PERACLEAN®

Peracetic acid solutions for disinfection and oxidation

EVONIK
POWER TO CREATE

AMERICAS

EUROPE / MEA

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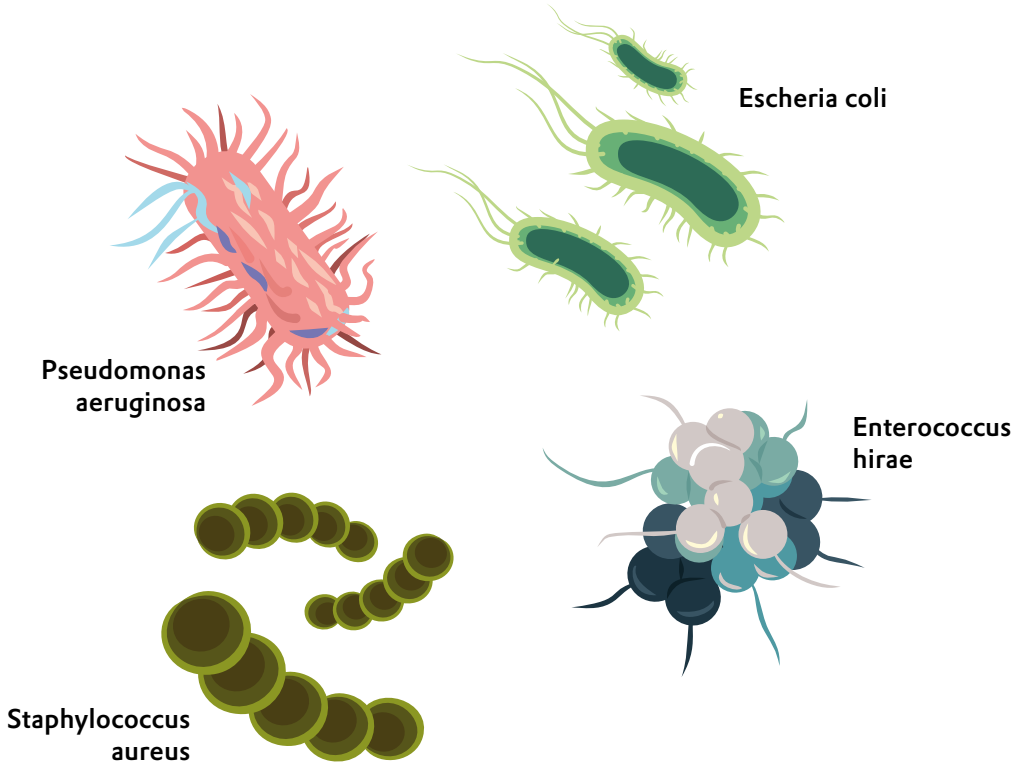
Evonik is one of the world's largest producer of hydrogen peroxide and peracetic acid. We have been manufacturing peracetic acid for more than 50 years and are the innovative leader in high-quality products and services. We manufacture a range of peracetic acid solutions that provide exceptional value to our customers around the world.

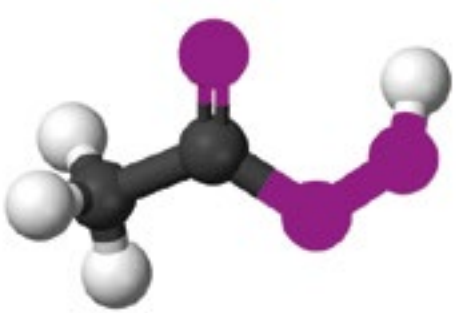


Various peracetic acid grades and several tailor-made recipes are available at Evonik under the tradename PERACLEAN®.

Peracetic acid has outstanding disinfectant properties and acts as a potent antimicrobial agent, even at low concentration. It is effective against bacteria, yeasts, molds and virus.

The reason for the excellent and rapid antimicrobial effects of peracetic acid is the specific capability to penetrate through the cell membrane. In the cell, peracetic acid irreversibly disrupts the enzyme system, which in turn leads to destruction of the microorganism. Our products have shown superior disinfectant properties in relevant efficacy tests. Nowadays, products based on peracetic acid are used as highly effective biocides in a wide range of applications.

Major uses of these products are disinfection,bleaching and chemical synthesis. Concentrations up to 15 percent are used as sanitizers, disinfectants and sterilants in the food and beverage industry, for water treatment, in laundries and for medical applications. Grades with higher concentrations up to 40 percent are exclusively used for oxidation reactions. On the next pages you will find information about the different applications areas of peracetic acid.



