Safe transport of organic peroxides in refrigerated containers (reefers)

Guidelines on safety aspects of handling, transport and operation
Introduction

In the transport regulations, organic peroxides are classified in transport division 5.2. A number of organic peroxides have to be transported under temperature controlled conditions because they are thermally unstable. Usually, this takes place in refrigerated containers, so-called reefers.

This type of transport requires special attention to reefer containers taking into account the properties of the products transported.

This guideline was developed by leading organic peroxide producers, members of the European Organic Peroxide Safety Group, and can be considered the best current practice regarding the safety aspects of handling, transport and operation of reefers containing organic peroxides.
Objective

Objective of this guideline is to give a minimum set of standards regarding the safety aspects of handling, transport and operation of organic peroxides in reefers which are recommended to achieve safe transport of these products under temperature controlled conditions.

Background and legal requirements

The transport of organic peroxides under temperature control is laid down in the various modal transport regulations (i.e. sea and land; transport of temperature controlled products is forbidden for rail and air mode). These regulations are all based on the United Nations Recommendations on the Transport of Dangerous Goods. In these UN recommendations, criteria are given for the requirement of cooling (temperature control) and temperature settings of the refrigerated container.

In the modal regulations you will find general descriptions of the accepted types of cooling (coolant, mechanical refrigeration, single or dual) and emergency procedures. For legal purposes this may be sufficient, however details regarding technical equipment, procedures on operational issues like pre-loading, container preparation, combined loading, electrical connections, instruction manuals, hand-over procedures, emergency procedures are not described in detail, but are necessary for safe handling, transport and operation.

The authors’ opinion is that the contents of this brochure will facilitate the safe handling, transport and operation of organic peroxides in reefers and will lead to a safer transport of organic peroxides for all stakeholders.

The starting point of this brochure is the IMO-IMDG code (sea transport regulations) requirement.
Technical equipment and description

To ensure the proper and safe transport of organic peroxides, the reefers have to fulfill the requirements of the IMDG code. This code describes in general terms the requirements of several technical features and equipment a reefer has to be provided with.

More technical details of the reefer containers as operated by organic peroxide manufacturers are given below. They go further than required by the IMDG code.

**Power supply**
The reefer container requires a power supply of 380/460 V and 50/60 Hz.

Each container has a separate diesel engine generator-set to supply electrical power as alternative if the power supply is not available. Diesel fuel is protected against freezing.

Capability of gen-set is for continuous operation.

**Cooling system**
All company managed reefer containers are equipped with two independent and redundant cooling systems to ensure a safe transport even if a technical malfunction may occur.

Each individual system is adequate to ensure a proper cooling and to maintain the pre-set temperature. Each cooling system is monitored by a separate control unit which also indicates failure report by signal lamps.
Temperature monitoring and recording
Temperature inside the container is continuously recorded and displayed even without electrical power. At least two separate temperature probes and indicators are available per reefer container.

Two set points are defined to indicate an increase over the set-temperature ($T_s$) (see graph on page 6).

$T_s + 5$ centigrade: H-Alarm
$T_s + 10$ centigrade: HH-Alarm

Insulation
Reefer-containers are completely insulated. The cold air circulates inside of the reefer in a closed loop.

The insulation fulfills or exceeds the requirements of the IMDG code.

Monitoring and alarm
The proper function of the systems and the temperature inside of the reefer container are permanently monitored. Any failure will be showed with an audible and visual alarm. Potential-free connector allows plug-in of remote alarm connection to the vessel’s system (adapter plug or cable needed)
Operational

It is essential that all operations done with reefers have to be executed by trained and skilled personnel!

Pre-loading procedure

Explanation and relevance of product temperatures

Prior to stowage of reefer containers, all temperature controlled organic peroxides are pre-cooled at least to or below the set-temperature ($T_s$).

$T_s$ is the working-temperature adjusted at the cooling-equipment. $T_s$ is set lower than the control temperature ($T_c$).

If a variety of products are transported together $T_s$ is always based on the product with the lowest $T_c$.

In this case even products with higher $T_c$ have to be pre-cooled to the lowest $T_s$ to prevent overheating during start-up or the hand-over of the reefer container.

To ensure proper pre-cooling the temperature $T_s + /- 5$° centigrade has to be maintained for at least 24 hrs prior to dispatch.

For some products a $T_{mn}$ is required for quality reasons or to avoid undesirable effects to products e.g. phase separation or freezing.

A schematic representation of all relevant temperatures is given in Figure 1.

IMDG temperatures

SADT = Self Accelerating Decomposition Temperature

$T_e$ = Emergency temperature

$T_c$ = Control temperature

Industry temperature settings (more conservative)

$T_s$ = Transport temperature setting

$T_{Hii}$ = Temperature high-high alarm

$T_{Hi}$ = Temperature high alarm

$T_{mn}$ = Minimum transport temperature
Reefer container preparation

Prior to each sea-transportation every reefer container has to pass an obligatory safety-preparation procedure. This procedure comprises:

- Successful passing and documenting the PRE-TRIP-INSPECTION (PTI) by instructed and trained personnel
- Correct temperature setting of $T_r$, $T_{APP}$, $T_{DEP}$, $T_{MIN}$ (see Figure 1)
- Test of proper working alarm function (both the visual and acoustic alarm)
- Check that temperature recorder is working properly
- Examination of all technical functions and inspection of equipment (box/framework)
- To ensure reliable functioning of all system-components; every reefer is to be tested for a reasonable time prior to shipment.

