119(m)(6) - Alternative substances:
The most common use for phosphoric acid in the organic production systems is as an equipment cleaner. Other acids which involve less environmental impact and/or human health hazard are organic acids such as citric, gluconic, tartaric, or acetic acids; these materials must also be used with care though, some more than others, depending on their respective concentrations. Such alternatives may or may not be as effective as phosphoric acid. Sulfuric, nitric, hydrochloric, and other such stronger acids are less favorable alternatives to phosphoric acid, and would fail OFPA criteria 2119(m)3 and 2119(m)4, perhaps more so than would phosphoric acid.

In many if not all cases there may be an alternative to using phosphoric acid, namely more intensive manual labor in cleaning, at least in cases where surfaces to be cleaned are not enclosed or are reachable by human hands and/or tools. This, combined with materials (such as scouring compounds, enzymatic cleaners, detergents, alkaline cleaners, colloids, and sequestrating/chelating agents) which more ideally satisfy the OFPA criteria on environmental effects of manufacture, misuse, and disposal, might likely suffice. Cost should not necessarily play an influential role in deciding which materials are suitable for organic systems, but overall environmental impact should. In summary, compared to the full spectrum of alternatives, phosphoric acid is a reasonable middle ground, but alternatives definitely exist in most cases, which may better fit the principles of organic production.

2119(m)(7): Compatibility:
Adequate sanitation is extremely important in the management of organic food production systems. Acidic compounds are useful for these purposes, and as such, phosphoric acid is a reasonable choice. However, it should be stated that if this material is used in organic systems, this allowance should only be made when it is demonstrated by the operation in question that cleaning methods and materials which are otherwise more in line with the ideals of organic production are not effective enough.

SUMMARY AND RECOMMENDATION:
List phosphoric acid as a synthetic material, REGULATED for use in organic livestock systems. Annotation should read: As an equipment cleaner only, and only when it is demonstrated that methods and materials which involve less overall environmental impact are not adequate.

COMMERCIAL/FINANCIAL INTEREST:
I unequivocally claim that I have no personal, commercial, or financial interest whatsoever in the this material or the decisions regarding it.

Phosphoric Acid Livestock

Chemical Name:
Orthophosphoric Acid
H_3PO_4

Introduction

Phosphoric Acid (H_3PO_4) is the orthophosphoric acid form of three types of phosphoric acid generally described in the literature. Additionally, there is the metaphosphoric (HPO_3) form and the pyrophosphoric acid ($H_4P_2O_7$) form. This review will focus only on the orthophosphoric acid form. However, it is important to recognize there are two other forms of phosphoric acid and review will focus on orthophosphoric acid (H_3PO_4) which is the most common form of phosphoric acid. (1)

Phosphoric acid is a colorless, odorless solution that is about 85-87% by weight in all commercial strengths with an approximate Molarity of 14.7 to 15.2. It is further diluted to different concentrations depending upon usage applications. It is a sequestering agent (i.e., binds cations such as Fe, Cu, Ca, and Mg) in fat and oil processing. It is used as an acidulent and flavoring in soft drinks (mainly colas e.g. Pepsi, Coke), jellies, frozen dairy products, bakery products, candy, cheese products and in the brewing industry. It is also used as a sequestrant in hair tonics, nail polishes and skin fresheners. The concentrated form is irritating to skin and mucous membranes. The final report to the FDA of the Select Committee on GRAS Substances indicated in 1980 that it should continue its GRAS status with no limitations other than GMP's. (2)

Overall Recommendation

SEP 02 1999

Based on how orthophosphoric acid is manufactured, it is clearly synthetic. I have added additional information regarding types and uses of phosphoric acid. I agree with the technical information as presented in the NOSB database. It is also important to recognize that three types of phosphoric acid exist and only the orthophosphoric acid form of phosphoric acid is being reviewed.

