Safety of organic peroxides
Safety: our top priority

For nearly everyone who makes decisions in the process industry, safety has become one of the primary points of consideration. The extensive safety efforts put forth by many companies have already resulted in a low statistical number of casualties in the chemical industry.

To this achievement simple protective measures for the workers (helmet, clothing, etc.), improved process control, proper safeguarding and comprehensive plant designs greatly contributed. Most companies perform Hazard and Operability studies and other techniques such as Quantitative Risk Analyses to assess the safety of a plant.

Such studies require a thorough knowledge of various intricate aspects, such as the process variables and the characteristics of the raw materials. For an estimation of the extent of the hazards, acquaintance with the effects of runaway reactions, gas/dust explosions, flammability, etc. is also a requisite. Therefore, these items are subject of continuing studies to get an even better understanding of the hazards.

As the global leader in organic peroxide safety we are committed to the safe handling and storage of our products. We at Nouryon always place safety as our top priority.

This brochure presents our view of the safety aspects of organic peroxides including the latest insights into their behavior and overall safety.
Our expertise is your expertise

Nouryon has a long history in organic peroxides, starting with dibenzoyl peroxide used for the bleaching of flour in the early 1920s. Since then we have added many new organic peroxides to our product portfolio, with the growth of plastics in everyday life.

Today, we are the world’s leading producer of organic peroxides. Each year, millions of tons of PVC, LDPE, acrylics, styrenics, CR-PP and other thermoplastics are manufactured with our products. Not to forget our range of organic peroxides for the curing of thermoset resins and the crosslinking of elastomers.

Organic peroxides are in principle thermally unstable compounds which require extensive safeguarding. Their behavior is different from that of many other organic chemicals and they are in fact thermally explosive.

Much of our success is due to our long-term commitment to developing and maintaining the highest safety standards. Our thorough understanding of organic peroxide chemistry is the basis for the development of safe processes and products, adapted to customers’ needs with respect to storage, handling and supply facilities. Sharing our experience in safety is one of the most important resources we offer.

Modern hazard and operability studies formulate risks as follows:

risk = probability x effect (eq. 1)

By this definition the probability that an accident will happen is an independent variable determining the risk involved in an operation. As a matter of fact, every industry working with hazardous materials, e.g. liquefied gases, or carrying out hazardous processes, e.g. polymerization at high pressures, tries to prevent undesirable events by reducing the probability of their occurrence.

The probability of a peroxide accident is reduced or in some cases even eliminated by a number of ways.

For example dry dibenzoyl peroxide is shock-sensitive, so that the probability of an explosion effect being initiated by mechanical treatment is very high.

The same product wetted with 25% water is practically insensitive to shock and thus has a much lower probability of being ignited. A more common way to reduce the probability of accidents is proper handling of the product. The effect parameter is reduced to an acceptable level by eliminating those peroxides which show extreme or avoidable hazards in our extensive safety tests.

Peroxide safety

The essential feature of organic peroxides is their ability to form free radicals at specific temperatures. These free radicals initiate the desired chemical process. For radical polymerization a typical process can schematically be given as:

peroxide + monomer $\rightarrow$ free radical + polymer + heat (eq. 2)

where, in practice, the peroxide concentrations in the monomer vary between 0.05 and 5%.

The main safety aspect of organic peroxides is inherently connected with their function as polymerization initiator. In the absence of monomer the above reaction proceeds as follows:

peroxide $\rightarrow$ free radical $\rightarrow$ decomposition products + heat (eq. 3)

The reaction is strongly exothermic, which gives rise to dangerous phenomena similar to those observed for many polymerization reactions, namely a runaway. In the case of peroxides the runaway is commonly called a thermal explosion. Details about the thermal instability of peroxides are thoroughly discussed in the following chapters. It is an essential part of their thermal behavior, which makes peroxides different from most other substances. Most other safety aspects of peroxides resemble those of common organic substances.

In terms of risk assessment (see eq. 1) the specific hazard of peroxides can be described as follows:

The probability parameter reflects the chance that a peroxide will be subjected to an unwanted temperature increase as expressed by eq. 3. The thermal activation of the peroxide is only functional in the polymerization process as indicated in eq. 2, but has to be avoided at any earlier stage.

