Sodium Carbonate Peroxyhydrate

Crops

Identification of Petitioned Substance

Chemical Name:
sodium carbonate peroxyhydrate

Other Names:
sodium carbonate peroxide
sodium percarbonate
PCS
disodium carbonate, compound with hydrogen peroxide (2:3)
disodium carbonate, hydrogen peroxide (2:3)
carbonic acid disodium salt, compound with hydrogen peroxide (H_2O_2) (2:3)

Trade Names:
FB® Sodium Percarbonate
Provox S
GreenClean® Pro Granular Algaecide Terracyte™
ECOX
PAK 27 Algaecide
technical sodium carbonate peroxyhydrate,
Phycomycin™

CAS Number:
15630-89-4

Other Codes:
128860 (US EPA PC Code)
70299-3, 70299-4, 70299-6, 68660-8, 68660-9
(US EPA Product Registration Numbers)

Characterization of Petitioned Substance

Composition of the Substance:
Sodium carbonate peroxyhydrate is composed of hydrogen peroxide and sodium carbonate. Based on the molecular formula, $2Na_2CO_3 \cdot 3H_2O_2$, pure sodium carbonate peroxyhydrate contains approximately 67.5 percent sodium carbonate and 32.5 percent hydrogen peroxide by weight (HERA 2002a).

However, due to its active oxygen content, commercialized sodium carbonate peroxyhydrate has a purity of more than 85 percent with the remaining 15 percent composed of salts, such as sodium carbonate, sodium chloride, sodium silicates, sodium sulfate, magnesium sulfate, sodium hexametaphosphate, and borates (HERA 2002a).

Properties of the Substance:
Sodium carbonate peroxyhydrate is a white granular, crystalline powder with an average particle size diameter of approximately 300 to 900 μm. It is extremely soluble in water (140 g/L) and has a pH of approximately 10.5 at 1 percent concentration. Because sodium carbonate peroxyhydrate decomposes when heated, a melting and boiling point cannot be determined (HERA 2002a).

Specific Uses of the Substance:
Sodium carbonate peroxyhydrate is used as an oxidizing agent in aquaculture to control algae, as well as for treating ornamental plants, turf grasses, and terrestrial landscapes. It is also used for treatment in commercial greenhouses, garden centers, and plant nurseries (EPA 2002a). Sodium carbonate peroxyhydrate is being petitioned for approval as a synthetic substance for use in organic crop production (NOP §205.601). Specifically, the petitioner intends to use the substance as an algicide, to control algae and noninvasive weeds, such as moss, liverworts, and pearl wort (BioSafe Systems, 2006; EPA 2002a).

Sodium carbonate peroxyhydrate is also used in various cleaning products, detergent formulas, and disinfecting agents (Chem-Online 2006, HPD 2005).

Approved Legal Uses of the Substance:

In 2002, EPA approved the use of TerraCyte™ (EPA Registration Number 70299-3), which uses sodium carbonate peroxyhydrate as the active ingredient, for use as an algicide and fungicide on ornamental plants and turf (EPA 2002b). In 2004, EPA received an application to register a pesticide product containing an active ingredient involving a changed use pattern. Solvay Interox, Inc. of Houston, TX, applied for the approval of PAK 27 Algaecide, a biochemical algaecide. The active ingredient in this algicide—which was being proposed for control of blue-green algae in lakes, ponds, and drinking water reservoirs—is sodium carbonate peroxyhydrate. There is no proposed classification/use (EPA 2004).

Action of the Substance:

In the presence of water, sodium carbonate peroxyhydrate disassociates into hydrogen peroxide and sodium carbonate. The hydrogen peroxide oxidizes critical cellular components of unicellular organisms and other simple multi-cellular organisms such as algae, moss, liverworts, slime molds, and their spores, consequently killing the target organism. The hydrogen peroxide is ultimately broken down into water and oxygen (EPA 2002c). The sodium carbonate dissociates into sodium and carbonate in water, and the carbonate ions subsequently react with water, forming bicarbonate and hydroxide until equilibrium is achieved (HERA 2002b).