After extensive review of all commercially available strong and weak acids, it is clear that there are no competitive alternatives to orthophosphoric acid. In reviewing 2119(m)6 alternatives to substance, I found the information to be technically accurate. There is not a suitable alternative that meets criteria with respect to safety, compatibility to agro systems and environmental impact issues.

I would propose that orthophosphoric acid be added to the National List of Allowed Synthetics. I base this decision on compatibility with sustainable agriculture, OFPA status, and the fact that there are no clear alternatives with less compromise of organic integrity.

I also would like to propose the following annotation: "Only the orthophosphate form of phosphoric acid may be used for livestock use as an equipment cleaner. Additionally, orthophosphoric acid must be of the highest purity and meet the ACS or USP criteria for purity when used in the dilute form, or as an added ingredient in equipment cleaning formulations."

I have no commercial or financial interest in any form of phosphoric acid.

References:

1. H.W. Ockerman. (1978) *Source Book for Food Scientists.* AVI Publishing Co. Westport, CT. p.205.

2. R. Winter. (1994) *A Consumer's Dictionary of Food Additives.* Crown Trade Paperbacks. NY, NY. P. 311.

Response
Reviewer Name: Anonymous

Substance: **Phosphoric acid** Livestock/Processing

Is the substance synthetic or non-synthetic (natural)?**Synthetic.**

The information provided about properties, uses and sources of the material is:
_Complete __Incomplete __Other

Criteria Section:
As in the discussion section it is stated that proper cleaning and sanitation is critical to organic programs and phosphoric acid appears to be the product of choice, it seems compatible.

I do not have a commercial or financial interest in this material.

Identification

Common Name	Phosphoric acid	Class	Livestock
Other Names	Orthophosphoric acid	Code #: CAS	7664-38-2
		Code #: Other	
Chemical Name		MSDS	yes

Characterization

Composition H_3PO_4

Properties Strongly acidic. Corrosive to concrete, most metals, and fabrics.

How Made Phosphoric acid can be made in two ways, either the wet process or the thermal (furnace) process. In the wet process, mined phosphate ore is treated with sulfuric acid and then the resulting phosphoric acid is separated from the calcium sulfate crystals produced. The chemcial reaction is the following:

$$(PO_4)_2Ca_3 + 3H_2SO_4 + 6H_2O \rightarrow 3SO_4\,Ca \cdot 2H_2O + PO_4\,H_3$$

This process conserves most of the impurities found in the ore (and is therefore mostly used for fertilizer production), but the product can then be purified further for technical and food-grade phosphoric acid. Thermal acid is made from elemental phosphorus and is considerably more expensive and purer than the wet process acid. The pure phosphorus is burned in excess air and the resulting phosphorus pentoxide is then hydrated, cooled, and the acid mist is collected.

Specific Use(s) Used in cleaning operations to remove encrusted surface matter and mineral scale found on metal equipment such as boilers and steam producing equipment. Also used to brighten metals and remove rust.

Action Chemical reaction of the acid with minerals found in deposits makes them water soluble and thus easy to remove.

Combinations For cleaning purposes phosphoric acid is almost always combined with a surfactant. Usually the surfactant will be a synthetic detergent. It is also sometimes combined with a sequestrant or chelating agent.

Status

OFPA In processing this would be considered a processing aid. For livestock use it would be considered an equipment cleaner in the exempt categories in 6517(1)(B)(i).

Regulatory Status On USDA dairy division list of cleaning aids for dairies.

Historic Use Most certification agents do not specifically regulate individual cleaning agents, except to specify that they be rinsed off food contact surfaces.

International unknown

Existing Restrictions

Proposed Annotation

OFPA Criteria

2119(m)1: chemical interactions

Phosphoric acid itself combines readily with many other chemicals, but there are no known detrimental interactions within the organic farming system.