FOOD & BEVERAGE INDUSTRY
Disinfectant

PERACLEAN® products have proven over years to be highly effective for biocidal applications in the food & beverage industry.

They are used to disinfect or sterilize equipment, surfaces, tanks, pipes and plastic bottles.
In food & beverage processing applications, the use of peracetic acid in CIP- or SIP-installations (cleaning or sterilization in place) is standard.

Cleaning/disinfection is done automatically following a fixed program. The whole procedure is designed to meet the stringent hygiene regulations.

In food & beverage packaging applications, many types of products are packaged in plastic bottles made from PET or PE. Juices, soft drinks, tea and liquid dairy products require perfect hygienic conditions during the packaging process to guarantee a long shelf life.

Sterilizing the packaging material with peracetic acid solutions or vapour in the rinsing step of the bottle filling line is used for aseptic cold filling to protect beverages along the production chain.

VETERINARY HYGIENE
Animal health

PERACLEAN® products are concentrated peracetic acid formulations with a broad spectrum of efficacy against virus, bacteria, fungi and spores.

They are highly effective in very low concentrations even at low temperatures and/or in presence of organic impurities. Applications include general surface and equipment disinfection, treatment of water supply systems and thermal fogging.

In surface disinfection the surfaces are cleaned and disinfected to avoid diseases in livestock.

The product is applied by mechanical sprayers or pressure washers. Water systems very often contain bacteria. Sanitizing cleans the system and eliminates growth of bacteria.

Thermal fogging is the preferred procedure to disinfect buildings, animal housings and inside areas that are difficult to access.
It requires special fogging equipment.

MEDICAL
Sterilizer and disinfectant

Due to their high potency at low concentrations and temperatures, peracetic acid based formulations are widely used in liquid sterilization processes for a low-temperature sterilization of reusable, immiscible medical devices, such as flexible endoscopes.

Typical uses of peracetic acid in medicine includes disinfection of medical equipment, cold sterilization of dentures, plastic implants, syringes, thermally sensitive nutritive media, disinfection of hemodialysis systems and decontamination of liquid and solid medical wastes in hospitals.

AGRICULTURE
Disinfectant and slimicide

Today, a highly efficient agriculture plays an important role due to increasing demand of a growing population. In open fields, there is a trend from traditional flood irrigation to more efficient drip irrigation. A major issue in drip irrigation is the clogging of tubes and emitters due to biofilm formation. In greenhouses, besides the drip irrigation system, there is an additional need to fight pathogens which can be found on any surface.
Also, it has been shown that disinfection of fruits or vegetables can extend their shelf life.

Solutions of peracetic acid have been proved to be a highly effective and environmentally friendly biocide in agriculture. Pulse cleaning of drip lines in the absence of plants, disinfection of tools, tables and containers as well as washing of harvested goods with peracetic acid are typical examples of the broad range of possible applications.

The main applications are:

- Washing water for potatoes
- Washing water for fruits
- Irrigation water (surface, rain and spring water)
- Greenhouses and other horticulture purposes

The concentration of peracetic acid depends on the specific requirements in the respective application. It is advisable to adapt the concentration on the basis of corresponding microbiological tests. The product is suited to kill harmful organisms such as Soft Rot (Erwinia Carotovora) and Brown Rot (Ralstonia Solanacearum). After disinfection peracetic acid decomposes into ecologically harmless residues such as water, oxygen and acetic acid.

LAUNDRY
Disinfectant

In the chemo-thermal disinfection of laundry, especially originating from hospitals and other medical care institutions, peracetic acid products are used in the washing stage as a disinfectant and bleaching agent.

The specially designed ratio of peracetic acid to hydrogen peroxide in Evonik's products gives a strong positive effect to the stability of the peracetic acid in the washing liquor, this results in a bleaching effect along with a high level of disinfection.

