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## MEDITERRANEAN ACTION PLAN (MAP) REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

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Fourteenth Meeting of the Focal Points of the Regional  
Marine Pollution Emergency Response Centre  
for the Mediterranean Sea (REMPEC)

REMPEC/WG.51/10/1  
Date: 6 May 2021

Online, 31 May – 2 June 2021

Original: English

Agenda Item 10

### STUDY ON CONDENSATE SPILLS

#### Note by the Secretariat

#### SUMMARY

**Executive Summary:** This present document provides information on the preparation of a study on condensate spills and the related proposals

**Action to be taken:** Paragraph 10

**Related documents:** REMPEC/WG.45/12/1, REMPEC/WG.45/16, REMPEC/WG.45/INF.14,  
REMPEC/WG.51/10

#### Introduction

1. The Thirteenth Meeting of the Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) (Floriana, Malta, 11-13 June 2019), discussed the outcome of Regional workshop on response to spill incidents involving HNS (MEDEXPOL 2018) (Valletta, Malta, 20-21 June 2018) presented in the document REMPEC/WG.45/INF.14.

2. The Meeting raised the need to develop guidance documents on marine pipeline, specific chemicals and on response to air contamination resulting from chemical incidents at sea, and one delegation proposed to conduct a study on the issue related to spills of condensate.

3. Recognising that the traditional techniques and response methods to combat marine oil spill may not be fit for the purpose of handling incidents involving condensate, the Meeting agreed to include in the Programme of Work of the MTWG for the biennium 2020-2021, the preparation of a study on the issue related to spills of condensate.

#### MTWG Consultation

4. In light of the above, the Secretariat initiated an internal review of existing material on condensate and was informed by Cedre of the development of a guidance document entitled 'Condensates – Chemical Intervention Guide', commissioned by TOTAL S.A. Noting that the said guidance prepared by Cedre was very much in line with the expected output requested to the MTWG, the Secretariat explored the possibility of benefiting from the ongoing work to avoid duplications.

5. The guidance document, herein referred to as the guide, appearing in **Annex I** to the present document, aims to provide operational staff who may be confronted by an accidental spill of condensates in an aquatic environment, with useful information on the response to pollution or in the development of response plans to address such a spill. It provides quick access to essential information for such an emergency, as well as to provide bibliographic sources relevant to the search for complementary data. It contains experimental data, as well as the results of scenarios corresponding to accidents on the high seas for surface or deep-sea (blowout) discharges. The guide is structured as follows:

- .1 Purpose of the guide
  - i. What you need to know about condensates
  - ii. Primary emergency data
  - iii. Examples of real cases and modelling of different accident scenarios
  - iv. Combating spills
  - v. Additional information
- .2 Appendix: Chemicals: classification, labelling and packaging

6. Considering the long-standing cooperation between TOTAL S.A. and REMPEC, and following the necessary consultation with Cedre and TOTAL S.A, it was agreed that REMPEC, along with the support of Cedre, would use the guide as a basis for possible further developments taking into account Mediterranean coastal States' contribution and input on condensates used in the region.

7. Upon completion of the guide by Cedre, at the end of December 2020, and further to its translation into English by REMPEC, the Secretariat disseminated the said guide and a condensate data sheet, reproduced in **Annex II**, to introduce the document to the MTWG's OPRC-HNS Correspondence Group and the OPRC Focal Points, and to request the following input:

- .1 a detailed list of the type of condensates transported by sea, produced, and operated on in the respective countries; and
- .2 comments, suggestions, and recommendations on the proposed guide.

8. Mediterranean coastal States' contributions are reproduced in **Annex III** to the present document. Only four (4) out of twenty-two (22) Contracting Parties to the Barcelona Convention, provided feedback: While two (2) Mediterranean coastal States provided information on the detailed list of the type of condensates, three (3) countries provided comments on the guide.

9. In light of the above, and noting that further consultations and work are required to complete this task, the Secretariat proposes to :

- .1 extend the consultation with Contracting Parties to the Barcelona Convention, to collect further input, as referred in paragraph 7.1 above, and to further examine the proposed guide;
- .2 request the Secretariat to review the guide as laid down in Annex I, taking into account Mediterranean Coastal States' contributions;
- .3 extend the period of the mandate of the MTWG to allow for further progress and finalisation of this task, preferably by end December 2021; and
- .4 request the Secretariat to submit it for examination and approval by the Fifteenth Meeting of the Focal Points of REMPEC.

#### **Action requested by the Meeting**

10. **The meeting is invited to:**

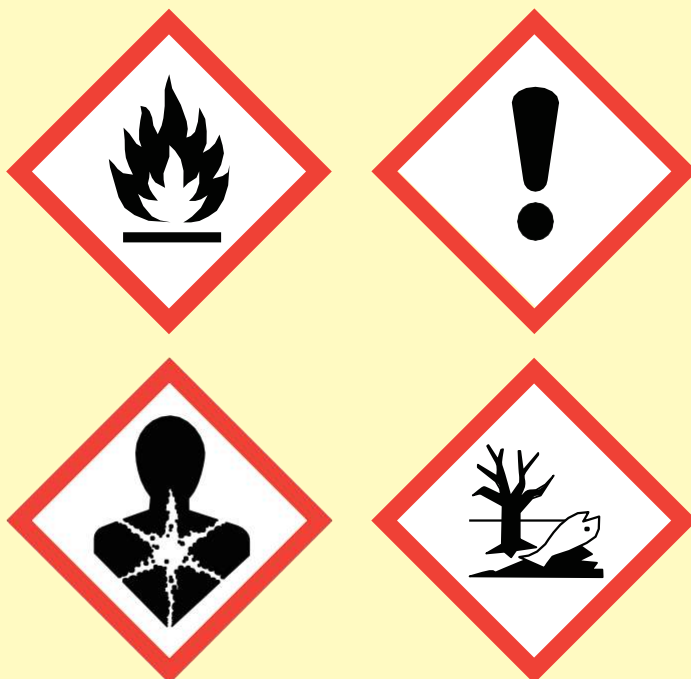
- .1 **take note** of the information provided by the Secretariat in the present document; and
- .2 **consider** and **agree** upon the proposals put forward by the Secretariat as laid down in paragraph 9 of the present document.