Status

International

Sodium carbonate peroxyhydrate is not specifically listed for the petitioned use or other uses in the following international organic standards:

- Canadian General Standards Board
- CODEX Alimentarius Commission
- European Economic Community (EEC) Council Regulation 2092/91
- International Federation of Organic Agriculture Movements
- Japan Agricultural Standard for Organic Production
- California Certified Organic Growers International
- Washington State Department of Agriculture: European Organic Verification Program

Evaluation Questions for Substances to be used in Organic Crop or Livestock Production

Evaluation Question #1: Is the petitioned substance formulated or manufactured by a chemical process? (From 7 U.S.C. § 6502 (21))

Sodium carbonate peroxyhydrate is manufactured from sodium carbonate and hydrogen peroxide. In the final product, there are approximately three molecules of hydrogen peroxide for two molecules of sodium carbonate. Both sodium carbonate and hydrogen peroxide are formed from natural and anthropogenic sources (HERA 2002b, 2005). Sodium carbonate occurs naturally in arid regions—especially in the mineral deposits formed when seasonal lakes evaporate. It can also be produced chemically via the Solvay process, which involves a reaction of sodium chloride from salt deposits, ammonia, limestone, and water to produce ammonium chloride and sodium bicarbonate. The solid sodium bicarbonate is then filtered and converted to sodium carbonate by heating (Kiefer 2002). Hydrogen peroxide forms naturally in the environment and can be found in trace amounts in rain, snow, and plants as a result of photochemical, chemical, or biochemical processes (Agri-Growth International 1999, HERA 2005). It is also produced chemically via autoxidation, a reaction that occurs in open air or in presence of oxygen and/or UV radiation of 2-ethyl-9,10-dihydroxyanthracene to 2-ethylanthraquinone and hydrogen peroxide (Cheresources 2004).

Sodium carbonate peroxyhydrate can be produced from sodium carbonate and hydrogen peroxide by dry, spray, or wet processes (HERA 2002a). The dry process involves spraying an aqueous hydrogen peroxide solution on solid sodium carbonate and results in a solid-liquid reaction to produce sodium carbonate peroxyhydrate. The wet process involves crystallization and salting out to produce sodium carbonate peroxyhydrate (HERA 2002a).

In the spray process, sodium carbonate peroxyhydrate is formed by spraying solutions of sodium carbonate and hydrogen peroxide into a drying chamber that causes the water to evaporate. This process involves the mixing of solutions of sodium carbonate and hydrogen peroxide, while heating in a fluid bed granulator. The water is subsequently evaporated in a drying chamber to yield a dry, granular product (BioSafe Systems 2005, HERA 2002a).

Because of its active oxygen content, commercialized sodium carbonate peroxyhydrate is often coated with single or multiple layers of various hydrophobic substances in order to increase the stability and storage of the final product. Examples of these hydrophobic substance and surfactants that are generally inert in presence of peroxy compounds include the following:

- fats, waxes or phosphotides;
- surfactants dissolved in the hydrophobic substance;
- disilicate and some chelating agent, such as glutaric acid, pimelic acid, citric acid, dicarboxylic acids; and
- inorganic compounds selected from alkali or alkaline earth metal carbonates, sulphates, chlorides and nitrates (Yun and Baoguo 2004).

Evaluation Question #2: Is the petitioned substance formulated or manufactured by a process that chemically changes the substance extracted from naturally occurring plant, animal, or mineral sources? (From 7 U.S.C. § 6502 (21).)

Although sodium carbonate peroxyhydrate is composed of substances that occur naturally in the environment (OCI Chemical Corporation 2000), the petitioned substance is not extracted from naturally occurring plant, animal, or mineral sources.

Evaluation Question #3: Is the petitioned substance created by naturally occurring biological processes? (From 7 U.S.C. § 6502 (21).)

The petitioned substance is not created by naturally occurring biological processes. As described in Evaluation Question #1, the petitioned substance is created by a chemical process that involves the mixing of sodium carbonate and hydrogen peroxide.