CHEMICAL SYNTHESIS
Oxidizing agent

Strong oxidative power, high stereo-selectivity as well as non-radical reaction pathways determine the use of peracetic acid in industrial preparation of various important intermediate products. Peracetic acid is frequently used for the synthesis of organic S-oxides in the pharmaceutical industry and in the manufacture of cephalosporins-antibiotics from penicilinis.
Peracetic acid is also used in a wide range of oxidation reactions such as:

- Epoxidation of olefins
- Selective epoxidation of various unsaturated compounds
- Oxidation of thioethers to sulfoxides or sulfones
- Oxidation of tertiary amines to amine oxides
- Oxidation of pyridines to pyridine oxides
- Oxidation of ketones to esters or lactones
- Baeyer-Villiger oxidation of acylbenzenes to o-acylphenols

In all these reactions peracetic acid has many advantages over other oxidants, since the reduction products can be easily removed and the oxidation products are thus obtained in high yield and purity.
The unique chemical properties of peracetic acid as well as the readily biodegradable effluents, the safe and convenient handling and the absence of halogenated by-products predetermine its use in manufacturing of a variety of specialty chemicals.

ENVIRONMENTAL
Disinfectant and slimicide

Formulations of peracetic acid are effective against a wide range of harmful aquatic organisms and to those which cause problems in industrial processes. Peracetic acid solutions are used for a wide range of water treatment applications such as the treatment of cooling water and industrial or municipal waste water.

Waste water is usually disinfected prior to discharge to remove pathogenic species. Products containing peracetic acid offer an alternative to common chlorine-based disinfectants such as sodium hypochlorite.

Utilization of a chlorine-free disinfectant prevents the formation of toxic chlorinated side products. Cooling with water is widely used in industry, power stations and various plants. Algae and a large number of bacteria species can grow in cooling circuits and produce slime which rapidly forms deposits and results in clogging problems. Moreover, the slime can also activate the development of other corrosive bacteria. Furthermore, mussel larva entering cooling systems can grow up to palm size, thereby causing enormous operational problems in industrial cooling circuits. Adding peracetic acid to the intake water stream prevents the microorganism from growing to adult species and reduces therefore the plugging of the heat exchangers and the cooling system as the whole. The dosage amount of the peracetic acid is adjusted experimentally to treat the water throughput requirements.

BALLAST WATER
Disinfectant

Ballast water is used to control trim, list, draught, stability or stresses of ships. Every year, ships transport and discharge billions of tons of ballast water around the globe, which results in a spread of invasive aquatic species (IAS). The UNO rates this spread of IAS as one of the four major threats to the world's oceans.
In 2004, the International Marime Organization adopted the international convention for the control and management of ships' ballast water and sediments to control the further spread of IAS. The convention requires ships to discharge ballast water only within specific discharge standards. Peracetic acid can disinfect ballast water to meet these standards.

The unique combination of its

- Broad spectrum of activity not only against microbes but also against all types of larger aquatic organisms such as phyto- and zooplankton,
- High efficacy in an extremely wide temperature range from arctic to tropical temperatures and in all types of water (fresh, brackish and marine water),
- Efficacy being very little impaired by dissolved organic carbon and sediments,
- Chlorine-free composition, keeping disinfection by-products far below of any environmental concerns,
- Environmentally benign reaction and degradation products being acetic acid, water and oxygen only, preventing any accumulation after use,
- High availability and storage stability

as well as the vast experience and knowledge that exists about its production, transport, handling and safety make peracetic acid the disinfectant of choice for the treatment of ballast water. The use of peracetic acid for the treatment of ballast water requires several international and national approvals of the commercial product used in combination with approved treatment processes. Evonik offers PERACLEAN® Ocean, a formulation for the specific requirements of ballast water on board of ships, which is approved in combination with ballast water treatment systems such as the AVITALIS™ BWTS offered by TeamTec (see www.teamtec.no) and the SKY-SYSTEM® of Nippon Yuka Kogyo.

PULP AND PAPER
Slimicide

In the pulp & paper industry there is a need to disinfect the white water system to prevent microbial contamination of fibrous material in the circulation water. Polysaccharides, which are leached from the wood pulp, act as nutrients for microbial growth and result into formations of microbial or semi-chemical slimes.

These cause critical failures in paper-making and a reduction in the quality of paper, resulting in overall losses. The uncontrolled growth of slimes can ultimately cause the breakage of paper and, as a consequence, a stoppage of the production line.

Solutions of peracetic acid have been proved to be an effective biofilm remover in the water systems and are used as an environment-friendly oxidizing biocide in the pulp & paper industry. Usually peracetic acid is dosed continuously to the white water system. Its target concentration in the water cycle is in the range of 50 - 100 ppm.

MANUFACTURING AND GRADES

For the preparation of peracetic acid Evonik uses the direct synthesis by a catalyzed, equilibrium reaction between acetic acid and hydrogen peroxide.

