



H. Environmental Assessment

1. Date:

January 14, 2000

2. Name of Petitioner:

Eka Chemicals, Inc.

3. Address:

1775 West Oak Commons Court
Marietta, Georgia 30062-2254

4. Description of Proposed Action:

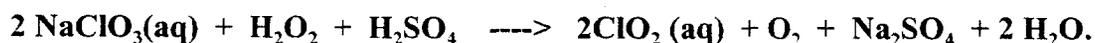
This petition requests that FDA amend 21 C.F.R. § 173.300 to approve a chlorate-hydrogen peroxide-sulfuric acid based generator system for the production of chlorine dioxide for disinfection of fruits and vegetables and poultry. Section 173.300 already approves chlorine dioxide for these uses when generated with chlorite-based or chlorite-chlorine-based generators. The proposed generation is potentially less polluting to the environment than conventional systems. Since no chlorine is used, unreacted chlorine from overfeed in the chlorite-based processes is not an issue. Therefore, virtually no hazardous chlorinated hydrocarbons such as trihalomethanes are produced.

As with the other approved chlorine dioxide generators, the chlorate-based generator will be located adjacent to the process water used in food processing plants throughout the United States. And, like these other approved generators, most of the chlorine dioxide will be consumed by the oxidation of organic matter and microorganisms present in the food process water. Consumed chlorine dioxide is reduced to chlorite and chlorate and eventually to chloride. Food processing water is either discharged to the local Publically-Owned Treatment Works (POTW's) or to irrigation water systems. Consequently, the use of chlorine dioxide produced with this technology to control microbial growth may result in small amounts of chlorine dioxide, sodium chlorite, sodium chlorate, and sodium sulfate being discharged to POTW's or irrigation water systems.

5. Identification of Chemical Substances that are the Subject of the Proposed Action

(a) Chemical Information for the Subject Additive, Precursor Chemicals and Impurities

The only difference between the proposed chlorate-based generation system and the chlorite-based systems is a slight difference in the chemical impurities discharged due to the difference in starting materials. The process is based on the following chemical equation:



In addition to the chlorine dioxide and its oxidation products, the process generates sodium sulfate and oxygen. The hydrogen peroxide completely decomposes to water and oxygen and does not contribute any contaminants. The oxygen created is much less than found normally in water in equilibrium with air at standard conditions. Only dilute sodium sulfate and dilute sulfuric acid are produced in process water in addition to chlorine dioxide and its oxidation products.

The most advanced feature of the generator is a microprocessor-based electronic controller to regulate reactor feed, calculate efficiency and control output. An ultraviolet (UV) spectrophotometer is used to continuously monitor the system. The controller offers programming flexibility and provides automatic control of ClO_2 generation. The operator need only enter the desired production rate to have the controller respond by adjusting reagent flows to maintain ClO_2 production with a conversion efficiency of up to 95% to 98%. (As a worst-case, we have employed a 90% conversion level in our exposure calculations for possible contaminants, as this is the minimum reaction efficiency for chlorine dioxide specified in Section 173.300.)

Excess sulfuric acid (approximately 4 times stoichiometry) is added to accelerate the reaction rate to achieve efficiency in the 95-98% range. (We use the 4-fold excess in order to be

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conservative in spite of the fact that less acid would be needed to achieve 90% efficiency.) The pH of the process water due to the unreacted sulfuric acid would be approximately 5.6, but if excess acid is added (4 times stoichiometry), the pH can drop to 3.35. This acidification can be neutralized with sodium carbonate, or some other acceptable, GRAS base if desired.

In summary, sulfate and hydrogen ion, are the only new contaminants not also produced by the chlorite-based ClO₂ generators.

The subject additive of this petition, chlorine dioxide, is presented below.

- | | |
|--|--|
| 1. Chemical Name | Chlorine Dioxide |
| 2. Synonyms | Chlorine Oxide, Chlorine (IV) Oxide |
| 3. CAS Registry Number | 10049-04-4 |
| 4. Formula and Structure
Molecular weight | ClO ₂ and O=Cl=O
67.45 g/mole |
| 5. Properties | |
| Melting point | -59 °C |
| Boiling point | 11 °C |
| Solubility | 3.01 g/l (@ 25 °C and 34.5 mm Hg) |
| 6. Purity | The purity of the starting materials is presented in Appendix III . Consistent with the regulatory level in Section 173.300, we have assumed 90% conversion efficiency in our calculations of impurities. |

(b) Use Rates

A maximum residual chlorine dioxide concentration level of 3 ppm is specified by Section 173.300 for use on fruits and vegetables and for use in poultry processing. These approved levels for chlorite-based generators are equally appropriate for chlorate-based generators since the same active ingredient is generated. This entails a production rate of as high as 10 ppm to maintain 3 ppm in contact with food and microorganisms. This is a maximum figure that will be used in the calculations so that possible environmental contamination will be evaluated conservatively. In

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practice, many users of the generation system may achieve 3 ppm residual chlorine dioxide with less total generation than 10.0 ppm chlorine dioxide.

(c) Impurities

This Environmental Assessment concentrates only on the impurities that are produced in addition to the oxidation products of chlorine dioxide which are generated at the same concentrations in already evaluated and approved chlorite-based generation systems, specifically sulfate and sulfuric acid.

Sulfate - The process produces sodium sulfate in the 20-30 ppm range. Most of this is from added excess sulfuric acid. Sodium sulfate is an innocuous salt with many uses as an indirect food additive in foods at low concentration levels. 21 C.F.R. §§ 173.310, 175.125, 177.120, 177.1400. Sodium sulfate at these low levels is safe for human consumption.

Sulfate ion or sulfate is found almost universally in natural waters in concentration ranging from a few tenths of a mg/liter up to several thousand mg/liter. In a 1970 survey of drinking water supplies the range of sulfate concentrations ranged from a low of 1 mg/liter (1.0 ppm) up to 770 mg/liter with an average of 46 mg/liter. NAS (1977) *DWAH*, Vol. 1.

