Phosphoric acid

Livestock

Identification

Chemical Names phosphoric acid
Other Names: Orthophosphoric acid, metaphosphoric acid, pyrophosphoric acid

CAS Numbers: 7664-38-2
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:

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

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 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

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