2119(m)2: toxicity & persistence

The acid will dilute quickly in the environment and there are no toxicity issues directly from its breakdown products. To the contrary, the well-known problems with excess phosphate polluting water with excessive algae growth are because of the nutritive value of the material to algae, but this causes environmental consequences to higher life forms in the water. It is impossible to judge how much of this phosphate pollution would come from phosphoric acid as a cleaner and how much from household laundry detergents, sewage-borne phosphates and other sources.

2119(m)3: manufacture & disposal consequences

There are many environmental consequences from the manufacture, misuse and disposal of phosphates in general and these cannot be separated out for phosphoric acid in particular. In figures from world phosphorus consumption in 1980, about 90% of phosphate consumption is for fertilizer, while 4.5% is for all detergents (which would include other cleaners such as tridsodium phosphate)(Becker, 1989). There are extreme environmental impacts from mining of phosphate ore which occurs in many parts of the world. Worker safety is of prime concern in the wet-process acid and elemental phosphorous used in the thermal process because of high acidity, heat released upon neutralization and toxic gases released. Plants will be equipped with proper safety procedures and equipment to deal with these issues.

The issues of phosphate pollution from disposal are discussed above but in general the dilution of the phosphoric acid will minimize disposal problems in the food processing or livestock facility.

2119(m)4: effect on human health

Inorganic phosphates are not hazardous to ingest and are in fact essential mineral nutrients.
The phosphoric acid is extremely corrosive and should not come into contact with skin or eyes.
The acid can produce corrosive toxic gases when heated and care should be taken to provide ventilation and protective clothing for workers.

2119(m)5: agroecosystem biology

As a cleaning agent the phosphoric acid will not interact very much with the agroecosystem, nor will it come into direct contact with livestock.

2119(m)6: alternatives to substance

Other strong acid agents used for cleaning operations include hydrochloric (muriatic), hydrofluoric, sulfamic, sulfuric, and nitric acids. Nitric and sulfuric acids are so corrosive that they are not generally used as cleaners. Hydrofluoric acid is very unstable and dangerous to handle and also extremely corrosive. Hydrochloric acid is very effective at descaling metals but has a real hazard with toxic fumes of hydrogen chloride gas. Phosphoric acid is preferred because it is the lowest in corrosiveness at the low concentrations which are effective and is compatible with many surfactants. (Marriott, 1994). Organic acids such as citric, tartaric, and gluconic are effective in some situations, especially removing mineral deposits formed as a result of using alkaline cleaning compounds or other cleaners. They are not as corrosive or irritating to the skin and they are good water sofenters and rinse easily. They can be irritating to the eyes, cost more, and do not work as well on metals.

Alkaline cleaning agents have different functions and would not be considered alternatives to acids, but would be used as a separate step in a thorough cleaning program. Synthetic detergents are also effective cleaning agents but do not replace by themselves the specific uses that require an acid cleaning agent.

2119(m)7: Is it compatible?

Since proper cleaning and sanitation is a key component of any organic management program, and phosphoric acid appears to be among the best and safest of the acid cleaning agents, this material seems to be compatible with an organic production and processing system.

Discussion

Acid cleaning compounds are necessary for removing encrusted surface materials and dissolving mineral scale deposits on metal equipment, both in livestock production such as milking equipment, and in food processing uses. A thorough review of cleaning agents should also address alkaline cleaning compounds and detergents as well as scouring compounds, colloids, sequestrants, enzymatic cleaners, and auxiliary compounds used in cleaners. Until the review of this very large group of cleaning materials is acheived, the very limited yet very essential uses of phosphoric acid cleaners should be considered for both livestock and processing applications.

Phosphoric acid References

Becker, Pierre. 1989. Phosphates & Phosphoric Acid - Raw Materials, Technology & Economics of the Wet Process, 2nd edition. Marcel Dekker, Inc.

Kirk-Othmer Encyclopedia of Chemical Technology, 3rd. edition, 1982. John Wiley & Sons.

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Troller, J.A. 1993. Sanitation in Food Processing, 2nd edition. Academic Press. 478 pp.

May 2003 NOSB meeting
Review of phosphoric acid
Crops