The NOAEL of sulfate recommended by the NAS in 1977 was 500 mg/liter, whereas the taste threshold may be as low as 200 mg/liter. The same level was adopted in the Academy's Fourth Report, 1982. The 1962 Drinking Water Standards of the U.S. Public Health Service recommended that sulfate in water should not exceed 250 mg/liter except when no more suitable supplies are available. NAS (1977), *DWAH*, Vol. 1.

A maximum of 28.5 ppm (28.5 mg/liter) is anticipated to be in process water; it is therefore safe and has no toxic significance as a contaminant in the retained water on the surface of fruits or vegetables.

Sulfuric acid - The expected decrease in pH from neutrality is to 3.35 ($\text{pH} = -\log [\text{H}^+] = -\log [5.11 \times 10^{-4}] = 3.35$). This is usually lower than the pH of most raw water supplies, and raises the possibility of enhanced corrosion in distribution pipes. Prior to entering the distribution

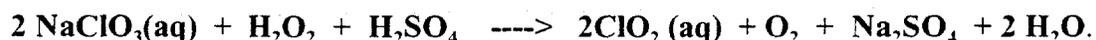
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system in the Seattle area the pH of the water was 5.4. Dangle, (1975) *Study of corrosion products in the Seattle Water Department*, EPA-670/2-75-036 EPA, Cincinnati, Ohio. However, there is little concern for health from this low acid level. Citrus fruits and some vegetables have even lower pHs. Irritation of the skin does not usually occur on contact with acids in this pH range. In fact, the skin typically has a more than adequate buffering capacity to handle occasional exposures to such low levels of hydrogen ions. Ingestion of water at this pH is totally without health consequences. This is apparent when one recalls the pH of the stomach content is approximately 1-1.5 due to hydrochloric acid.

6. Introduction of Substances into the Environment

(a) Production Releases

The chlorine dioxide is produced on site within a closed reactor. Therefore, production releases (none) and use releases (a small amount) occur at the same site. This chlorate-based chlorine dioxide generation is based on the reduction of sodium chlorate by hydrogen peroxide in the presence of sulfuric acid. The stoichiometric chemical equation is:



The starting chemicals are fed into the water-containing reactor and the finished aqueous solution is automatically drawn out of the reactor and metered into the stream of process water. We use 90% conversion in our calculations to conform to the FDA minimum. The products entering the process water stream consist of the following: (1) chlorine dioxide, (2) sodium sulfate, (3) oxygen, and (4) water. In addition there are small amounts of the following unreacted starting ingredients: sodium chlorate, sulfuric acid, and hydrogen peroxide. The chlorine dioxide-containing water adds a very small volume increment to the stream of the process water (typically

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1 part per 100 or less). The rate of introduction of the ClO_2 is controlled by monitoring the chlorine dioxide concentration and maintaining it at a residual concentration of 3 ppm.

Excess sulfuric acid may be added. Since the excess acid is not consumed in the reaction, it is carried over into the process water where it increases the pH. It is assumed that 4 times the stoichiometric amount of sulfuric acid has been added.

(b) Use Releases

Air Releases - Air releases from the approved uses of chlorine dioxide are negligible. Since the production of chlorine dioxide is confined to a closed system, the only potential release of ClO_2 is by evaporation from the process water. The EA from FAP No. 4A4408 (poultry) showed that the maximum possible air concentration of ClO_2 from a ClO_2 aqueous solution of chiller water was 0.03 ppm. This level would soon decrease further by decomposition processes active in the outside environment. Appendix 4 of FAP No. 4A4408 provides the complete calculation for estimating air concentration of chlorine dioxide. The generation system for fruit and vegetable processing are similar and the air releases of ClO_2 will be similarly negligible.

Water Releases - According to the stoichiometric equation above, one mole of sodium sulfate is produced for every 2 moles of chlorine dioxide formed. Sodium sulfate is therefore the principal impurity formed in the process of ClO_2 generation and is carried with it onto the food. The equation also shows that water and oxygen gas are formed. The formed oxygen contributes to the much larger amount of ambient oxygen (approximately 30 ppm) required to saturate water at normal pressure and temperature. Data show that virtually all of the hydrogen peroxide decomposes into water and oxygen before it enters the process stream.

In addition to these primary products, it is assumed that approximately 10% of the unreacted starting ingredients may be carried over into the process water stream (based on 90% reaction efficiency). The sulfuric acid will be approximately 4.45×10^{-4} molar in the process stream. The pH of the process water due to the excess carried-over sulfuric acid would in this case be approximately 3.35. This acidification can be neutralized with sodium carbonate, or some

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other acceptable GRAS buffer if desired, but the pH is within the range of variation of many process waters.

In order to maintain a chlorine dioxide residual of 3 ppm in the process water, more than 3 ppm must be generated to allow for the ongoing reaction with food and food microorganisms. The precise amount of excess chlorine dioxide depends on the demand of the process and the degree of decontamination desired. Other petitioners have suggested that a total generated level of 5-10 ppm chlorine dioxide is adequate for both poultry and fruits and vegetables. We have chosen 10 ppm for the calculations. Upon reaction with food or food microorganisms, chlorine dioxide immediately forms chlorite and some chlorate. The Amended Environmental Assessment for FAP No. 4A4415 (fruits and vegetables) cites data from Werdenoff and Singer, 1987, and from several other tests that show that residual chlorite concentration is about 70% of chlorine dioxide consumed with chlorate likely accounting for most of the remainder. We have used this 30/70 ratio to calculate the residual chlorate/chlorite concentrations.

The information presented at **Table 2** provides the calculated concentration of the unreacted starting materials and the products produced by the generating reaction. If it is assumed (as in the Amended EA to FAP No. 4A4415) that 50% of the total water discharged from a food processing plant is treated with chlorine dioxide, then the concentration of effluent from such a plant would be one half of the concentration of the process water. Further, if a worst-case estimate of the flow percentage that is contributed by a food processing plant is 27% of the total (as in the Amended EA to FAP No. 4A4415), then the average POTW contribution would be only 27% of the waste water concentration. For further information, please see the calculations provided in **Appendix IV**.