**ANNEX I**

**The Condensates – Chemical Intervention Guide**

# CONDENSATES

EU classification:



UN number: 1268

CAS number: 64741-47-5



CHEMICAL INTERVENTION GUIDE

# CONDENSATES

PRACTICAL GUIDE

INFORMATION

DECISION

INTERVENTION

This guide was prepared by the Centre for Documentation, Research and Experimentation on Accidental Water Pollution (Cedre) with the financial support of Total S.A.

Authors:

Julien Guyomarch and Fanny Chever

The information contained in this guide is the result of an effort to synthesise, as well as Cedre's experience. The latter cannot be held responsible for the consequences of its use.

Publication: December 2020

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This Version is translated from French by REMPEC for the development of the Study on the issue related to spills of condensate

## Purpose of the guide

Dissemination in the form of guides of study results, experimental research and feedback from accidents constitutes an important component of Cedre's activities, highlighted by its strategic committee.

This guide is intended for operational staff who may be confronted by an accidental spill of condensates in an aquatic environment. This document does not deal with soil pollution. It aims to provide operational staff with useful information in the fight against pollution or in the development of response plans to address such a spill.

The purpose of this guide is to provide quick access to essential information (see Chapter B, *Primary emergency data*), as well as to provide bibliographic sources relevant to the search for complementary data.

It contains experimental data, as well as the results of scenarios corresponding to accidents on the high seas for surface or deep-sea (blowout) discharges. These scenarios are meant solely to provide emergency guidance to decision makers. Each real accident case must be analysed specifically, and the decision maker cannot avoid measurements *in situ* (in air, water, sediment, aquatic fauna, etc.) in order to specify the exclusion zones.

This guide is intended for specialists who are familiar with the techniques to be implemented in the event of a disaster and who are able to judge the advisability of applying the recommended measures. While the fight to limit the consequences of spills is at the centre of our concerns, we cannot ignore the protection of workers and human toxicology.

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**Lille** (regional university hospital) - Tel.: 0800 59 59 59

**Lyon** (civil hospices of Lyon) - Tel.: 04 72 11 69 11

**Marseille** (university hospitals of Marseille) - Tel.: 04 91 75 25 25

**Nancy** (regional university hospital) - Tel.: 03 83 22 50 50

**Paris** (Fernand Widal Hospital) - Tel.: 01 40 05 48 48

**Toulouse** (university hospital) - Tel.: 05 61 77 74 47

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# What you need to know about condensates

## Definition

Condensates occupy an intermediate spot along the spectrum of unrefined hydrocarbons, which extends from natural gas to crude oils. Together with natural gas deposits and the gaseous portion of oil fields, they represent the share of hydrocarbons that, gaseous in the deposit, condense in liquid form during their expansion under atmospheric pressure. Condensates are generated by separation on site, at the wellhead or in more complex processes in natural gas processing plants and refineries. Generally, they are made of alkanes containing at least five carbon atoms, unlike liquefied petroleum gases (propane, butane), which contain fewer. In addition to aliphatic compounds, condensates also contain aromatic compounds such as benzene, toluene, ethylbenzene and xylene (BTEX compounds) and naphthalene in most abundance. Certain condensates may also contain hydrogen sulphide (H<sub>2</sub>S). They are volatile, light, unstable and flammable products characterised by an API density of at least 45 (density less than 0.80 g/L at 15°C).

A great variability of chemicophysical composition and behaviour exists in condensates. Some are similar to kerosene, characterised by low asphaltene content and rapid evaporation. These condensates do not, *a priori*, form emulsions and appear to be

poorly suited to chemical dispersion. By contrast, other, heavier condensates, richer in asphaltenes, are less prone to evaporation, emulsify and are potentially dispersible. These chemicophysical differences have important consequences in terms of behaviour in the environment and the control techniques to be implemented in the event of an accident. It is therefore necessary to be very careful and to determine, as a priority, the type of condensate that must be faced.

In this guide, we will discuss diverse examples of condensates studied in the laboratory and/or at the pilot stage, in order to observe the widest possible spectrum of behaviours and the responses to be provided in the event of an accident.

## Use

Because of their almost immediate use (little processing in a refinery or gas treatment plant), condensates are of very high economic value. Their production is increasing sharply. They are mainly used for the production of naphtha, kerosene and diesel fuel.

## Production, processing, transport

Condensate deposits are located on land or offshore and are distributed globally (North Sea, Africa, the Middle East, Southeast Asia, etc.). They are transported by pipelines to coastal refineries. Some refineries are specially designed to process them (the Ras Laffan refinery in Qatar, Skikda refinery in Algeria or



Daesan refinery in South Korea). The countries with the longest condensate pipelines are Algeria, Indonesia and Libya. Processed condensates are discharged by sea into oil tankers.

### Risks

#### Fire:

Highly flammable liquid and vapour. During use, a flammable/explosive vapour-air mixture may form. Vapour denser than air remain at ground level, with a very high risk of explosion. The friction caused by the flow of the product creates static electricity charges that can generate sparks, causing ignition or explosion.



#### Toxicity:

- Harmful by inhalation. May have anaesthetic effects if high vapour concentrations are inhaled.
- Harmful if swallowed. May give rise to inhalation pneumonia, developing within a few hours in the event of aspiration into the lungs due to its low viscosity. Medical supervision is essential for 48 hours.



- Harmful to skin. May cause skin and eye irritation in the event of contact with the liquid or exposure to the vapours.

### Behaviour in the aquatic environment

When discharged into water, condensates float (density < 0.8 at 15°C) and form a slick on the surface, of which some compounds dissolve. The evaporation of the slick can be rapid depending on the winds and the type of condensates (between 50 and 90% in three to four days). If the atmospheric turbulence is low, condensate vapours, heavier than air, move to the water's surface.