Stowage

Stowage, based on stowage plans, is done by the shipper only. Stowage of all products within cargo-hold has to be done properly and sufficient air-ventilation has to be guaranteed (ensure air flow on all sides for instance by the use of palletised cargo only).

The product with the lowest $T_c$ should be stowed within the reefer container in accessible position close to the doors. The stowage shall be such that, if disposal is necessary at sea, the packages or closed cargo transport unit can be jettisoned quickly and easily.

Manual/handbooks and reefer-connecting aboard vessel

Manual/handbooks

The manual, which describes the basic use and features of the reefer container, is kept within each unit. It contains:

- Descriptions of special functions
- Electrical wiring-plans and schematic drawings
- A trouble shooting guide

The manual may be kept in a box outside of the reefer or handed out to the vessel’s master or first engineer along with additional explanations regarding the operating-instructions of the reefer.
Pictograms
Loading on board of vessel

The exact location of the reefer on board of the vessel shall be coordinated in advance. Reefer containers with organic peroxides may only be stowed on deck in such a way that the doors, cooling units and temperature controls are easily accessible. It must be possible to open the doors easily, in case it becomes necessary to jettison the cargo. If containers are stacked on top of each other, the refrigerated container should be at the bottom of the stack standing on the deck as near as possible to the deck rail.

The container must be placed in such a way that the refrigeration units and the loading doors are easily accessible.

The actual inside temperature of the reefer container should be checked, monitored and recorded every 4-6 hours in ship's log book.

Whilst boarding at port of loading, a professional reefer service (on behalf of the shipper) should be present for:

- Support during the hand-over procedure
- Check on the connection and plugs of the electric power supply
- Check and demonstration of the cooling equipment and the diesel-generator on board of the vessel
- Giving explanations about operating and working principles of the reefer container to the captain or engineering officer
- Making sure that the container manual /handbook is handed over to captain or engineering officer
Emergency procedures

For emergency measurements you have enough time to react if you recognize the deviation in early stages.

Any deviation of normal transport conditions must be considered potentially dangerous and treated accordingly.

Deviations could be for example:

- Abnormal rise of monitored temperature
- Any alarm
- Any spillages
- Smell, smoke or abnormal noises coming from the container

In case of deviation you should call the emergency response number immediately indicated on the transport documents, reefer manual or reefer itself!

The emergency response number is available 24 hours a day. You will get technical assistance and advice based on predefined emergency procedures. In case of doubts keep a safe distance to the container and prepare fire-fighting equipment.

Whenever you call the emergency response number you should have following information available:

- Name of the vessel and position
- Container id
- Product type (UN number), product name and quantity
- Nature of the incident and its development
- Corrective actions undertaken
- If available recorded temperature values
- Current temperature of the cargo
- Your contact details

See also the emergency procedures for organic peroxide (IMDG 7.8.3 and 7.8.5) but in all cases contact the emergency response number!
Contact us

For product inquiry and ordering information, please contact your Nouryon account manager or regional Nouryon sales office.

Américas
US and other countries
Citadel Center
131 S Dearborn St, Suite 1000
Chicago IL 60603-5566
USA
T +1 800 828 7929 (US only)
E polymerchemistry.na@nouryon.com

Mexico
Av. Morelos No. 49
Col. Tecamachalco
Los Reyes La Paz Estado de Mexico
C.P. 56500 Mexico
T +52 55 5858 0700
E polymerchemistry.mex@nouryon.com

Brazil
Rodavia Nouryon no. 707
Portão A – Planta C
Bairro São Roque da Chave
13295-000 Itupeva - São Paulo
Brazil
T +55 11 4591 8800
E polymerchemistry.sa@nouryon.com

Europe, India, Middle East and Africa
France, Italy, Spain and Portugal
Autovia de Castelldefels, km 4 65
08820 El Prat de Llobregat
Barcelona
Spain
T +34 933 741991
E polymerchemistry.es@nouryon.com

India
North Block 801, Empire Tower,
Reliable Cloud City Campus,
Off Thane – Belapur Road
Airoli, Navi Mumbai - 400708
India
T +91(0) 22 68426700
E polymerchemistry.nl@nouryon.com

Middle East
Silicon park, Building A6
Office no 402, 4th floor
Dubai Silicon Oasis
Dubai
United Arab Emirates
T +971 4 2471500
E communications.me@nouryon.com

Russia and CIS
Smolnaya Str., 24D,
Commercial Tower Meridian
125445 Moscow
Russia
T +7 495 766 16 06
E info.moscow@nouryon.com

Other countries
Zutphenseweg 10
7418 AJ Deventer
The Netherlands
T +31 88 9841229
E polymerchemistry.nl@nouryon.com

Asia Pacific
22F, Eco City, 1788 West Nan Jing Road
Shanghai 200040
P.R. China
T +86 21 2220 5000
E polymerchemistry.ap@nouryon.com

Additional information
Product Data Sheets (PDS) and Safety Data Sheets (SDS) for our polymerization initiators are available at
www.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 its purposes. The information contained herein supersedes all previously issued information on the subject matter covered. The customer may forward, distribute, and/or photocopy 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.

Perkadox and Trigonox are registered trademarks of Nouryon Chemicals B.V. or affiliates in one or more territories.
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.