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Table 2 Concentration of Components in the Process Water Stream, the Waste Water Stream, and the Average Concentration distributed to POTW's per 10 ppm of ClO ₂ Produced				
Compound	Conc (M) (Process water)	PPM (Process water)	PPM (Waste water)	Avg PPM (Distribution water)
ClO ₂	4.45 x 10 ⁻⁵	3.0	1.50	0.41
SO ₄ ⁻²	2.97 x 10 ⁻⁴	28.5	14.25	3.85
H ⁻	4.45 x 10 ⁻⁴	0.448	0.224	0.06
ClO ₂ ⁻¹	7.26 x 10 ⁻⁵	4.90	2.45	0.66
ClO ₃ ⁻¹	4.76 x 10 ⁻⁵	3.97	2.00	0.54
H ₂ O ₂	0.0	0.0	0.0	0.0

Based on the assumption that the reaction goes 90% to completion. The amounts include (1) the yield pertaining to 10 ppm ClO₂, (2) the unreacted starting material passing over into the process water representing 10% (on a Molar basis) of the products, and (3) the decomposition of 7.0 ppm of ClO₂ back to chlorite and chlorate in a 7:3 ratio. The amounts also include 4 times the stoichiometric quantity of acid.

These effluents are comparatively low strength wastes which are well within the capacity of POTW's. None of these calculated concentrations reflect the fact that most of the chlorine-containing substances would be reduced to chloride before completing its circulation within the distribution system. EPA, Sept. 1987, *Guidance Manual for Preventing Interference at POTW's* NITS No. PB92-117969, provides a published a list of substances known to cause interference with POTW's. Neither chlorite, chlorate or chlorine dioxide were indicated on the list. (Amended EA to FAP No. 4A4415, Appendix 3).

As indicated by **Table 2**, the input of chlorine dioxide oxidation products to POTW's from food processing plants is small and well below levels added by POTW's themselves to treat water for purification. The purity of the treated water from POTW's will not be affected by the low levels of chlorine dioxide products coming from food processing plants. Also, as indicated above, the pH of waters entering POTW's is naturally variable within a wide range and the small contribution of acidified water from food processing plants is well within normal variation. The same is true for sulfate ion.

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Irrigation Systems - Use of fruit and vegetable process water as irrigation water is anticipated to have a negligible environmental impact since extensive efforts are made, particularly in California, to conserve irrigation water. Accordingly, runoff of irrigation water to aquatic bodies is expected to be very limited.

Indoor air releases - The air concentration of chlorine dioxide from its use in disinfecting processed fruits and vegetables and from poultry is expected to be below the U.S. Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 0.1 ppm (0.3 mg/m³). This conclusion is based on the information supplied in the Amended EA to FAP No. 4A4415.

(c) Compliance status

Chlorine dioxide generated by the processes prescribed at Section 173.300 is cleared for use in the processing of poultry and fruits and vegetables. SVP-Pure generated chlorine dioxide is intended to replace that which is now produced and used in compliance with the existing provisions of Section 173.300. Accordingly, approval of the subject petition should not affect compliance with current regulations.

7. Fate of Emitted Substances in the Environment

As discussed above in Section 6 of this EA, the previous petitions demonstrate that chlorine dioxide will be rapidly converted in the environment to chlorite and chlorate. These are moderately stable in water but both substances will eventually be reduced to chloride.

The use of the chlorate-peroxide-sulfuric acid based generator will contribute only small levels of sulfate and acid (hydrogen ion) in addition to the chlorine dioxide derived products. As indicated in Section 6, these levels are within normal variation from natural water.

8. Environmental Effects of Released Substances

We incorporate by reference the studies used in the Amended EA of FAP No. 4A4408 to support the use of chlorine dioxide from chlorite-generation. These include (1) Aquatic studies; (2) Terrestrial Organism Studies; and (3) Environmental Benefits.

Chlorine dioxide is an alternative to chlorine for disinfection in the poultry industry and in the fruit and vegetable industries. Widespread replacement of chlorine with chlorine dioxide has already occurred. We anticipate that the proposed method of chlorine dioxide generation, with its economic advantages, will encourage more switching from chlorine as well as some replacement of chlorite-generation. The energy trade off is negligible; the energy required to manufacture chlorine dioxide is offset by a decrease in the energy required for chlorine manufacture.

Sulfate is found almost universally in natural bodies of water at concentrations ranging from a few tenths of a mg/L up to several thousand mg/L. In a 1970 survey of drinking water supplies, the range of sulfate concentrations ranged from a low of 1 mg/liter up to 770 mg/liter, with an average of 46 mg/liter. NAS (1977) *Drinking Water and Health*, Vol. 1.

The NOAEL of sulfate recommended by the NAS in 1977 was 500 mg/liter, whereas the taste threshold may be as low as 200 mg/liter. The same level was adopted in the Academy's Fourth Report, 1982. The 1962 Drinking Water Standards of the U.S. Public Health Service recommended that sulfate in water should not exceed 250 mg/liter except when no more suitable supplies are available. NAS (1977) *DWH*, Vol. 1.

9. Mitigation measures

No adverse environmental effects are anticipated if this petition is approved. Therefore mitigation measures are not required.

10. Alternatives to Proposed Action

No alternative actions are necessary.

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Eka Chemicals, Inc.

11. List of Preparers

This assessment was prepared by Robert J. Scheuplein, Holly H. Foley, and Martha E. Marrapese.

12. Certification

The undersigned certifies that the information presented is true, accurate and complete to the best knowledge of Keller and Heckman LLP.

Name: Martha E. Marrapese

Title:

Signature:

Date: January 14, 2000

* * *

The foregoing and all appendices to this Petition considered, it is respectfully requested that the Food and Drug Administration promulgate an order amending Section 173.300 of the food additive regulations in substantially the form proposed in **Appendix I** of this Petition to permit the use of chlorine dioxide produced by chlorate-peroxide-sulfuric acid generator.