Evaluation Question #4: Is there environmental contamination during the petitioned substance's manufacture, use, misuse, or disposal? (From 7 U.S.C. § 6518 (m) (3).)

As noted previously, sodium carbonate peroxyhydrate is formed from hydrogen peroxide and sodium carbonate, both of which are included on the NOP National List. According to EPA (2002c), sodium carbonate peroxyhydrate appears to be biodegradable and is likely to have a low impact on crops or stored agricultural products.

Additionally, according to the California state Water Resources Control Board (CSWRCB), there is currently no state or EPA-based criteria for sodium carbonate peroxyhydrate; therefore, there are no receiving water limitations for this compound. However, dischargers of aquatic pesticides are required to monitor their releases of sodium carbonate peroxyhydrate (CSWRCB 2006).

No additional information available from EPA or other sources suggests that environmental contamination will result from the manufacture, use, misuse, or disposal of sodium carbonate peroxyhydrate.

Evaluation Question #5: Is the petitioned substance harmful to the environment? (From 7 U.S.C. § 6517 (c) (1) (A) (i) and 7 U.S.C. § 6517 (c) (2) (A) (i).)

According to the EPA (2002a), sodium carbonate peroxyhydrate should not cause unreasonable adverse effects to the environment when used in accordance with printed directions and warnings on the label. Sodium carbonate peroxyhydrate dissolves rapidly and biodegrades in the presence of water by readily disassociating into hydrogen peroxide and sodium carbonate (EPA 2002c).

According to the CSWRCB (2006), hydrogen peroxide has a half-life of less than 8 hours in an aquatic environment and is degraded via hydrolysis, photolysis, anaerobic and aerobic metabolism, leaching and adsorption/desorption, and sediment dissipation. Hydrogen peroxide subsequently decomposes into water and oxygen (HERA 2002a, DC Chemical Co., Ltd. 2001).

According to the "HERA Risk Assessment for Sodium Carbonate" (2002b), sodium carbonate dissociates into sodium and carbonate in water. Because these ions do not readily adsorb to sediment, there is little risk for the distribution or transport of these ions to the atmosphere. For this reason, however, environmental risks may occur in the aquatic environment. Sodium carbonate in water results in an increase in alkalinity and a subsequent increase in pH. The carbonate ions react with water, forming bicarbonate and hydroxide until equilibrium is achieved. In addition, both sodium and inorganic carbon that result from the breakdown of sodium carbonate are ubiquitous in the environment (HERA 2002b). However, alterations in pH may influence the availability and solubility of chemicals in impacted waterbodies and may aggravate nutrient problems, thus affecting sensitive systems. For example, an alteration in pH may cause the solubility of phosphorus to increase, which would make it more available for plant growth. Consequently, this could result in a greater long-term demand for dissolved oxygen (Water on the Web 2004). Available acute ecotoxicity studies with fish and water fleas resulted in LC_{50} values that were higher than 68 mg/L. The resulting increase in pH of the receiving water was used to determine the acceptable amount of sodium carbonate that can be added to aquatic ecosystems, and depending on the buffer capacity of the aquatic ecosystem, it was determined that an acceptable amount of sodium carbonate in water ranges between 2 and 20 mg/L (HERA 2002b).

If label instructions are not followed, the petitioned substance may be toxic to birds, fish, and aquatic invertebrates. According to EPA (2002c), manufacturers of products containing sodium carbonate peroxyhydrate are required to place labels containing the following information on their products:

> Do not apply directly to water, or to areas where surface water is present or to inter-tidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of wash waters. This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment. Do not apply this product or allow it to drift to crops where beneficial insects are part of an integrated pest management strategy.

In addition, manufacturers of sodium carbonate peroxyhydrate are required to place labels on their product that state that all applications (of the granular pesticide) must be made over wet surfaces. One reason for this warning is that non-target plants may suffer contact burn if undiluted granules are accidentally spilled on them (UCIPM 2006). Birds or other animals may also be at risk of ingesting the granules if spilled on dry ground.