Condensates are toxic for aquatic organisms and can cause long-term adverse effects in the aquatic environment. They are weak but potentially bioaccumulative. The rates of condensate biodegradability are highly variable and depend on the content of polar compounds in aged chemicals.

### Control strategy

Above all, condensates pose a safety hazard (fire, explosion, accumulation of vapour in areas of concentration). Their great variability implies different control strategies to be implemented according to the chemical. From an antipollution point of view, if the chemical has reached the water's surface, control may be limited to the lightest to allow the chemical to evaporate naturally.

In the case of the heaviest chemicals forming emulsions of low viscosity, chemical dispersion may be considered whatever the volumes involved, provided that the general recommendations

## Condensates

### Chemical intervention guide

specific to this technique are complied with (sufficient sea conditions, distances to the coast, consideration of particularly sensitive areas from an ecological perspective, etc.).

In the event of a small spill, after the evaporation of the light elements, the heaviest condensates can be trapped in absorbent materials.

In case of significant accidents, condensates can be recovered by pumping or concentrated skimming, or by diverting the slicks with floating dams.

In the latter case, for safety reasons, the recovery area can, if necessary, be covered with fire foam to reduce evaporation. These operations involve the ability to manage the risk of fire throughout the recovery chain (storage/transfer of recovered chemicals).

In case of blowout, chemical dispersion by submarine injection, after selection of an effective dispersant can be an efficient and safer technique in terms of safety. In the event of accidents in sensitive coastal areas (marshes, for example), *in situ* burning could be envisaged.

A

# Primary emergency data

- Chemicophysical characterisation of some condensates \_\_\_\_\_ **B1**
- Typical chemicophysical data \_\_\_\_\_ **B2**
- Identity sheet \_\_\_\_\_ **B3**
- Flammability data \_\_\_\_\_ **B4**
- First aid data \_\_\_\_\_ **B5**
- Transport, handling, storage \_\_\_\_\_ **B6**
- Toxicological data \_\_\_\_\_ **B7**
- Ecotoxicological data \_\_\_\_\_ **B8**
- Behaviour in the aquatic environment \_\_\_\_\_ **B9**
- Persistence in the aquatic environment \_\_\_\_\_ **B10**
- Environmental impacts following a spill \_\_\_\_\_ **B11**
- Potential impacts on different environments \_\_\_\_\_ **B12**
- Potential impacts on economic resources \_\_\_\_\_ **B13**

**B**

## Condensates

### Chemical intervention guide

# Chemicophysical characterisation of some condensates

Condensates are a liquid mixture of hydrocarbons that are lighter than crude oils, generally containing more than five carbon atoms. The majority of the compounds are linear or branched alkanes, various monoaromatic compounds (BTEX: benzene, toluene,

ethylbenzene and xylene), polyaromatics (including naphthalene), as well as, potentially, sulphuric hydrogen. BTEXes are among the most toxic or harmful lightweight chemicals and are subject to numerous regulations.

Name of the condensate	Country	nC <sub>7</sub> Asphaltenes (% wt)	Paraffins (%)	Density at 20°C	250 °C+ (% vol.) <sup>1</sup>
Absheron *	Azerbaijan	0.12	8.8	0.808	50
Akpo *	Nigeria	0.2	4.2	0.796	53
Maharaja Lela *	Brunei	0.14	0.9	0.818	64
Gudrun/Sleipner mix **	Norway	0.03	3.6	0.779	67
Handil *	Indonesia	0.33	1.7	0.822	67
Vega **	Norway	0.02	3.90	0.770	72
Dolphin *	Qatar	0.04	<0.1	0.774	81
South Pars*	Iran	0.04	0.1	0.752	83
**	Myanmar	<0.01	<0.1	0.906	86
Alve ***	Norway	0.03	5.0	0.793	61
Snøhvit blend ***	Norway	0.10	1.6	0.767	76
Smørbukk ***	Norway	0.06	2.6	0.801	57
Sleipner ***	Norway	<0.1	0.9	0.742	86
Huldra ***	Norway	0.01	5.0	0.806	53
Kristin ***	Norway	0.60	7.3	0.795	60
Midgard ***	Norway	0.01	0.02	0.761	88

\* Total condensate / Cedre data

\*\* Statoil condensate / Cedre data

\*\*\* Statoil condensate / SINTEF data

Figure 1: Example of the main chemicophysical properties of condensates

Nearly all condensates have a density of less than 0.85 to 20°C, a value which corresponds to light crude oils. For half of them, it is less than 0.80 and may be close to the specifications applied to petrols, of the order of 0.75.

The asphaltene levels, an indicator of the chemical's ability to emulsify, and paraffin levels are extremely variable. They are,

however, for nearly all chemicals, less than 0.2% and 10%, respectively.

Figure 2 shows the condensates and crude or refined petroleum products studied at Cedre for the period 2009-2019, according to their asphaltene and paraffin levels.

<sup>1</sup> The distillation residue at 250°C is used to define the maximum expected rate of evaporation at sea.

The size of the circles is proportional to the density at 20°C, and their colour is related to the maximum expected rate of evaporation at sea (the darkest colours correspond to the chemicals that evaporate the least). The condensates are marked with a red star.

In the remainder of this guide, these condensates will often serve as an example for discussing the variability of behaviours and the control techniques to be implemented. Data from safety data sheets (SDSes) from different sources will also be integrated for aspects not treated during the trials (flammability, for example) and to illustrate the diversity of values according to the sources of information.