Respectfully submitted,
Eka Chemicals, Inc.

By


Martha E. Marrapese
Keller and Heckman LLP

Counsel for the Petitioner



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Eka Chemicals Inc.

APPENDIX I

PROPOSED ORDER

Title 21	-	FOOD AND DRUGS
Chapter 1	-	FOOD AND DRUG ADMINISTRATION
		PART 173 - SECONDARY DIRECT FOOD ADDITIVES:
		PERMITTED IN FOOD FOR HUMAN CONSUMPTION
Subpart D	-	Section 173.300
		Chlorine dioxide.

The Commissioner of the Food and Drug Administration, having evaluated the data submitted in a Petition filed by Eka Chemicals, Inc., Marietta, Georgia, has concluded that Part 173 of the food additive regulations should be amended in Section 173.300 to provide for the safe use of chlorine dioxide produced by the reduction of sodium chlorate by hydrogen peroxide in the presence of sulfuric acid with poultry and fruits and vegetables.

Therefore, pursuant to the provisions of the Federal Food, Drug, and Cosmetic Act (§ 409(C)(1), 72 Stat. 1786; 21 U.S.C. § 348(c)(1)), and under the authority delegated to the Commissioner (21 C.F.R. § 5.1), Part 173 is amended in Section 173.300, paragraph (a), by inserting text to read as follows:

§ 173.300 Chlorine dioxide.

* * *

(a) The additive is generated by one of the following methods: (1) treating an aqueous solution of sodium chlorine gas or a mixture of sodium hypochlorite and hypochloric acid, or (2) treating an aqueous solution of sodium chlorate with hydrogen peroxide in the presence of sulfuric acid. The generator effluent contains at least 90 percent (by weight) of chlorine dioxide with respect to all chlorine species as determined by . . .



APPENDIX II

SVP-PURE™ CHLORINE DIOXIDE GENERATOR, DIAGRAM

000036

SVP-Pure™ ClO₂ Process Technology

EKA CHEMICALS: THE LEADER IN ADVANCED ClO₂ TECHNOLOGY

Since the introduction of the Single Vessel Process (SVP®) in 1969, Eka Chemicals has maintained its position as the world leader in innovative chlorine dioxide (ClO₂) technology. We're continually developing new technologies to produce ClO₂ safely and efficiently — with the lowest possible impact on the environment. It's no wonder Eka Chemicals has been called on to install more than 50 advanced, large-scale ClO₂ generation systems for the worldwide pulp and paper industry.

While the majority of the ClO₂ produced today is used for bleaching wood fibers, it is increasingly growing in acceptance for water treatment, disinfection and sterilization applications. ClO₂ is a strong oxidizer. It effectively oxidizes metals and is highly reactive with organic species, breaking down aromatic rings and high molecular weight organics, without producing chlorinated organic by-products.

Despite the obvious cost saving advantages over chlorite-based systems, small-scale sodium chlorate-based processes have not enjoyed widespread application. This has been largely due to the inability to achieve high chemical conversion efficiencies without excess acid feed, undesirable by-products or the implementation of very sizable, costly systems.

With the invention of Eka Chemicals' new SVP-Pure™ (patent pending) process technology, all of this has changed. The new process employs the attributes of our patented hydrogen peroxide chemistry, successfully operating in large production bleaching operations, and fulfills the demand for much lower levels of production.

SVP-PURE™ CHLORINE DIOXIDE TECHNOLOGY: PROCESS ADVANTAGES

HIGHLY EFFICIENT - Eka Chemicals' proprietary reaction vessel design optimizes mixing of feed chemicals yielding high conversion rates. System efficiencies of 95+% are consistently maintained via programmable logic control (PLC).

CHLORINE-FREE - In comparison to competitive technologies, the environmentally friendly SVP-Pure™ chemistry requires no gaseous chlorine feed and no chloride ion addition, thus eliminating by-product chlorine.

ECONOMICAL - Based on the relative costs between sodium chlorate and sodium chlorite, and given its high chemical conversion efficiencies, SVP-Pure™ can achieve significant reductions in operating costs.

EASY TO OPERATE - An onboard, fully programmed PLC enables truly operator-friendly performance of the SVP-Pure™ system. Simply enter the desired ClO₂ production rate and the system responds, accurately maintaining production at high efficiency.