The equilibrium peracetic acid is produced by combining the initial components. Therefore, the resultant peracetic acid solution is a mixture of peracetic acid, hydrogen peroxide, acetic acid and water. The equilibrium concentration of peracetic acid is adjusted by the type and concentration of the catalyst used as well as by the molar ratio of the starting materials. Peracetic acid solutions are clear, colorless liquids with a specific pungent odour.
They are miscible with water and organic solvents. Concentrated peracetic acid solutions boil with decomposition.

Depending on the requirements of the particular application, Evonik offers various peracetic acid grades under the brand PERACLEAN®.

PERACLEAN® products are used in the food and beverage industry for disinfection of installations, tanks, pipelines and equipment as well as for packaging material and in the animal health applications for sanitation of surfaces and stables.

PERACLEAN® products were designed and registered for the treatment of washing water in agricultural applications and for use in water treatment applications to reduce the amount of harmful organisms such as algae, bacteria and germs. PERACLEAN® grades with high peracetic acid content are successfully utilized in the chemical, pharmaceutical and cosmetic synthesis as a strong oxidizing agent.

$$H_2O_2 + HAc \underset{}{\overset{\text{acid}}{\rightleftharpoons}} PAA + H_2O$$

Application	Product
Pharma Cosmetics Chemical synthesis	PERACLEAN® 35 PERACLEAN® 40
Health care Medical devices	PERACLEAN® 0.1 PERACLEAN® 0.25 PERACLEAN® 0.4 PERACLEAN® 1 PERACLEAN® 5 Steri
Veterinary hygiene	PERACLEAN® 5 PERACLEAN® 15 PERACLEAN® 5 vet
Food & beverage (CIP) Food processing	PERACLEAN® 5 PERACLEAN® 10 PERACLEAN® 15 PERACLEAN® 6 PERACLEAN® 17 PERACLEAN® 5 C PERACLEAN® 5 L PERACLEAN® 1 Foam PERACLEAN® 15 cw
Aseptic packaging	PERACLEAN® 5 PERACLEAN® 15
Water treatment and environmental Agriculture	PERACLEAN® 2 wt PERACLEAN® 5 wt PERACLEAN® 15 wt PERACLEAN® 2 PERACLEAN® 5 PERACLEAN® Ocean PERACLEAN® 15
I&I Laundry	PERACLEAN® 5 PERACLEAN® 10 PERACLEAN® 10 Ultra

Specialty grades are available on request. Please contact us for a recommendation regarding the most suitable grade for your application. Due to different national regulatory requirements not all grades are available in every country.

REGULATORY
Explosive Precursor Regulation

Explosive precursors are chemical substances which can be made into explosives with relative ease e.g. by mixing or blending with other substances, or by simple chemical processing. The vast majority of chemicals are used for legitimate purposes by consumers, but an illicit manufacture of explosives is possible. Hydrogen peroxide falls under the Explosive Precursor Regulation. As peracetic acid contains hydrogen peroxide it falls under the Explosive Precursor Regulation as well.

As the European Union has experienced more and more terrorist and criminal attacks using explosives, home made explosives (HMEs) and improvised explosive devices (IEDs) in recent years, not to mention various attacks that were prevented or which failed, it passed regulation (EU) No. 98/2013 of the European parliament and of the council on the marketing and use of explosive precursors.
The regulation establishes harmonized rules concerning the making available, introduction, possession and use of substances or mixtures that could be misused for the illicit manufacture of explosives, with a view to limiting their availability to the general public, and ensuring that appropriate reporting of suspicious transactions, significant disappearances and thefts, throughout the supply chain is introduced.

Evonik acts according to the Chemicals Prohibition Ordinance (ChemVerbotsV) with a transparent supply chain, reporting of suspicious transactions, requesting end user declarations and not selling to private persons.

REACH

Evonik has registered its product peracetic acid for the European production sites under the European REACH legislation (Registration, Evaluation and Authorization of Chemicals). According to this directive, chemical substances manufactured, imported or used in volumes above one ton per year must be registered. This applies to all substances, even if they are part of formulations or mixtures.
CAS-No. peracetic acid: 79-21-0

MEDICAL DEVICES DIRECTIVE 93/42/EEC

Peracetic acid can be registered as a medical device according to Directive 93/42/EEC at a notified body. Evonik does have an ISO 13485-certified management system in place for the production of peracetic acid and fulfils the requirement for medical device registration by our customers. Our customers can therefore apply for a CE-label for their registered medical device.
Please contact us if you have any questions regarding the explosive precursor regulation, REACH or the Medical Devices Directive.