The effect parameter reflects the magnitude of the thermal explosion effect. The degrees of violence vary widely. Aqueous peroxide suspensions and emulsions for instance have a low decomposition effect. For most other peroxides the effect is high and precautions are required. On the other hand, it has to be noted that peroxides exhibiting properties similar to those of explosives, are not marketed by Nouryon.
The safe handling and storage of organic peroxides is only possible if the hazards are known. In this chapter, the hazards, including those which organic peroxides have in common with most other chemicals, are presented.

### Fire
Many peroxides burn violently. The reason is that the high temperatures at the flame front induce decomposition in the peroxide surface layer. Therefore, the burning rate is high, which in combination with the presence of flammable decomposition products gives rise to heavy fires. Selection of site and construction of organic peroxide storage buildings is mainly based on fire hazard (see chapter Storage on page 14). Some peroxide formulations, aqueous peroxide suspensions and emulsions are an exception to this rule.

### Ignitability
Due to their low vapor pressure the flashpoint of organic peroxides is generally higher than their decomposition temperature. Explosive gas mixtures will therefore not be present in peroxide storage rooms. A noticeable exception is di-tert-butyl peroxide, which has a flashpoint of 6°C. On the other hand, the decomposition vapors of organic peroxides are of course combustible. Ignition of peroxides may take place due to external fire, hot surfaces or auto-ignition.

### Decomposition temperature
The lowest temperature at which a runaway can take place with a substance in the packaging as used in transport, is called Self-Accelerating Decomposition Temperature (SADT). SADT values can be found in our product catalog or Product Data Sheets (PDS) which can be downloaded from polymerchemistry.nouryon.com.

### Contamination
Contamination constitutes a hazard, because many chemicals seriously reduce the decomposition temperature (SADT) of organic peroxides. Notorious examples are metal salts, amines, acids, bases and construction materials such as iron, copper and other heavy metals. Compatibility must have been proven before foreign materials are mixed with peroxides or before materials are used in contact with peroxides. Solvents sometimes reduce the thermal stability as well.

### Mechanical sensitivity
Friction, shock and impact can cause decomposition mainly due to the high local temperatures they create. The decomposition can propagate through the peroxide.

More information about this important aspect of peroxide safety is given in chapter Thermal stability on page 8. For SADT values of peroxides in containers other than the commercial packing units, e.g. storage tanks and supply vessels, please consult your supplier.

### Thermal explosion
The effect of a decomposition varies from mild to violent. Peroxides are subjected to a series of tests to classify the hazard (see chapter Thermal explosion hazard on page 11). Do not put peroxides in closed metal containers or glass bottles without having installed appropriate venting devices.

### Physiological effects
In general, peroxides are moderately toxic upon inhalation and ingestion. Because of their low vapor pressure at handling temperatures no special precautions for inhalation are required during regular handling. Proper ventilation is strongly advised. In case of dust formation, dust masks are recommended. Do not ingest peroxides as they may affect the internal organs.

A noticeable physiological hazard is the contact of the liquid peroxide with the eyes and skin. Particularly, ketone peroxides and hydro-peroxides can lead to serious eye damage and sometimes blindness, if the eyes are not immediately rinsed with copious amounts of water.

Contact with the skin may cause lesions or irritation. For this reason, personal means of protection, such as safety goggles and protective gloves are recommended.

Detailed information on a specific peroxide can be found in the Safety Data Sheet (SDS) available at polymerchemistry.nouryon.com.
Thermal stability

Free radicals are obtained by thermal activation of the peroxide. For strongly diluted peroxides the rate of free radical formation at various temperatures can be determined from the Arrhenius equation in our online product catalog.

Nouryon offers a wide range of organic peroxides for the polymerization of various monomers at temperatures from 250°C to as low as 40°C. However, formation of free radicals should be avoided during storage and handling because of quality and safety reasons.

The safety aspect is assessed by thermal stability studies of the concentrated peroxide at low temperatures. This results in SADT charts to be used for the handling of the peroxides.

In a way the SADT charts are the counterpart of the half-life charts used for the processing. Half-life charts are applicable to low peroxide concentrations. The half-life is an important process parameter in polymerization reactions.