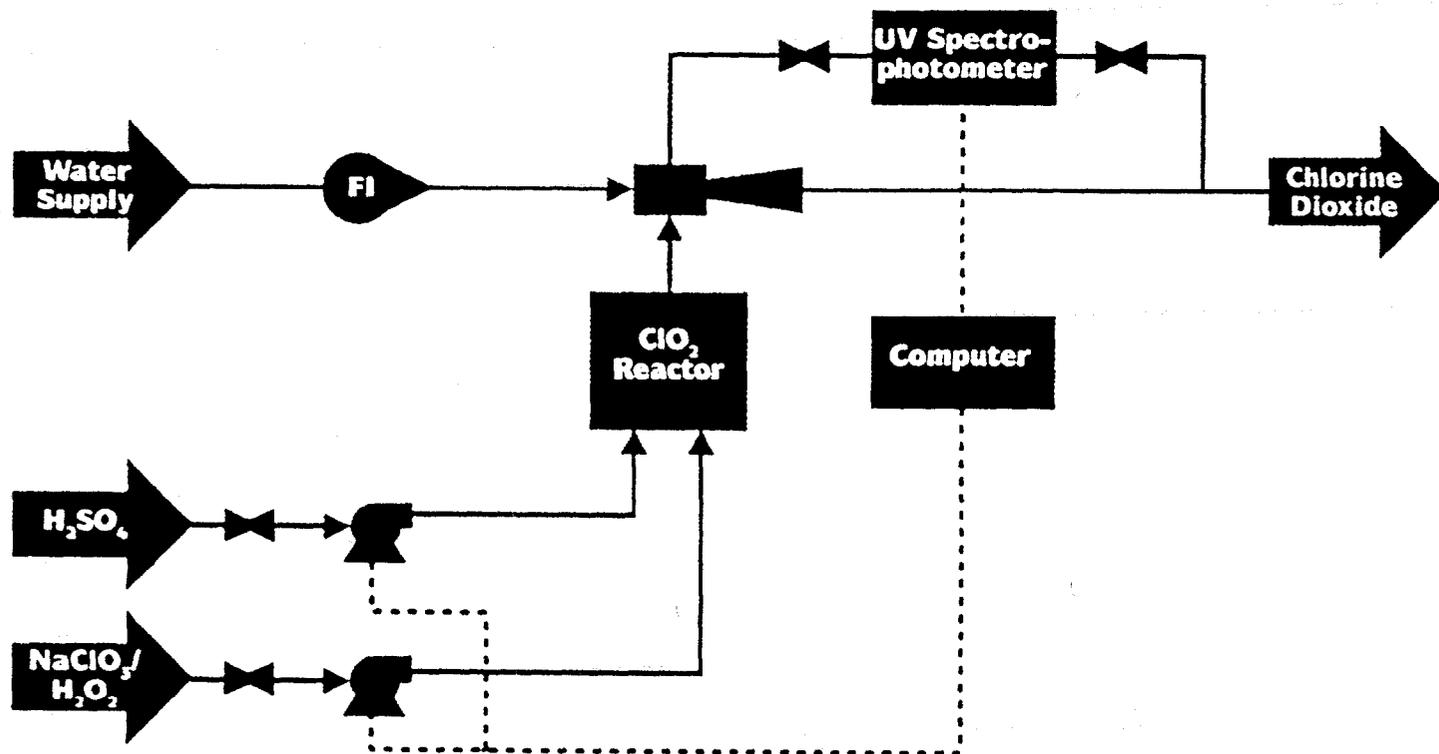
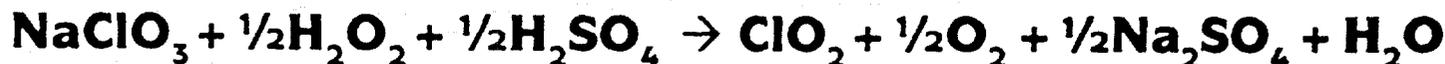
RELIABLE - The SVP-Pure™ system has proven reliable in long-term field applications. System design, materials of construction, and component selections are based on Eka Chemicals' 30+ years of experience in ClO₂ process design and fabrication.

SAFE - As with all Eka Chemicals' SVP® installations, safety is a primary concern. The SVP-Pure™ design has been challenged by the most rigorous hazard/safety analysis. The highest level of safety is achieved with the application of Eka Chemicals' emergency shutdown logic and our fail-safe process design concept.



An Efficient, Environmentally Friendly Chemistry

Eka Chemicals' small-scale reaction unit uses the company's patented hydrogen peroxide-based chemistry. Sodium chlorate is reduced by hydrogen peroxide in sulfuric acid to produce chlorine dioxide as shown in the equation below. The advantages of this chemistry are fast reaction speeds and no harmful by-products, i.e., chlorine.



The unique system design provides safe, reliable operation

The chlorine dioxide production system is sized to produce up to 10 lb/hr of chlorine dioxide. The process flow diagram is illustrated above.

The unit consists of small chemical metering pumps which transfer sodium chlorate, sulfuric acid, and hydrogen peroxide. The chemicals enter Eka Chemicals' proprietary reactor. Inside the reactor, the chemicals react to produce chlorine dioxide, oxygen, sodium sulfate and water. The products are drawn out of the reactor into a water slip stream. The motive water flows through an eductor which creates a vacuum for removing products from the reactor. Chemical products are absorbed in the process stream entering the eductor. The rate of chlorine dioxide generation is monitored using an ultraviolet (UV) spectrophotometer.

The process water contains chlorine dioxide and small amounts of unreacted by-products. Chemical conversions are typically

greater than 95% over the 1-10 lb/hr production range. Hydrogen peroxide reacts in the process and none enters the process water. Unreacted sulfuric acid exits the reactor with the product and consequently lowers the process water pH. If it is necessary, any of several chemicals, magnesium oxide, sodium carbonate, caustic, etc., can be used to neutralize the water without adverse effects on the chlorine dioxide.

The desired production rates are maintained at high chemical efficiencies utilizing a user-friendly PLC. Fail-safe operation is also maintained via the PLC, which incorporates Eka Chemicals' emergency shutdown logic.

Call on Eka Chemicals for your ClO₂ requirements

Experience has made Eka Chemicals the world's source for ClO₂ process technology. To discover the tremendous difference our SVP-Pure™ technology can make for your application, contact an Eka Chemicals' Sales Representative at 1 800 241-3900. We'll provide valuable information and technical details on how SVP-Pure™ can fulfill your ClO₂ production requirements.



APPENDIX III

PRODUCT SPECIFICATION SHEETS



MEMORANDUM

[SUBJECT]: Request for Raw Material Specification sheets – Chlorate, Peroxide, and Acid

TO: Martha Marrapese
FROM: David C. Lovetro
DATE: November 11, 1999 *DCR*

CC: Eka Chemicals : JMG (cover, F.Y.I.)