BIOCIDAL PRODUCT REGISTRATION (BPR)

The aim of the BPR is to harmonize the European rules for biocidal products and their active substances. Through risk assessment it intends to provide a high level of protection for people, animals and the environment and to ensure that products are sufficiently effective against the target species.
The BPR stipulates a two-step process, in which the active substance evaluation is followed by a product authorization of individual biocidal products.
Biocidal products from Evonik containing peracetic acid and hydrogen peroxide fulfil the obligations of the European Biocidal Products Regulation (BPR) (EU) No. 528/2012 and will therefore be actively supported in the product registration under the BPR. In the transitional period the existing biocidal products are marketed with existing national biocidal registrations.

Article 95 of the BPR regulates the transitional measures for placing active substances or individual biocidal products containing these active substances on the market. For this purpose, the European Chemicals Agency (ECHA) has published a list of companies that have submitted a dossier in support of an active substance under the review program for existing substances.
As a member of the Cefic Hydrogen Peroxide Sub Group and Cefic Peracetic Acid Registration Group, Evonik has supported hydrogen peroxide and peracetic acid as active substances in the framework of the BPR. Thus, Evonik fulfils the obligations according to article 95 and is listed on the above-mentioned list of active substance suppliers.
Evonik does an EU-wide biocidal product registration. Please contact us if you have any questions or need support with your registration.

LABELING

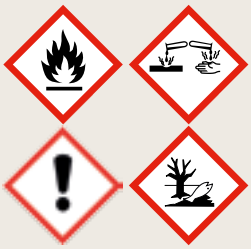
According to Global Harmonized System (GHS) and the European Regulation No. 1272/2008 aqueous solutions of peracetic acid are dangerous substances and therefore must be labeled and handled correspondingly.

The exact classification of the particular product depends on the concentration of peracetic acid and hydrogen peroxide. The table below represents the classification of the selected products.

Please refer to the material safety data sheet of the corresponding product for its exact GHS classification.

PERACLEAN® 5

Hazard statements	H242	Heating may cause a fire
	H290	May be corrosive to metals
	H302	Harmful if swallowed
	H312	Harmful in contact with skin
	H314	Causes severe skin burns and eye damage
	H332	Harmful if inhaled
	H335	May cause respiratory irritation
	H410	Very toxic to aquatic life with long lasting effects
Prevention statements	P210	Keep away from heat/sparks/open flames/hot surfaces - no smoking
	P234	Keep only in original container
	P273	Avoid release to the environment
	P280	Wear protective gloves/protective clothing/eye protection/face protection



PERACLEAN® 15

Hazard statements	H242	Heating may cause a fire
	H290	May be corrosive to metals
	H302	Harmful if swallowed
	H312	Harmful in contact with skin
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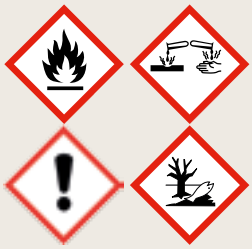
Prevention statements	P210	Keep away from heat/sparks/open flames/hot surfaces - no smoking
	P273	Avoid release to the environment
	P280	Wear protective gloves/protective clothing/eye protection/face protection



PERACLEAN® 40

Hazard statements	H242	May cause fire or explosion, strong oxidizer
	H271	Heating may cause a fire
	H290	May be corrosive to metals
	H301	Toxic if swallowed
	H312	Harmful in contact with skin
	H314	Causes severe skin burns and eye damage
	H331	Toxic if inhaled
	H335	May cause respiratory irritation
	H410	Very toxic to aquatic life with long lasting effects
Prevention statements	P210	Keep away from heat/sparks/open flames/hot surfaces - no smoking
	P261	Avoid breathing dust/fume/gas/mist/vapors/spray
	P264	Wash hands thoroughly after handling
	P273	Avoid release to the environment
	P280	Wear protective gloves/protective clothing/eye protection/face protection

PACKAGING, TRANSPORTATION & STORAGE

According to the different physico-chemical properties there are differences in transportation, storage and delivery of peracetic acid solutions.