SADT

For concentrated organic peroxides, the occurrence of a runaway reaction is determined by the product temperature. At high temperatures the exothermic decomposition gives rise to self-heating. This, in turn, causes an increase in temperature. At the higher product temperature the decomposition becomes even faster and thus a self-accelerating decomposition is attained resulting in phenomena described in chapter Thermal explosion hazard on page 11. The lowest temperature at which self-acceleration occurs is referred to as Self-Accelerating Decomposition Temperature (SADT). At temperatures below the SADT, some decomposition of the peroxide can occur, but it does not lead to self-acceleration and its accompanying hazardous effects.

Seven days after having reached its new ambient temperature of 30°C the peroxide content has deteriorated from 97.2% to 93.5%. Finally, the product at 25°C reaches the oven temperature and does not show a perceptible extra temperature increase, but suffers some quality loss in the considered time span of 7 days.

Thermal conditions

The occurrence of a thermal runaway, i.e. self-accelerating decomposition, is basically determined by the heat balance between the heat generated in the exothermic decomposition reaction and the heat dissipated to the surroundings.

Consequently, SADT values are different for each peroxide and influenced by external conditions such as amount of peroxide, heat transfer coefficient and type of packing. One could argue that it would be advantageous to pack organic peroxides in containers facilitating the heat exchange between product and its surroundings.

This would indeed lead to higher SADT values but not to higher storage temperatures. Although the heat losses have increased, the decomposition, i.e. quality loss, remains.

At the recommended storage temperature the heat produced by the peroxide is so low that it easily dissipates. Details about SADT and heat production data of peroxides can be found in references 1-4.

SADT values are influenced by the amount of peroxide per container. Test and calculation methods are available to determine SADT values for peroxides in drums, supply vessels and storage tanks. Since the external conditions in these cases may vary, no uniform SADT values can be given (see also Figure 3 and accompanying test on page 10). Contamination of peroxides can drastically reduce the SADT. SADT values of solid organic peroxides can decline considerably when they are dissolved.

Peroxide packing and storage rooms are designed to keep the product temperature constant, not to cool a product of too high temperature to normal. Considerable misconception exists with regard to this matter, which frequently results in unwanted decompositions.

References:

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The thermal explosive decomposition of a peroxide is not the most common accident with peroxides; that is a fire.

Nevertheless, knowledge of the damaging effect caused by a violent decomposition is helpful for the preparation of a balanced set of precautions and is necessary for the design of appropriate means of protection. Peroxides are subjected to a number of safety tests to determine the effect of the decomposition under a variety of external circumstances. To obtain an impression of the thermal explosion hazard a brief description of the most important phenomena is given below.

Figure 4 shows the pressure effect of a 5 g sample in a 200 l vessel. The pressure reaches 25 bar in about 75 milliseconds. The shape of the pressure curve is similar to those of gas and dust explosions in closed containers. The maximum pressure of peroxide explosions is determined by the amount of peroxide in relation to the total volume of the container.

Explosive properties
The most hazardous peroxides have been subjected to detonation tests. Detonation is a characteristic property of explosives. Some peroxides showed violent or questionable effects. These peroxides are usually phlegmatized until a definite detonation is shown to be absent. Chemical substances which do not detonate can still be considered to have explosive properties, if the product shows violent decomposition effects or a rapid propagation of the decomposition.

Hazard rating and labelling
Peroxides vary widely in hazard. Di-lauroyl peroxide, tert-butyl cumyl peroxide, dicetyl peroxydicarbonate and others show minor hazardous effects. Dibenzoyl peroxide, diisopropyl peroxydicarbonate and in particular didecyl peroxide can be hazardous in the pure state or in case of inadequate phlegmatizing. Moreover, decompositions of dry dierbenzyol peroxide and dry acetone peroxide are easily initiated by friction.

The combination of violence and high mechanical sensitivity makes them very dangerous.

In addition to the labeling according to international transport regulations, labels may be put on packages containing organic peroxides. The 'corrosive' label is applied to those organic peroxides which show a violent decomposition or rapid deflagration in the package as used for transport. The 'explosive' label is to be applied to those organic peroxides which show a violent decomposition or rapid deflagration in the package as used for transport. The 'dangerous' label is to be applied to those organic peroxides which show violent decomposition or rapid deflagration in the package as used for transport.