In our telephone discussion of Nov. 09, 1999, Raw Material Specification sheets were requested for sodium chlorate, hydrogen peroxide, and sulfuric acid, indicative of the feed chemicals used in the production of chlorine dioxide from Eka's SVP-Pure™ technology. Individual Product data sheets for these chemicals are included below:

Eka Chemicals manufactures Purate™ in bulk quantities at its plant facility in Columbus, MS. Purate™ is manufactured by re-dissolving crystal sodium chlorate in a high purity process water stream, in combination with its 50% Chemical Grade hydrogen peroxide product. The enclosed Product Data sheets for both Pulp Grade and Technical Grade Crystal are indicative of the same quality of material used in our Purate™ manufacture. The Pulp Grade Product Data sheet is used in conjunction with bulk shipment of chlorate while the Technical Grade Product Data sheet is used in conjunction with drum shipments. You should note that the maximum contaminant levels for compounds like NaCl, Chromium, and Iron are stated as "not to exceed" values, and that typical contaminant levels routinely fall below those maximum specifications. It should also be noted that Eka's sodium chlorate crystal product as well as its 50% Chemical Grade hydrogen peroxide has been certified by the National Sanitation Foundation (NSF) under NSF Standard 060, Drinking Water Treatment Chemicals – Health Effects. In a similar manner, Purate™ has received NSF Certification under NSF Standard 060, as well.

The attached telefax communication dated 11/12/98 (To El Paso Water Authority) provides basic raw material specifications for the acid feed as well as sodium chlorate and hydrogen peroxide. No Eka Chemicals Product Data sheet is available since the company is not a sulfuric acid manufacturer. Although the acid specification lists maximum iron concentration below 50 ppm, it should be noted that SVP-Pure™ technology is capable of successful, stable chlorine dioxide generation using acid with iron contamination as high as 250 ppm.

David C. Lovetro
Manager, Applications Engineering
Specialty Oxidants Group

Attachments: (X)

[Document Code Number]
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QC4.4-TSP-MAR/ALL-DOC-04030.01-EE
Rev. 1 April 15, 1998
Approved: J.C. Sokol

000040



EKA CHEMICALS

PRODUCT DATA SHEET
SODIUM CHLORATE

TECHNICAL GRADE CRYSTAL

INTRODUCTION

Sodium Chlorate is a white to pale yellow odorless crystalline solid. It is a very strong oxidizing agent and is very soluble in water and alcohol.

FORMULA: NaClO_3

MOLECULAR WEIGHT: 106.44

SPECIFICATIONS

		<u>Minimum</u>	<u>Maximum</u>	<u>Typical</u>
NaClO_3	% by wt.	99.6	-	99.8
NaCl	% by wt.	-	0.1	0.05
H_2O	% by wt.	-	0.2	0.02
Cr	ppm	-	8.0	3.0
Fe	ppm	-	5.0	2.0
Insolubles	ppm	-	20.0	5.0

PHYSICAL PROPERTIES

Melting Point	248°C (478°F)	Specific Gravity (Solid)	2.49
Decomposition Point	300°C (572°F)	(Bulk Crystal)	1.56 - 1.74
Bulk Density	1560 - 1740 kg/m^3 97.5 - 108.2 lbs/ft^3	Heat of Solution	-52.6 cal/g

USES

Sodium chlorate is widely used in the generation of chlorine dioxide. As an oxidizing agent, it is used in dye manufacturing and in metal finishing. Some grades of sodium chlorate are used in agricultural applications.

CAUTION: Sodium Chlorate may not be used as a weed killer, cotton defoliant, or for other agricultural uses unless it is registered with the EPA and corresponding state agency. If you intend any such use, please contact Eka Chemicals to assure that you received sodium chlorate that has been registered.

IMPORTANT! The information presented herein, while not guaranteed, was prepared by technical personnel and is true and accurate to the best of our knowledge. No warranty or guaranty, express or implied, is made regarding performance stability or otherwise. This information is not intended to be all inclusive as the manner and conditions of use, handling, storage and other factors may involve other or additional safety or performance considerations. While our technical personnel will be happy to respond to questions regarding safe handling and use procedures, safe handling and use remains the responsibility of the customer. No suggestions for use are intended as, and nothing herein shall be construed as a recommendation to infringe any existing patents or to violate any Federal, State, Provincial, or local laws.

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SHIPPING INFORMATION

DOMESTIC SHIPMENT DESCRIPTION:

DOT Name: Sodium Chlorate
Technical Name: Sodium Chlorate
Hazard Class: 5.1
Label Required: Oxidizer
Identification No: UN1495

**TARIFF DESCRIPTION for
RAIL AND TRUCK SHIPMENTS:**

Sodium Chlorate Dry Crystal

CONTAINERS: (bulk, bags, drums)

(Drums are non-returnable)

<u>Steel Drums</u>	<u>Net Weight</u>	<u>Gross Weight</u>
9 Gallon	100 lbs.	108 lbs.
20 Gallon	325 lbs.	340 lbs.
40 Gallon	450 lbs.	474 lbs.
55 Gallon	600 lbs.	640 lbs.

SALES OFFICE

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Marietta, Georgia 30062

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Approved: 
12/29/98

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TECHNICAL DATA HYDROGEN PEROXIDE -- CHEMICAL GRADE

INTRODUCTION

Eka Chemicals' Chemical Grade Hydrogen Peroxide is specially formulated with a proprietary stabilizer system for chemical synthesis applications.

The 70% concentration is only available in bulk form, and can be diluted with high quality distilled or deionized water for bulk storage or use at lower concentrations.

SAFETY AND HANDLING

NOTICE: Contact of all industrial grades of hydrogen peroxide with the eyes or mucous membranes can result in burns or other serious health effects and requires immediate medical attention. Eye effects may be delayed for as long as a week or more after exposure. Even though no severe pain is noted, adhere to the Safety and Handling Procedures outlined below.

Hydrogen peroxide is a very reactive chemical and must be handled carefully. Solutions should be stored in their original containers until ready for use, and any material removed from its original container must not be returned to it. Personnel should wear rubber gloves, eye and face protection, and suitable protective clothing when handling this chemical. Utensils used for handling hydrogen peroxide must be made of compatible materials like glass, stainless steel, aluminum or plastic. Hydrogen peroxide must never be placed in a closed, unvented container. Although hydrogen peroxide is nonflammable, it can accelerate combustion if allowed to contact other combustible or flammable materials. Any spilled hydrogen peroxide should be immediately flooded and washed away with liberal quantities of water. Although neither hydrogen peroxide nor its decomposition products, oxygen and water, are systemic poisons, concentrated solutions irritate the skin, mucous membrane tissue and the eyes.