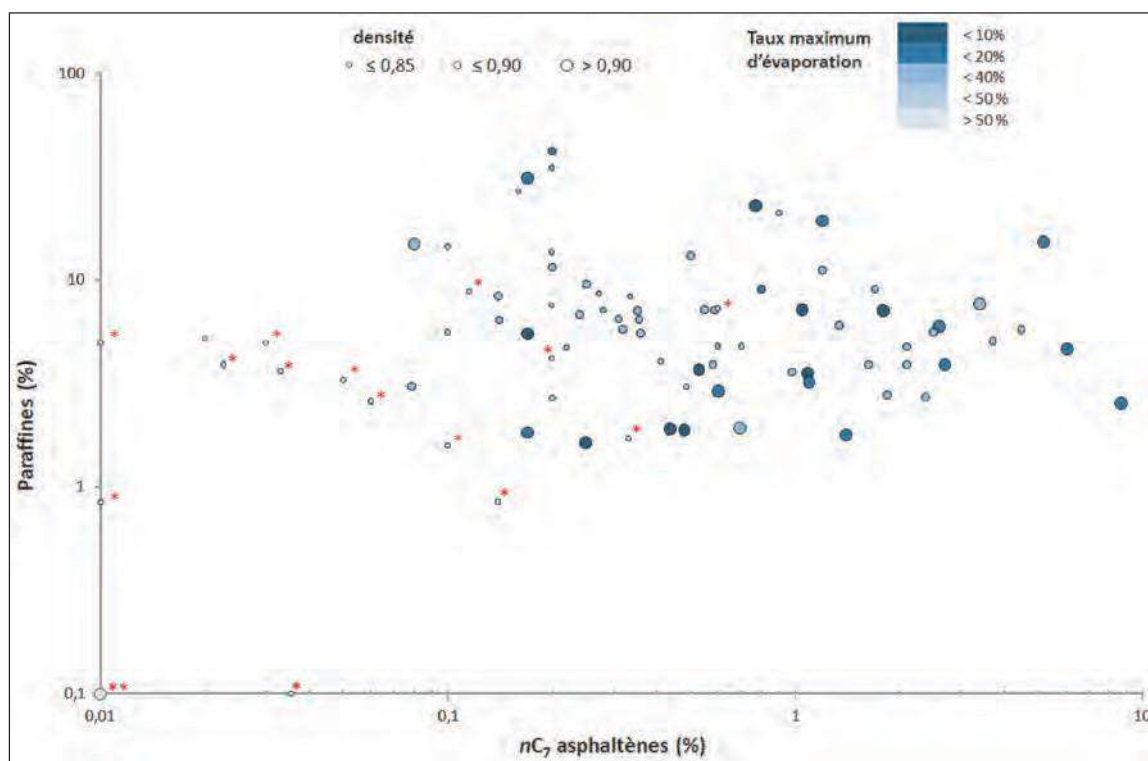


Figure 2: Positioning of condensates on the raw and refined petroleum product spectrum studied at Cedre (marked with a red star on the graph)

### Detailed chemical composition and distillation curves

Petroleum products consist of thousands of molecules that can be grouped into four chemical families:

- **Saturates:** They contain only hydrogen and carbon atoms. The simplest are gases (methane, ethane, propane, etc.) and the heavier are paraffins (usually between 20 and 30 carbon atoms).
- **Aromatics:** They contain only carbon and hydrogen atoms but in the form of aromatic rings. They are known for their toxicity, like benzene, the

B1

simplest in the family, or benzo[a]pyrene. There are also many branched derivatives that correspond to the base molecule with one or carbon atoms added (C<sub>2</sub>-benzene, for example, benzene with two extra carbon atoms). The lightest compounds also have a relatively high solubility compared to the other constituent molecules of petroleum products.

- **Resins and asphaltenes:** These molecules are not volatile and contain, in addition to carbon and hydrogen, sulphur, oxygen or nitrogen. Asphaltenes are distinguished from resins by their insolubility in so-called non-polar

solvents (pentane, hexane, heptane), which explains how these two families are often grouped together. It should be noted that the metals present in petroleum products are associated with asphaltenes.

The detailed chemical composition of nine condensates was determined in accordance with the modelling software OSCAR. The main families of compounds presented in Figure 3 include light saturates in particular, having up to 10 carbon atoms (C<sub>1</sub>-C<sub>10</sub> saturates), C<sub>6</sub>-C<sub>10</sub> monoaromatics, aromatics grouped under the acronym BTEX (benzene and C<sub>1</sub>-benzene, toluene, ethylbenzene and xylene) and C<sub>2</sub>-/C<sub>3</sub>-/C<sub>4</sub> benzenes, as well as the heaviest subset, greater than 25 carbon atoms (>C<sub>25</sub>).