Evaluation Question #6: Is there potential for the petitioned substance to cause detrimental chemical interaction with other substances used in organic crop or livestock production? (From 7 U.S.C. § 6518 (m)(1).)

Several substances can reduce the stability of sodium carbonate peroxyhydrate and result in the accelerated decomposition of the petitioned substance. For this reason, sodium carbonate peroxyhydrate should not be mixed in the presence of heat or with any materials containing the following substances according to Solvay Chemicals (2005):

- water;
- transition metals (e.g., iron, manganese, nickel, chromium) and their salts;
- organic materials;
- acids;
- bases;
- reducing agents; and
- dirt.

When sodium carbonate peroxyhydrate decomposes, it releases oxygen and heat which could result in the combustion of other substances (Solvay Chemicals 2005).

Evaluation Question #7: Are there adverse biological or chemical interactions in the agro-ecosystem by using the petitioned substance? (From 7 U.S.C. § 6518 (m) (5).)

The potential exists for an increase in soil and water pH due to repeated application of sodium carbonate peroxyhydrate in the agro-ecosystem. Sodium carbonate, a breakdown product of the petitioned substance, further disassociates into sodium and carbonate in water and results in an increase in alkalinity and pH. Such an increase in soil pH may adversely affect plant growth, but is not expected to significantly affect water quality. The carbonate ions will react with water, forming bicarbonate and hydroxide until equilibrium is achieved (HERA 2002a, 2002b, UCIPM 2006).

In addition, both sodium and inorganic carbon resulting from the breakdown of sodium carbonate are ubiquitous in the environment. In general, sodium has a low toxicity and because the amount of sodium released is relatively low compared to background concentrations, it will not have an adverse effect on the aquatic organisms in the receiving water (HERA 2002b).

Evaluation Question #8: Are there detrimental physiological effects on soil organisms, crops, or livestock by using the petitioned substance? (From 7 U.S.C. § 6518 (m) (5).)

Because sodium carbonate peroxyhydrate and its breakdown product hydrogen peroxide are oxidizing agents, there is a potential for low level of toxicity to birds, fish, aquatic invertebrates, non-target plants, and non-target insects (e.g., honey bees) as a result of its use. However, when used in accordance with printed directions and warnings on the label, no harm is likely for these organisms (EPA 2002a, UCIPM 2006). Thus, EPA has waived all Tier 1 ecological studies for registration of products containing the petitioned substance.

Evaluation Question #9: Is there a toxic or other adverse action of the petitioned substance or its breakdown products? (From 7 U.S.C. § 6518 (m) (2).)

Based on its intended use, sodium carbonate peroxyhydrate and its breakdown products are unlikely to cause toxic or other adverse effects. Sodium carbonate peroxyhydrate is composed primarily of hydrogen peroxide and sodium carbonate, which are generally biodegradable and nontoxic (see Evaluation Question #5) (EPA 2002a).

Additionally, both of the production and breakdown products are included as allowed substances on the NOP National List. According to NOP §205.605(a), sodium carbonate may be used as an ingredient in or on processed products for livestock production labeled as "organic" or "made with organic." Hydrogen peroxide is a synthetic substance that is allowed under NOP §205.601(4) in crop production as long as it does not contribute to contamination of crops, soil, or water.

However, in addition to producing oxygen and water, the decomposition of hydrogen peroxide also produces approximately 200 times its own volume in gas. This gas production can pose a risk of explosion for the handling and storage of any product containing sodium carbonate peroxyhydrate (Kemira 2005).

Evaluation Question #10: Is there undesirable persistence or concentration of the petitioned substance or its breakdown products in the environment? (From 7 U.S.C. § 6518 (m) (2).)