Our commercial peroxides have been selected so as to avoid such hazards. A low mechanical sensitivity is essential for organic peroxide applications. Therefore, mechanical sensitive molecules are either not selected or made insensitive by appropriate formulization. Phlegmatization, dilution and formulation are frequently used to make a peroxide less hazardous. For example, the hazardous properties of the peroxide in aqueous suspensions and emulsions have been downgraded to such a low level that these products are regarded as non-hazardous. All organic peroxides are labeled according to the Globally Harmonized System (GHS), or according to regulations of the International Maritime Dangerous Goods Code (IMDG), or according to national regulations of the various countries.

Hazard rating and labeling
Peroxides vary widely in hazard.

Gas evolution          smoke          boiling          foaming          thermal explosion (milliseconds)

Dutch Pressure Vessel Test

Induction times
Peroxides can be handled for a limited period of time at temperatures close to and even above their SADT values. Firstly, because it takes some time for the peroxide to reach the new ambient temperature; see Figure 1 on page 9, secondly, because the self-heating process takes some time, which is called induction time.

The first time-lag can be used for transferring cooled peroxides from one vessel to another, the second time-lag for the supply of the peroxide into the polymerization process.

Handling of the peroxide during the induction time requires careful engineering. Figure 1 on page 9 also illustrates the induction times for Trigonox 21S in 30 l packages: 10 hours at 40°C and 100 hours at 35°C, ambient temperatures. Figure 3 on this page illustrates another use of induction times: peroxides in supply vessels. For a 600 l supply vessel filled with a 25% Trigonox 25 solution the induction times have been calculated.

The induction time becomes infinite at low temperature; the critical point being the SADT for the product in the tank.

At high temperatures the induction time decreases exponentially with temperature. Induction times are notably shorter than the corresponding half-lives of the product.

The induction time plot can be used to determine the time available for emergency actions.

One should restrict the duration of the operation at high temperatures to one fourth of the induction time.

Table: Induction times

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The graph is an example only and shown for reference. Specific charts can be made upon special request.

Figure 4: Fast pressure rise as a result of a thermal explosion $P_{max}$ 25.3 bar $dP/dt_{max}$ 250 bars.

The uncontrolled decomposition
The temperature record of a peroxide decomposition is as shown in the graph on page 9. The asymptotic temperature increase can reach several hundred degrees centigrade. Recording the pressure of the explosive decomposition in a closed laboratory vessel is done on a routine basis at the laboratory of Nouryon Safety Testing and Modelling.

A product heated to a temperature slightly above its SADT shows the following chain of events:

- Gas evolution
- Boiling
- Foaming
- Thermal explosion (milliseconds)

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Peroxide containers and their transport

Packing and mode of transport are important to the user, who must adapt his storage and handling systems accordingly. The container size has been selected on the criteria of safety. The basic point is that a number of small packing units is less hazardous than the same amount in a large container. Whereas in a large container the entire contents can decompose as a unit, it is impossible that all the small packing units decompose at the same time.

Containers
- Most of the pure and highly concentrated liquid peroxides are supplied in 30 l polyethylene containers.
- Most solid peroxides are packaged in polyethylene bags inside a corrugated cardboard box. Others are available in fibre drums. The packing itself provides an optimum in safety: insulation (see chapter Thermal stability on page 8), rupture when necessary (see chapter Thermal explosion hazard on page 11). The containers are stacked on pallets in two layers or four layers.
- A few peroxides are packed in 200 l drums or larger containers. The peroxide and its container have to meet certain standards. The major safety criteria for the transport of the peroxide in a larger container are: no mechanical sensitivity, minor deflagration effects, low explosive power, low thermal explosion effect. The container must be adjusted to the peroxide hazards. Compatible construction material, mechanical strength, relief valves and bursting discs are some of the required provisions.
- The main objective is to prevent fragmentation of the tank in case of a decomposition.

Nouryon was the first organic peroxide producer to introduce intermediate bulk containers (IBC’s). These IBC’s offer a balance of economy and safety for the transportation, storage and handling of organic peroxides. In addition, IBC’s have several advantages over smaller packages, such as: reduced worker exposure to organic peroxide vapors, elimination of packaging waste and reduced handling of organic peroxides and packaging.

The specifically designed 1,250 l stainless steel IBC for diluted organic peroxides and peroxide emulsions has obtained approvals for the transport of organic peroxides by road and by sea. The spring-loaded clamping device, used as an emergency vent, is an Nouryon invention and has been patented. And we’re continually looking for new ways to optimize safe transport, handling and storage of organic peroxides.