B1

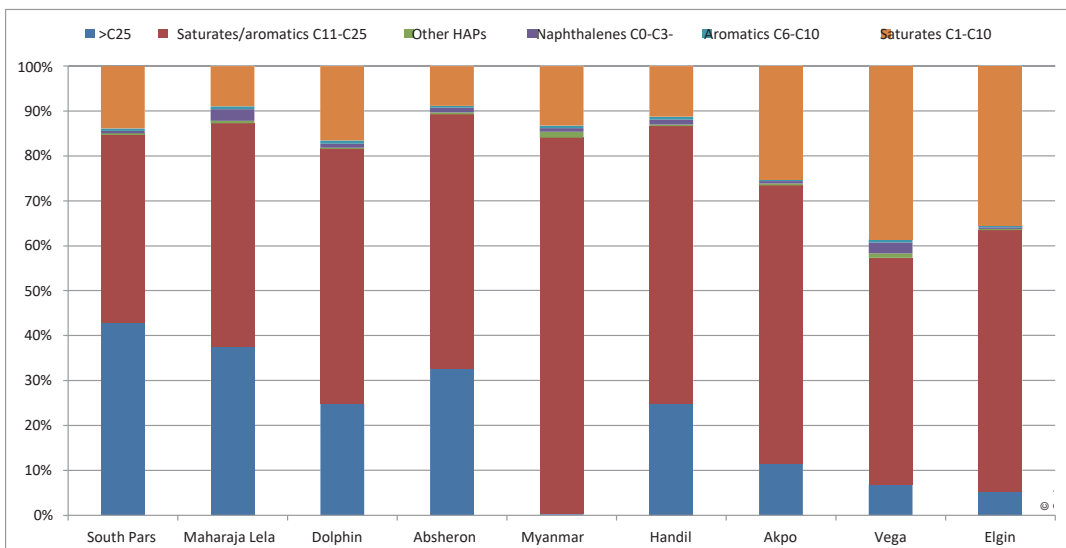


Figure 3: Simplified chemical composition of the condensates studied

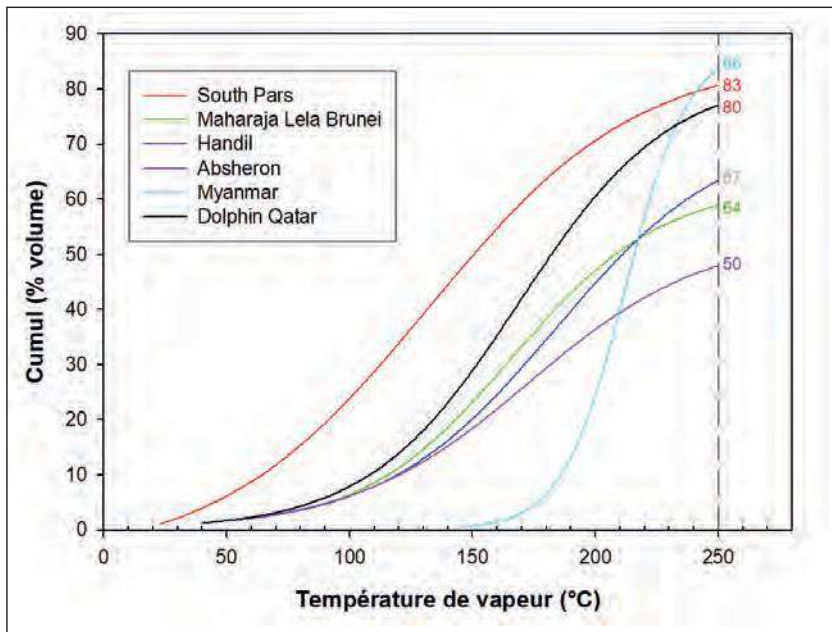


Figure 4: Distillation curves of the condensates studied

The distillation curves in Figure 4 illustrate the diversity of chemicals grouped in the condensate category. The lightest fraction of each chemical does not necessarily correspond to very volatile compounds. For example, South Pars distils from 25°C, while Myanmar only distils from

approximately 150°C to have, ultimately, the highest evaporation rate at 250°C. This diversity is illustrated by the chromatograms shown in Figure 5, as well as by the range of flash points (see **B4**).

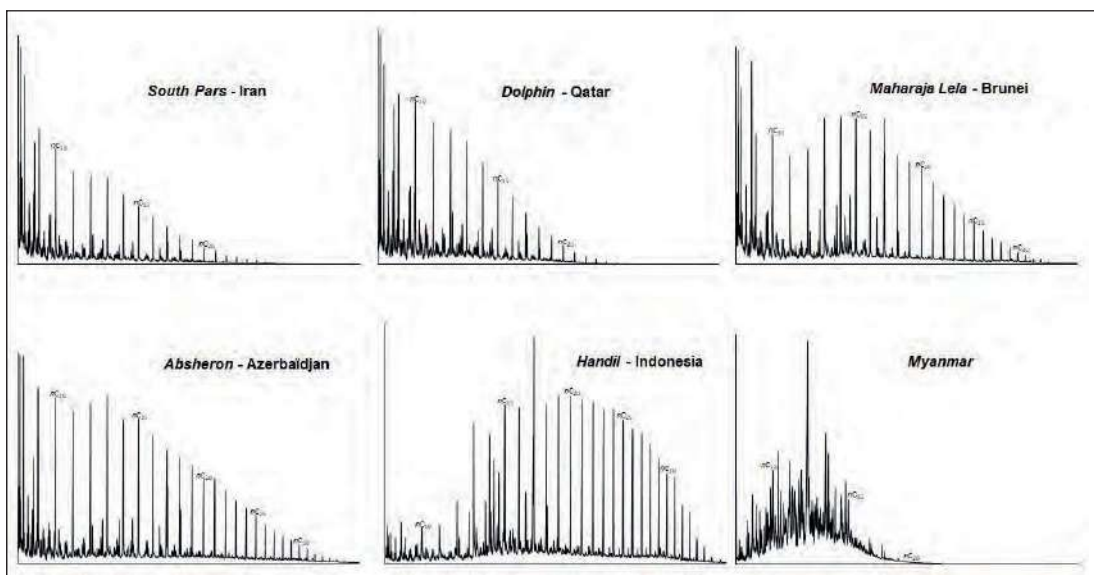


Figure 5: Illustration of the compositional diversity of some condensates studied at Cedre

B1

# Typical chemicophysical data

<b>Physical state / colour</b>	Liquid ranging from colourless to dark brown*
<b>Odour</b>	Characteristic of petroleum, rotten eggs if hydrogen sulphide is present*
<b>Density</b>	<800 kg/m <sup>3</sup> at 20°C (API > 45) 810 kg/m <sup>3</sup> for the majority of the condensates studied (with an exception at 906) SDS Total: 750-900 kg/m <sup>3</sup> at 15°C SDS Akpo total: 903,1 kg/m <sup>3</sup> at 15°C All other SDSes: 600-800 kg/m <sup>3</sup> at 15°C
<b>Viscosity</b>	Very low: 0.8 to 1.8 mm <sup>2</sup> /s at 40°C
<b>Vapour pressure</b>	21 to 500 hPa at 20°C** 1 to 18 mPa.s at 26°C, according to the Cedre/Total data
<b>Boiling temperature</b>	< 340°C**
<b>Solubility</b>	In water at 20°C: insoluble (<1,600 mg/L)** Soluble in organic solvents, greasy substances** Monoaromatics (BTEX) <sup>1</sup> dissolve mainly (<100 mg/L)***
<b>Evaporation (in volume)</b>	50- 90% (depending on the nature of the condensate), according to the Cedre/Total data

Figure 6: Typical chemicophysical data on condensates

<sup>1</sup> The solubility of monoaromatics is highly dependent on benzene content. As a guideline, from a Concawe source:  
- for 1.5% benzene by weight: benzene concentration: 18-90 mg/L  
- for 3% benzene by weight: benzene concentration: 60 mg/L

\* Sources: SDS Total condensates, SDS Total Akpo condensate, SDS Statoil stabilised condensate, SDS Gudrun Statoil petroleum/condensate, SDS Phillips 66 natural gas condensate, SDS HESS and Concawe natural gas condensate

\*\* SDS Total

\*\*\* Concawe



# Identity sheet

Condensates occupy an intermediate spot between natural gas and crude oil and have variable chemicophysical

compositions. They exist under different designations and are classified under different identification numbers.