Concentration of PAA	PAA < 35 %	PAA 35 %	PAA 40 %
Canister	30 kg	30 kg	30 kg
Drum	220 kg	220 kg	
IBC	1100 kg	1000 kg	
Bulk	yes	no	no

Please feel free to ask for conditions under which bulk deliveries could be arranged. Due to transport regulations and depending on composition of the specific grade, our products are classified either as oxidizers belonging to hazard class 5.1 (UN 3149) or as organic peroxides belonging to class 5.2 (UN 3109, UN 3105) and classified as corrosive.

Concentration of PAA	PAA < = 5 %	5 %<PAA<=35 %	35 %<PAA<=40 %
UN-No.	3149	3109	3105
IMDG-Code, ARD/RID	3149, 5.1, PG II	3109, 5.2	3105, 5.2
Labels			

For the exact product classification as well as labeling please refer to the corresponding material safety data sheet.
PERACLEAN® formulations must be stored in an upright position and in their original containers. They have to be stored in a cool place, protected from direct sun light and with good ventilation. Any contamination, especially with metal ions, alkalis and reducing agents must be avoided.

PERACLEAN® formulations must be kept away from any heat source and combustible materials, especially organic solvents. Vapours of highly concentrated peracetic acid may form explosive mixtures with air. Packages are equipped with venting devices to avoid overpressure. Do not cover the closures which allow venting. All containers should be checked regularly. When properly transported and stored in the originally sealed containers, all peracetic acid products show no notable loss of content for at least 12 months. The shelf life of plastic containers with high-strength peracetic acid is limited to 24 months. Applicable storage regulations for each country must be followed (for example, Gefahrstoffverordnung in Germany, CPR 3E in the Netherlands or HSE CS21 in the UK).

SAFETY & HANDLING

PERACLEAN® formulations products have oxidizing and corrosive properties. Safety precautions have to be applied accordingly.

While working with PERACLEAN® formulations, proper care must always be taken. Safety goggles, protective gloves and suitable protective clothing must be worn. If necessary, a gas mask should be used with an appropriate filter.

If peracetic acid comes into contact with skin and eyes, it must be rinsed off thoroughly with plenty of water and the person must seek medical attention.

If the product is spilled during processing, it must be absorbed with inert material or diluted immediately with a large amount of water and washed away.
In case of fire use water or foam.

Clean equipment made from compatible materials such as polyethylene, glass or stainless steel must only be used.
Products must not be confined in containers, vessels, piping systems or between valves. There must always be a pressure release or breathing device. Once the product has been drawn from the original container it should never be returned due to a risk of contamination and decomposition.

If our PERACLEAN® formulations are used as biocides always read labels, material safety data sheets (MSDS) and product information before use. Use biocides safely.

Germicidal Effect of PERACLEAN®

The following table shows kill times in minutes according to the suspension method of the DLG (German Agricultural Society), with colony counts of 10^7-10^8 per ml of the inoculum.

Temperature of action	5 °C		10 °C		20 °C		40 °C	
Application concentration (%) as PAA 100%	0.01	0.025	0.01	0.025	0.01	0.025	0.01	0.025
Gram-positive bacteria								
Staph. aureus	5	3	3	2	2	1	1	0.5
Strept. faecalis	3	3	3	2	2	1	1	0.5
Gram-negative bacteria								
Enterobacter aerogenes	1	1	1	1	1	1	1	0.5
Ps. aeruginosa	3	1	2	1	1	0.5	1	0.5
Salmonella types	3	2	3	2	2	2	1	1
Yeasts								
Sacch. cerevisiae	20	10	10	5	3	1	1	0.5
Cand. mycoderma	120	40	90	40	40	10	3	1
Molds								
Penicilium camerunense	>120	90	>120	90	20	10	3	1
Asp. niger	>240	>240	>240	>240	90	60	10	5
Mucor spec.	>240	>240	>240	>240	20	5	3	1
Application concentration (%) related to PAA 100%	0.025	0.05	0.025	0.05	0.025	0.05	0.025	0.05
Sporulators								
Bac. cereus	>60	>60	>60	>60	>60	>60	40	10
Bac. subtilis	>60	40	>60	>60	>60	60	40	10
Bac. mesentericus	>60	40	>60	40	10	5	10	1
Thermophile sporulators	>60	40	40	40	20	5	5	2
Clostridium perfringens	>60	10	>60	10	20	5	2	1

Source: Greenspan, F.P. et al: the convenient preparation of per-acids. J. Am. Chem. Soc. 68 (1946) 907

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