The regulations divide substances into classes: flammable liquids, compressed gases, toxic substances, etc. Organic peroxides constitute a separate class, generally numbered 5.2 ‘Organic Peroxides’. Class 5.2 is a so-called restricted class: only those products listed in the regulations are allowed for transport.

Some of the items regulated are: transport temperature, packing type, maximum amount of product per packing, labeling, emergency temperature, etc.

Additional stipulations depend on the mode of transport, e.g. for sea transport the location of the load, storage, surveillance, emergency procedures, etc. We have a large fleet of sea containers, each of which is equipped with two independent refrigeration units to safely transport our products.

Nouryon

IMDG code
ICAO
ADR
RID

Worldwide transport recommendations
- United Nations
- IMDG code
- ICAO

Transport regulations
- sea transport
- air transport

Various transport regulations exist:
- Europe by road
- Europe by rail
- ADR
- RID

Dry-break connection. All unloading facilities are present on the trailer. In diluted form (20 to 40% peroxide concentration) bulk transport is feasible for practically all peroxides in tanks of 10 to 20 m³ capacity. Both the peroxide and the tank should be approved by the national governmental authorities. Since the polymer production and processing industries mostly use peroxides in diluents, the dilution does not constitute a problem. Nouryon has an increasing number of bulk carriers in operation.

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Storage

This chapter describes the storage of organic peroxides packed in the commercial container. Due to their specific properties organic peroxides cannot simply be put in any chemical warehouse for chemicals. Separate storage facilities are recommended. The separate storage and the requirements for such a store room have the same underlying principles.

The thermal explosion hazard has been reduced to a hazard of secondary importance due to the type of packing (small and fragile). This fact is supported by the accident record of peroxide storage rooms. Decomposition of peroxides in their containers mainly results in large amounts of fumes or a peroxide fire.

Peroxide fires and the subsequent consequences for storage rooms have been the subject of extensive investigations by the peroxide industry and the governmental authorities. The experiments performed with the Bundesanstalt für Materialprüfung (BAM) in Berlin were extended to tests involving 5,000 kg of liquid peroxide. These tests yielded the following characteristic data for highly concentrated liquid peroxides:

Typical values of a peroxide fire for 10,000 kg:
- burning rate 250 kg/min
- heat of combustion 30,000 kJ/kg
- radiant heat fraction approx. 20%

This results in a 8 kJ/m²/s radiation at 25 metres, an intensity that chars wood and that humans can endure only a short time (1 second).

The requirements for a peroxide store room can be derived from above mentioned items.

Maximum temperature

Temperature control is only possible, if a thermometer is installed. Type T1 for uncooled products and type T1C for cooled products. The temperature should preferably also be recorded outside at the door entrance, so that the personnel can check the inside temperature before entering. The proper storage temperature should be marked at the entrance. The thermometer can be used for fire alarm as well (TIA or TICA function).

In that case, two set-points are useful: low alarm to indicate an increase above the maximum storage temperature and high alarm to indicate decomposition or fire (see also section Fire prevention on page 15). Close supervision should be given to any alarm situation. In order to avoid any temperature rise inside the peroxide as a result of self-heating (see chapter Safety parameters on page 6), it is necessary to have an air circulation inside the building. Space between the pallets of peroxide and natural convection ventilation are sufficient to prevent selfheating at storage temperatures.

The design requirements to achieve a temperature inside the storage room, which is below the maximum storage temperature of the product, differ for uncooled and cooled peroxides.

Uncooled products

In order to retain good quality of the peroxide for uncooled products a maximum storage temperature of 25–40°C is strongly recommended. One should be aware of summertime conditions and northerly effects.

Adequate means are walls and roof (non-flammable or fire retardant) of low heat transfer materials, no windows and sufficient air ventilation. Openings for ventilation should roughly constitute 0.5% of the floor area and be covered with gratings. Leave some space between wall and peroxide. In this way, sun radiation on the roof is not directly transferred to the product and air circulation removes the heat input from outside. In hot climates an extra sunroof or water spray on the roof can be helpful to keep the temperature below 40°C. Wintertime can be a problem, as some products may solidify. If heating is applied, the temperature of the heater should not exceed 50°C, nor act as an ignition source. Keep peroxides at a safe distance from the heater.