If the chemical comes in contact with the skin, it should be immediately and thoroughly washed off with

generous quantities of water for at least 15 minutes. If it contacts the eyes, flush thoroughly and consult a physician promptly. If swallowed, drink lots of water but do not encourage vomiting. Call a physician immediately. Clothing must be washed thoroughly with water should it come in contact with hydrogen peroxide. If allowed to dry in the fabric, the chemical may cause fire, particularly if the clothing is soiled.

PROPERTIES

Hydrogen Peroxide (H₂O₂) solutions are clear, colorless water-like in appearance and can be mixed with water in any proportion. At high concentration, it has a slightly pungent or acidic odor. Hydrogen Peroxide has a molecular weight of 34.02 and the pure material as well as its aqueous solutions are nonflammable. The Chemical Abstracts Service Registry Number for Hydrogen Peroxide is 7722-84-1. Other specifications and typical physical and chemical properties are listed below.

SPECIFICATIONS

	C-50	C-70
H ₂ O ₂ content, wt%	50-51.5	70-71.5
Apparent pH	<2.5	<2.5
Color (PtCo)	≤15	≤15

PHYSICAL PROPERTIES

	C-50	C-70
Active oxygen, wt%	23.5	32.9
Density @ 20 °C (68 °F)		
Specific Gravity	1.196	1.288
lb/gal	9.98	10.7
g H ₂ O ₂ (100%)/ml	0.598	0.902
Freezing point, °C	-52	-37
°F	-62	-35
Boiling point, °C	114	126
°F	237	259
Vapor Pressure @ 30 °C (86 °F)		
mm Hg (H ₂ O ₂ + H ₂ O)	18	11
kPa	2.4	1.5
Viscosity (approx.)		
@ 0 °C (32 °F), cP	1.87	1.94
@ 20 °C (68 °F), cP	1.17	1.24

TECHNICAL DATA
HYDROGEN PEROXIDE – CHEMICAL GRADE

STANDARD CONTAINERS

Bulk shipments of hydrogen peroxide are available in tank trucks or rail car quantities.

NOTICE: Hydrogen peroxide above 8% concentration is classified as an "oxidizer" by the Department of Transportation and all containers must carry the Yellow DOT label. Hydrogen Peroxide over 20% concentration is classified as an "oxidizer and corrosive" by the DOT and must be labeled accordingly.

TYPICAL HYDROGEN PEROXIDE COMMERCIAL USES

Commercial Applications:

- Odor Abatement
- Color Removal
- Textile Finishing / Bleaching
- Toxicity Reduction
- BOD / COD Reduction
- Hazardous Waste Reduction / Destruction
- Metal Finishing / Pickling
- Water Treatment / Disinfection
- Groundwater & Soil Remediation
- Air Pollution Control
- Chemical Synthesis

Oxidation of:

- Aldehydes
- Phenols
- Hydroquinones
- Low molecular weight amines
- Thiosulfates
- Bisulfites and Sulfites
- Formaldehyde
- Cyanides
- Photo wastes
- Iron (Fe + +)
- Refractory organics
- H₂S and mercaptans
- Sulfur dioxide
- Oxides of nitrogen
- Manganese Compounds

Supplemental Oxygen needs:

- Overloaded aeration facilities
- Denitrification
- High BOD, COD

Reduction of:

- Chlorine
- Hypochlorite
- Chromium (Cr + 6)
- Chlorine Dioxide

For a discussion on how Eka Chemicals might help solve your hydrogen peroxide needs please contact:

Eka Chemicals Inc.
Technology & Specialty Peroxides Division
Specialty Peroxides Group
1775 West Oak Commons Court
Marietta, GA 30062
(770) 578-0858 (800) 241-3900 Fax: (770) 321-5865

All information concerning this product and/or all suggestions for handling and use contained herein are offered in good faith and are believed to be reliable. Eka Chemicals Inc., however, makes no warranty as to the accuracy and/or sufficiency of such information and/or suggestions, as to the product's merchantability or fitness for any particular purpose, or that any suggested use will not infringe any patent. Nothing contained herein shall be construed as granting or extending any license under any patent. Buyer must determine for himself, by preliminary tests or otherwise, the suitability of this product for his purposes. The information contained herein supersedes all previously issued bulletins on the subject matter covered.

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Eka Chemicals
1775 West Oak Commons Court
Marietta, Georgia 30062

To	Doug Rittmann	Reference	chemical prop.
Company	El Paso Water Utilities		
Location	El Paso, TX		
Date	11/12/98	Document No.	
Fax No.	915 542 0718	Customer No.	
From	Gerhard Scherer	Phone	770 321 5801
		Fax	770 321 5865

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RECIPIENT	INTERNAL
Please copy and distribute this facsimile message to the following individuals:	The following individuals have received a copy of this facsimile:

This is the first page of a 1 page facsimile.

Per our previous conversation her are the properties for the SVP-Pure™ operating chemicals:

Sodium Chlorate	532 g/l	Hydrogen Peroxide	600 g/l
By weight	40 wt%	By weight	50 wt%
Sodium Chloride	< 2%	active oxygen content	23.5%
pH	8-12	decomposition (16hr/96°C)	<2%
Spec. Gravity	1.33 g/ml	apparent pH	<3
		Spec. Gravity	1.196 g/ml

Sulfuric acid	1329 g/l	1700 g/l
by weight	wt 78%	wt 93%
Iron	<50 ppm	<60 ppm
Kappa value	<5	<6
Spec. Gravity	1.7043 g/ml	1.8279 g/ml

Regards

Gerd Scherer

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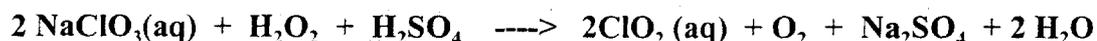
APPENDIX IV
CONCENTRATION OF COMPONENTS IN THE
PROCESS WATER STREAM PER 10 PPM ClO_2 , PRODUCED
TO MAINTAIN 3 PPM RESIDUAL ClO_2 , CALCULATIONS

The concentration levels anticipated in the process water are based on the chemical stoichiometry of the Eka Chemical's SVP Pure™ chlorine dioxide generator system and the specific conditions governing the rate of chlorine dioxide production appropriate to the proposed use in controlling microbial growth in these food processing applications.