<b>Synonyms</b>	Liquid natural gas well, pentane plus, C5+, low boiling point naphtha. Anglophones also call it "lease" or "plant condensate"
<b>Transport designation</b>	Petroleum distillates (benzene, toluene, n-hexane, aromatic hydrocarbons), crude oil, liquid hydrocarbon, flammable liquid
<b>Identification</b>	UN number: 1268 (or 1267, 1993, 3295) CAS number: 64741-47-5 (68919-39-1) EC number: 265-047-3 (272-896-3)
<b>Related petroleum products (composition and behaviour)</b>	Petrol for the impacts and risks linked to the phases of evaporation and solubilisation, kerosene for the chemicophysical properties of the lightest chemicals

**B3**

Figure 7: Main condensate designations

## Product labels



GHS02  
Flammable



GHS08  
Sensitising,  
mutagenic,  
carcinogenic,  
reprotoxic



GHS07  
Toxic, irritant,  
sensitising,  
narcotic



GHS09  
Dangerous for  
the environment

## Flammability data

Condensates are extremely flammable chemicals.

<b>Flashpoint (ASTM D 93)</b>	<35°C (Pensky/Martens) SDS Total 50°C for Myanmar
<b>Auto-ignition point</b>	> 400°C SDS Total (although this value may be lower for other SDSes: 250°C)
<b>Flammability or explosivity limits (% in air)</b>	Lower limit: 0.85% (Total Akpo), 1.4% (Phillips 66) Upper limit: 5.0% (Total Akpo), 7.6% (Phillips 66)
<b>Chemicals with hazardous decomposition (SDS Total)</b>	Complete combustion, in the presence of excess air, generates carbon dioxide (CO <sub>2</sub> ) and water vapour. Incomplete combustion generates carbon monoxide (CO), soot and split chemicals: aldehydes, ketones
<b>Stability and Reactivity (SDS Total)</b>	<b>Stability:</b> stable given recommended handling and storage conditions <b>Reactivity:</b> combustible if it is brought to a temperature greater than its flashpoint <b>Conditions to avoid:</b> Avoid the proximity of hot surfaces, flames, static electricity or sparks Keep away from any source of ignition Do not smoke nearby

Figure 8: Flammability data




Laboratory tests done at Cedre on six condensates show initial flashpoint values, before any ageing phenomenon, spread over a wide range (from below -10°C up to 50°C). These data are consistent with the distillation curves and chromatographic profiles that have shown a very volatile and highly variable fraction ratio (Figure 5).

The flashpoint values measured on residues at 150°C are more homogeneous, in the range 40-55°C, which is explained by the effect of distillation. It is accepted that these residues at 150°C are representative of a time at sea in the order of two to three hours, which must nevertheless be qualified according to the circumstances of the spill at sea (continuous or discontinuous, low or high volumes, etc.),

as well as oceanic weather conditions (high temperatures and winds accelerate the increase in the flashpoint). With the same nuances, the distillation residue at 200°C is close to a time at sea of six to seven hours. The corresponding flashpoints sit between 70 and 85°C.

It should be noted that the harmonised system of classification and labelling of chemicals (SGH) defines several categories of flammable chemicals by flashpoint value, as shown in Figure 9.

**Condensates are therefore classified, on average, as flammable for up to two to three hours at sea and non-flammable after six to seven hours.**

Classification	Labelling	Classification criteria
<b>Flammable liquid Category 1</b> H224: highly flammable liquid and vapour	 Hazard H224	Flashpoint < 23°C Boiling point ≤ 35°C
<b>Flammable liquid Category 2</b> H225: highly flammable liquid and vapour	 Hazard H225	Flashpoint < 23°C Boiling temperature > 35°C
<b>Flammable liquid Category 3</b> H226: flammable liquid and vapour	 Caution H226	23°C ≤ flashpoint ≤ 60°C

B4

Figure 9: Definition of classes of flammability (source: Ineris). See the different categories and H grades in the appendix