Cooled products

Cooling/refrigeration will be necessary. Cooling agent: non-flammable and chemically non-reducing. The use of insulated walls, roof and door is evident. Special provisions are required to overcome a cooling unit failure. Firstly, a warning system is essential so that the failure is detected in an early stage. Secondly, a back-up refrigeration system that can be used in case of failure of the primary unit (a dry sprinkler system for refrigerated products) or in the case of refrigerated products, a liquid nitrogen fire-protection system might be considered and a 20 kg sodium bicarbonate-based powder extinguisher for small fires, location outside near the door.

Fire control

Burning material, liquid peroxide or solid peroxide floating on the fire-fighting water can spread in all directions if not contained by an adequate construction of the store.

Appropriate means for control are:
- basin type floor construction
- channels which direct the burning flow to an open pit. The common sewage system of the plant is not suitable for this purpose
- safe distances: the fierce burning of peroxides can constitute a threat to the surroundings. Safe distances depend on sensitivity of neighbouring objects (hospitals, houses, roads, plants), amount and type of product stored, construction of store-room, etc. For a 7,200 kg store the distances can vary from 50 to 40 metres.

Contamination

One of the main reasons for a separate peroxide store is to prevent contamination, which can seriously reduce the thermal stability of peroxides. Thus, maximum storage temperatures would become unreliable safeguards. In the peroxide store itself leakage and spillage are another type of contamination hazard. Spilled peroxide on the ground gets contaminated with dirt which is a reputed source of ignition. Remove liquid spillage with vermiculite, perlite or sand. Proper housekeeping will suffice.

General storage recommendations

The recommended maximum capacity of a peroxide store unit depends on the available safety distance. When large quantities are to be stored, the storage building can be divided into several units by means of fire resistant walls. The entrance should be clearly marked with the international organic peroxide shield and the required storage temperature. Other common provisions to be applied are: emergency venting, lightning protection and flame-proof electrical equipment inside the store.

Observe the good practical rules with respect to the stored product:
- use the oldest material first (first in/ first out principle)
- do not store for longer than half a year.

Small quantities

Small quantities of organic peroxides do not need a separate building. A separate room, chest or, for cooled products, a refrigerator/freezer will suffice. Basically, the same principles as those outlined in the previous chapters are applicable. Particularly the following items should be observed:
- doors or lids open easily to release any pressure build up inside (no locks, etc.)
- the organic peroxide may auto-ignite
- maximum storage temperature of the product
- minimum storage temperature.

Final remarks

The construction of a peroxide storage building appears to be as complicated as for many other chemicals (LPG, HCI, etc.). This can be overcome, if some general aspects are taken into account right from the start, such as:
- national laws, local regulations, codes of practice, etc.
- plant lay-out, local circumstances, amount of peroxide to be stored
- insure opinion
- advice of a knowledgeable peroxide supplier.

Nouryon can provide you with detailed instructions and examples of storage rooms.
Cleaning and disposal

The disposal of organic peroxides should also be carried out properly. The destruction of peroxides and cleaning of peroxide equipment, e.g. containers is not complicated but should be done with accuracy and care.

Cleaning
First verify that the container or equipment is empty. Then flush or rinse equipment with a mineral oil; heptane, dodecane, etc. will do. Do not use acetone as a start, especially not with ketone peroxides and hydroperoxides, because the hazardous solid acetone peroxide might be formed and precipitate.

Subsequently, apply copious amounts of water. Finally, proceed with the regular cleaning or disposal procedure.

In order to avoid confusion, remove or cross out the organic peroxide labels. Never reuse the polyethylene container for food and drinks.

Equipment that will be reused for peroxides after some time, or any new equipment should be passivated before use (ask your supplier for the passivation procedure).

Please keep in mind that any clothing wetted with peroxide should be placed in water immediately and not worn again until laundered. Spills of liquid organic peroxides can be absorbed with large amounts of vermiculite. Add water to saturate the vermiculite.

Disposal
The most effective way of peroxide elimination is burning. An alternative is chemical destruction. You can, of course, contract the waste treatment out to an officially recognized disposal company.

Burning
Organic peroxides burn very well. However, technically pure peroxides burn too violently for direct incineration.