Summary of assumptions

- (1) The process needs to generate 10 ppm in order to maintain a residual of 3 ppm in the process water.
- (2) The reaction goes at least 90% to completion and less than 10% of the starting materials are passed over into the process water.
- (3) Excess sulfuric acid, approximately 4 times the stoichiometric amount, is added to increase the reaction velocity and reaction efficiency.
- (4) All the hydrogen peroxide is decomposed rapidly and none gets into the process water.
- (5) Upon reaction with food and microorganisms, chlorite is immediately formed. Approximately (30%) is oxidized into chlorate and approximately 70% remains as chlorite.

Chlorine dioxide is produced at 10.0 ppm in the process water according the following stoichiometric equation.



The chlorine dioxide concentration, $[\text{ClO}_2]$, is assumed as initially 10 ppm = 10 mg/L / 67.45 x 10^3 mg/mole = 1.483×10^{-4} M.

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Since the reaction is at least 90% efficient, it takes $100/90 \times 1.483 \times 10^{-4} \text{ M} = 1.648 \times 10^{-4} \text{ M}$ sodium chlorate to produce $1.483 \times 10^{-4} \text{ M}$ chlorine dioxide. Therefore, there will be an unreacted portion of sodium chlorate equal to $1.65 \times 10^{-5} \text{ M}$ which will pass through into the process water.

In the stream of process water in contact with food or microorganisms, approximately 70% or 7 ppm of ClO_2 reacts with food and microorganisms to produce chlorite (ClO_2^{-1}) and chlorate (ClO_3^{-2}) leaving a residual chlorine dioxide concentration, $[\text{ClO}_2]$, of 3 ppm. ClO_2^{-1} is produced at approximately 70% ($0.7 \times 7 \text{ ppm} = 4.9 \text{ ppm}$), and ClO_3^{-1} is produced at approximately 30% ($0.3 \times 7 \text{ ppm} \times 83.45 \text{ g/mole} / 67.45 \text{ g/mole} = 2.6 \text{ ppm}$). Werdnoff and Singer, 1987. The concentrations of the chlorine-containing products are then as follows:

$$[\text{ClO}_2] = 3 \text{ ppm} / 67.45 \times 10^3 \text{ mg/mole} = 4.448 \times 10^{-5} \text{ M} = 3 \text{ ppm}$$

$$\begin{aligned} \text{ClO}_3^{-1} &= \text{unreacted portion} + \text{decomposition product} \\ &= 1.65 \times 10^{-5} \text{ M} + [2.6 \text{ ppm}] / [83.45 \times 10^3 \text{ mg/mole}] \\ &= (1.65 + 3.11) \times 10^{-5} \text{ M} = 4.76 \times 10^{-5} \text{ M} = 3.97 \text{ ppm} \end{aligned}$$

$$\begin{aligned} [\text{ClO}_2^{-1}] &= \text{decomposition product} \\ &= 4.9 \text{ ppm} = 4.9 / 67.45 \times 10^3 \text{ mg/mole} = 7.26 \times 10^{-5} \text{ M} = 4.9 \text{ ppm} \end{aligned}$$

Based on the stoichiometry, 2 moles of H^+ are consumed per 2 moles of ClO_2 produced. The required concentration of acid at stoichiometry is the same as the chlorate; therefore, using 90% efficiency, the acid concentration is:

$$[\text{H}^+] = 1.483 \times 10^{-4} \text{ M} \times 100/90 = 1.648 \times 10^{-4} \text{ M}$$

The sulfate concentration would be $[1.483 \times 10^{-4}] / 2 = 7.415 \times 10^{-5} \text{ M} = 7.1 \text{ ppm}$ according to the stoichiometry. In practice, users add 4 times the stoichiometric amount of acid to drive

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the reaction faster, or, $4 \times (1.483 \times 10^{-4} \text{ M}) = 5.932 \times 10^{-4} \text{ M}$. In such case, the amount of acid remaining unconsumed is as follows:

$$[\text{H}^+] = \text{total added} - \text{amount consumed} = [5.932 \times 10^{-4} \text{ M} - 1.483 \times 10^{-4} \text{ M}] = 4.45 \times 10^{-4} \text{ M} = 0.448 \text{ ppm}$$

$$\text{pH} = -\log [\text{H}^+] = -\log [4.45 \times 10^{-4} \text{ M}] = 3.35$$

Accordingly, the sulfate concentration would be:

$$[\text{SO}_4^{-2}] = 4 \times (1.483 \times 10^{-4}) / 2 = (2.97 \times 10^{-4} \text{ M}) \times 96.06 \times 10^3 \text{ mg/mole} = 28.5 \text{ ppm}$$

Compiling this information in Table 3 below, we have the following:

Compound	PPM	Molar	Mol. Weight
ClO ₂	3.0	4.45×10^{-5}	67.45
SO ₄ ⁻²	28.5	2.97×10^{-4}	96.06
H ⁺	0.448	4.45×10^{-4}	1.008
ClO ₂ ⁻¹	4.9	$7.26 \times 10^{-5} \text{ M}$	67.45
ClO ₃ ⁻¹	3.97	$4.97 \times 10^{-5} \text{ M}$	83.45
H ₂ O ₂	0.0	0.0	34.00

Based on the assumption that the reaction goes 90% to completion. The amounts include the yield pertaining to 10 ppm ClO₂, plus unreacted starting material passing over into the process water representing 10% (on a Molar basis) of the products, and the decomposition of 7.0 ppm of ClO₂ back to chlorite and chlorate in a 7:3 ratio. The amounts also include adding excess sulfuric acid at four times the stoichiometric quantity.