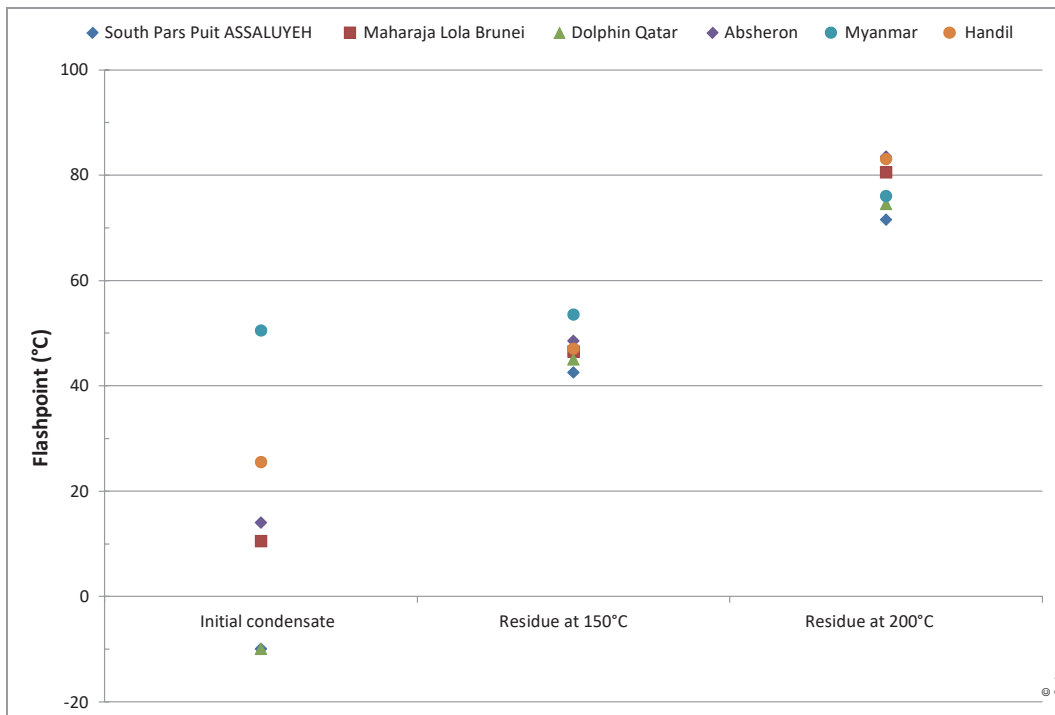


Figure 10: Flashpoints of some condensates studied at Cedre and their distillation residues

## First aid data

In case of serious or persistent disorders, call a doctor or seek emergency medical assistance.

### Inhalation

- Transport the victim to the outdoors and keep them at rest in a position where they can breathe comfortably.
- Call a doctor immediately.
- If necessary, provide oxygen.
- In case of respiratory arrest, apply artificial respiration.
- Place under medical supervision.

### Skin contact

- Remove affected clothing.
- Perform immediate and prolonged washing with abundant soap and water. Hospitalise in case of serious contamination.

### Eye contact

- Do not use contact lenses in work areas.
- Wash immediately with plenty of water for at least 15 minutes, keeping eyelids open wide.
- Consult an ophthalmologist.

### Ingestion

- Do not drink any fluids or induce vomiting (risk of pulmonary aspiration).
- Risk of serious disorders if aspirated into the lungs (during vomiting, for example).
- Emergency transport to hospital.
- If swallowed, rinse mouth with water (only if the victim is conscious).

### Protection of rescuers

In case exposure is likely to pass the occupational exposure limit:

- In a well-ventilated area, use a respiratory protection device.
- In a confined space, use an air-supply device.

## Transport, handling, storage

### Transport

UN number: 1268 (or 1267, 1993, 3295)

Official transport designation: petroleum distillates (benzene, toluene, n-hexane, aromatic hydrocarbons), crude oil, liquid hydrocarbon, flammable liquid.

#### Ground transport:

- RID (rail) regulation/ADR agreement (road)
- Vapour pressure at 50°C (kPa): ≤110
- Hazard identification classification: 3
- Classification code: F1
- Hazard code: 33
- Packing group: I (or II for certain types of condensates)
- Dangerous for the environment: yes  
Tunnel code: D/E
- Label(s): 3 + N



#### Inland water transport:

- ADN regulation
- Hazard identification classification: 3
- Classification code: F1
- Packing group: I
- Hazardous to the environment: yes  
Label(s): 3
- Hazards: (3+N2+CMR)

#### Maritime transport:

- IMDG code
- Hazard identification classification: 3
- Packing group: I

- IMDG-marine pollution: marine pollutant
- IMDG-EmS: F-E, S-E
- IMDG label(s): 3

#### Air transport:

- OACI/IATA regulations
- Hazard identification classification: 3
- Packing group: I
- Dangerous for the environment: yes
- Hazard label(s): class 3 – flammable liquid

#### Handling

- Handle in a well-ventilated environment.
- During use, a flammable/explosive vapour-air mixture may form.
- Avoid the formation or diffusion of vapours, fumes or aerosols into the atmosphere (especially during chemical loading or unloading).
- Vapours are denser than air and can spread at ground level.
- Maintain distance from all sources of ignition.
- Avoid proximity to hot surfaces, flames, static electricity or sparks.
- In case of possible exposure, use suitable protective clothing, including gloves and goggles.
- Use safety shoes and protective clothing that does not generate electrostatic charges.
- install showers and eyewash fountains.
- Do not eat, drink or smoke during use.

## Condensates

### Chemical intervention guide

#### Technical measures:

Inspection, storage, cleaning and maintenance of storage tanks require strict procedures.

- Only work on cold, degassed and ventilated tanks (risk of explosive atmosphere).
- Take precautionary measures against static electricity discharges that can occur during mixing and transfer operations.
- Provide appropriate explosion-proof electrical equipment.
- Ground all conductive materials.

#### Tips for use:

- Only use the chemical in a closed system.
- Ban air for transfers.
- Travel at low speeds (static electricity).
- Take special precautions in case the use or processing of the chemical leads to stable emulsions with water.

#### Storage:

- Only use aromatic-hydrocarbon-resistant containers, seals, pipes, etc.
- The chemical can form an explosive mixture with air, particularly in empty, unclean containers.
- Store far from heat sources. Avoid the accumulation of static electricity by grounding equipment.
- Store in a well-ventilated area.
- Store preferably in the original packaging. Otherwise, if necessary, transfer all the indications on the regulatory label to the new packaging.
- Design the installations to prevent the spread of flaming slicks.
- Provide a retention tank.

#### Recommended packaging material:

- Stainless steel.

#### Materials to avoid:

- Strong oxidants.
- Acids and bases.

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## Toxicological data

The toxicity of condensates depends critically on their BTEX levels, benzene in particular. If the chemical contains hydrogen sulphide (H<sub>2</sub>S), it may be particularly harmful by inhalation (very toxic gas).

### Acute human toxicity

- **Inhalation:** harmful. Risk of headache, drowsiness, nausea. In case of inhalation of high vapour concentrations: neurological disorders, loss of consciousness, coma.
- **Ingestion:** harmful. Digestive disorders: diarrhoea, vomiting.
- **Skin contact:** harmful. In case of significant skin contact, cutaneous penetration may cause toxic effects: central nervous system, digestive system.