According to the EPA (2002c), sodium carbonate peroxyhydrate is a reduced-risk pesticide due to its unstable nature. More specifically, in the presence of water, sodium carbonate peroxyhydrate decomposes into hydrogen peroxide and sodium carbonate. Additionally, once the hydrogen peroxide has oxidized its target, it decomposes into water and oxygen (EPA 2002a). Other degradation products include carbon dioxide, bicarbonate, and carbonate. According to the Material Safety Data Sheets (MSDSs) for Terracyte® and GreenClean® Pro, none of these degradation products are threat for persistence in the environment (BioSafe Systems 2004, 2005). Thus, the products and their breakdown products are unlikely to have an undesirable persistence in the environment when used as petitioned and according to printed directions and warnings on the product label.

Evaluation Question #11: Is there any harmful effect on human health by using the petitioned substance? (From 7 U.S.C. § 6517 (c) (1) (A) (i), 7 U.S.C. § 6517 (c) (2) (A) (i)) and 7 U.S.C. § 6518 (m) (4).)

According to the results of an eye irritation study, adult rabbits demonstrated severe irreversible eye damage (conjunctival irritation including corneal and iridial effects) when exposed to sodium carbonate peroxyhydrate over a 96-hour period (EPA 2002c). Other adverse health effects resulting from exposure to sodium carbonate peroxyhydrate include slight irritation of the skin if directly contacted; severe irritation of the mouth, throat, esophagus, and stomach if swallowed; and slight irritation of the nose and throat if swallowed; no other adverse effects on human health from the intended use were identified (BioSafe Systems 2004, 2005).

The EPA has determined that no unreasonable adverse effects to the general population, including infants and children, will result from sodium carbonate peroxyhydrate usage if used in accordance with label instructions (EPA 2002a). In addition, according to the "HERA Risk Assessment of Sodium Percarbonate" (HERA 2002a), neither hydrogen carbonate peroxyhydrate itself nor hydrogen peroxide or carbonate present a risk for reproductive, developmental, or systemic toxicity.

Evaluation Question #12: Is there a wholly natural product which could be substituted for the petitioned substance? (From 7 U.S.C. § 6517 (c) (1) (A) (ii).)

Cinnamic aldehyde occurs naturally in the bark of cinnamon trees and other trees of the same genus, and can be used as a fungicide (EPA 2000). At the correct concentrations, cinnamic aldehyde kills mosses, liverworts, and pearlworts (*Sagina* sp.), and ornamental crops, such as Scotch Moss, without any phytotoxicity to the crop plants (Svenson, undated). Furthermore, according to the EPA, cinnamic aldehyde is not soluble in water and is rapidly degraded in the soil; thus, it is not expected to pose any hazard to non-target organisms (EPA 2000).

Evaluation Question #13: Are there other already allowed substances that could be substituted for the petitioned substance? (From 7 U.S.C. § 6518 (m) (6).)

According to NOP 205.601(a), other allowed algicides, disinfectants, and sanitizers, including irrigation system cleaning systems that could be substituted for sodium carbonate peroxyhydrate include the following:

(1) alcohols.
  (i) ethanol.
  (ii) isopropanol.
(2) chlorine materials – Except, that, residual chlorine levels in the water shall not exceed the maximum residual disinfectant limit under the Safe Drinking Water Act.
  (i) calcium hypochlorite.
  (ii) chlorine dioxide.
  (iii) sodium hypochlorite.

(3) copper sulfate – for use as an algicide in aquatic rice systems, is limited to one application per field during any 24-month period. Application rates are limited to those which do not increase baseline soil test values for copper over a timeframe agreed upon by the producer and accredited certifying agent.
(4) hydrogen peroxide.
(5) ozone gas – for use as an irrigation system cleaner only.
(6) peracetic acid – for use in disinfecting equipment, seed, and asexually propagated planting material.
(7) soap-based algicide/demossers.

Evaluation Question #14: Are there alternative practices that would make the use of the petitioned substance unnecessary? (From 7 U.S.C. § 6518 (m) (6).)

The relatively recent development of commercial blends of bacteria and enzymes, often called microbial products, provides a potential alternative to the use of algicides used in lake and pond management. However, results from a greenhouse study did not suggest that microbial products are as efficacious as biological controls for algae (Duvall and Anderson 2001).

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