As a result of diluting the hazardous peroxide properties can be reduced to a minimum. Acceptable diluents are mostly the common hydrocarbons and fuel oil.

On handling the diluted waste peroxide, two possible hazards should be taken into account:

- the peroxide waste may give rise to gas evolution
- heating of the peroxide waste when contained in closed metal vessels or pipe segments will result in substantial pressure build up.

These hazards can easily be controlled by appropriate venting devices. Small quantities of organic peroxides can be burned without dilution, if necessary and allowed by the relevant authorities.

Preferably, the burning is carried out as a pool fire in a shallow basin. In emergency situations the peroxide in the commercial container can be burned as a whole. The best way is to cover the container with wood chips or other similar material and sprinkle it slightly with gasoline.

In all cases the ignition should be done from a safe distance, e.g. by means of a burning rag fastened to a pole. This type of burning, if permitted, must be done in the open at some distance (minimum 15 metres) from buildings.

Furthermore, it will be clear that such a job should be carried out by experienced firebrigade personnel.

Chemical destruction
Chemical destruction is possible, but requires a chemical process installation: reaction vessel equipped with jacket for cooling and heating, stirrer and a scrubber. The chemical reduction of peroxides should not be carried out without a proper process description.

Most processes are based on hydrolysis of the peroxide in a 25% caustic solution with a surfactant and a protic solvent, followed by or combined with an aqueous sodium sulfite treatment.

The peroxide must be added slowly; the total amount per batch should not be more than 30% of the total aqueous solution. The active oxygen concentration needs to be checked after the phase separation. The batch time is several hours. In case chemical destruction is considered, please consult your supplier for an appropriate process description.
Leading the way in safety

Next to your trusted supplier of Butanox®, Perkadox® and Trigonox®, Nouryon is recognized as the global leader in organic peroxide safety. We always place safety as our top priority. Sharing our experience in safety is one of the most important resources we offer. Classroom reviews of safety and handling of organic peroxides, online trainings, consultation on storage and peroxide dosing equipment as well as demonstrations and publications on the safe use and handling of organic peroxides are just some of the services we offer.

How to store peroxides

- Store in a cool room away from direct sunlight.
- Observe maximum and minimum storage temperature as printed on the packaging and SDS.
- Leave in the original packaging.
- Close packaging after use.
- Do not store together with accelerators or other chemicals.
- Do not mix peroxides with accelerators.
- Avoid any contact with dust, metal or other chemicals.

How to handle peroxides

- Wear safety goggles.
- Wear appropriate protective gloves and clothing.
- Remove spillages immediately.
- Only use compatible materials when handling.
- Do not smoke.
- Avoid heat sources.
- Avoid open fire.
- Never heat peroxides.

In case of emergency call the following telephone number:
+31 (0)570 679 211

How to act in case of:

- Fire
  Alert fire department. Fight small fire with powder or carbon dioxide and safety water.

- Spillage
  Liquids: absorb with inert material and add water. Solid/pastes: take up with compatible aids and add water. Move to safe place and arrange disposal as soon as possible.

- Skin contact
  Wash with water and soap.

- Eye contact
  First rinse with water for at least 15 minutes. Always seek medical attention.

- Ingestion
  Drink large amounts of water and consult doctor immediately. Do not induce vomiting.

Additional information

Product Data Sheets (PDS) and Safety Data Sheets (SDS) for our polymerization initiators are available at polymerchemistry.nouryon.com.

All information concerning this product and/or suggestions for handling and use contained herein are offered in good faith and are believed to be reliable. Nouryon, however, makes no warranty as to 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. Nouryon does not accept any liability whatsoever arising out of the use of or reliance on this information, or out of the use or the performance of the product. Nothing contained herein shall be construed as granting or extending any license under any patent. Customer 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 information on the subject matter covered. The customer may forward, distribute, and/or photostate this document only if unaltered and complete, including all of its headers and footers, and should refrain from any unauthorized use. Don’t copy this document to a website.

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We are a global specialty chemicals leader. Industries worldwide rely on our essential chemistry in the manufacture of everyday products such as paper, plastics, building materials, food, pharmaceuticals, and personal care items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability, and innovation, we have established a world-class business and built strong partnerships with our customers. We operate in over 80 countries around the world and our portfolio of industry-leading brands includes Eka, Dissolvine, Trigonox, and Berol.