### Local effects

Irritating to the skin.

Contact with the liquid or vapour exposure may cause eye irritation.

### Specific effects

Condensates contain benzene, classified as carcinogenic and mutagenic.

- **Genotoxicity:** *In vivo* and *in vitro* tests indicate genotoxic potential.
- **Carcinogenesis:** Benzene is carcinogenic to humans.

- **Toxicity for reproduction:** fertility: toxic effects for the reproductive system. Foetal development: toxic effects for foetal development.
- **Aspiration hazard:** In case of accidental ingestion, the chemical may be aspirated into the lungs due to its low viscosity and give rise to pneumonia from inhalation, developing within a few hours. Medical supervision is essential for 48 hours.

### Specific toxicity for certain target organs (STOT: *Specific Target Organ Toxicity*)

- **STOT single exposure:** may cause drowsiness and dizziness.
- **STOT repeated exposure:** risk of serious effects to organs following repeated or prolonged exposure. Prolonged and repeated exposure by inhalation of vapours and/or prolonged skin contact may cause benzene poisoning.
- **Target organ(s):** at high doses, central nervous system, digestive system, renal impairment, haematological system.

# Ecotoxicological data

## SDS Total condensates

The ecotoxicological data mentioned in the safety data sheet written by Total on condensates are as follows:

### Acute toxicity for the aquatic environment

CL50 - 96 hours - fish: 1.1-4.4 mg/L  
EC<sub>50</sub> - 48 hours - Daphnia magna: 1.2-2.7 mg/L

### Chronic toxicity to the aquatic environment

No information available.

### Effect on terrestrial organisms

No information available.

Cedre conducted ecotoxicological tests on the Akpo condensate in accordance with three OSPAR protocols. For tests on fish and algae, only dissolved fractions were evaluated.

The following results were obtained:

<b>Fish</b> ( <i>Scophtalmus maximus</i> )	Maximum dissolved aromatic at 300 mg/L No effect on fish
<b>Crustacean</b> (amphipod <i>Corophium</i> sp.)	Sediment levels of 33 to 862 mg/kg EC <sub>50</sub> = 161 mg/kg
<b>Algae</b> ( <i>Skeletonema costatum</i> )	Maximum dissolved aromatic at 488 mg/L No effect on algae

Figure 11: Ecotoxicological data for the Akpo condensate

It should be noted that the concentrations in dissolved aromatics correspond to the concentrations of 20 so-called parent polycyclic aromatic hydrocarbons (naphthalene, phenanthrene, benzo[a]pyrene, etc.), as well as 25 families of branched derivatives (C<sub>1</sub>-naphthalenes, C<sub>2</sub>-naphthalenes, etc.).



# Behaviour in the aquatic environment

Given their compositions, characterised by low levels of asphaltenes and paraffins and associated with evaporable fractions generally greater than 50%, the predominant behaviours of condensates are spreading and evaporation. However, some types of condensates can emulsify, hence their behaviour is similar to that of light crude oil. The results presented below illustrate laboratory test results on six condensates provided by Total, as well as data obtained according to the same protocols provided by the company Equinor. In addition, experiments were conducted in the Polludrome® on the Vega and Akpo condensates, which are representative of the range of chemicals *a priori* capable of forming emulsions. These hydrocarbons have similar paraffin content (3.9% and 4.2%, respectively) but significantly different asphaltene content (0.02% and 0.2%, respectively).

## Evaporation

Condensates have high vapour pressure. As a result, evaporation is an important process during a spill and can cause the near-total disappearance of the chemical within three or four days. The maximum evaporation rate can be estimated by the fraction distilling below 250°C. For chemicals with a density of less than 0.81 at 20°C, it is possible to establish a relationship between density and the maximum expected rate of evaporation at sea (Figure 12). This relationship makes it possible, therefore, to provide a first item of important operational data, namely the quantity of hydrocarbon that can persist at sea.

B9

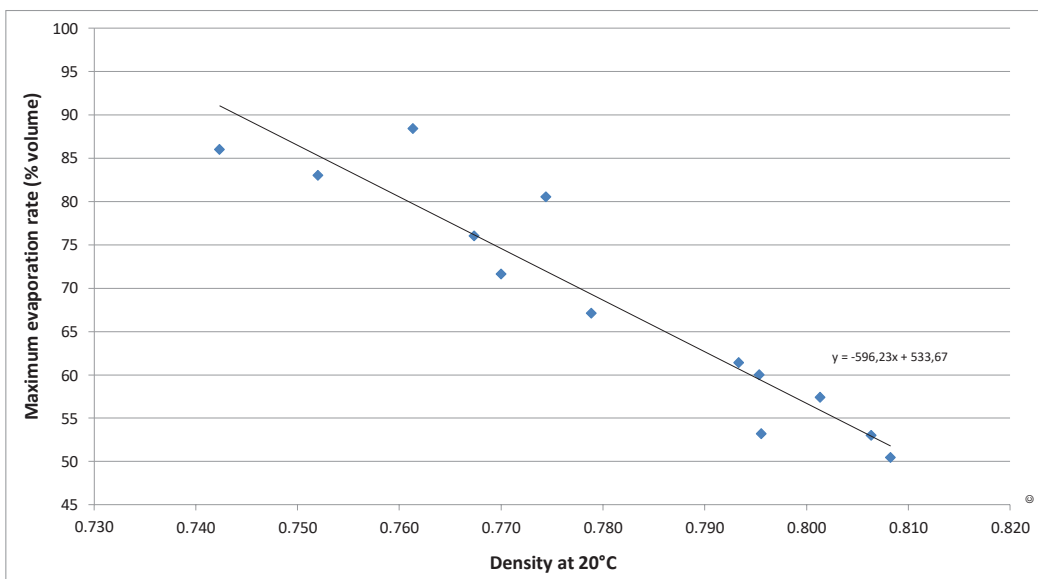


Figure 12: Relationship between condensate density at 20°C and their maximum rate of evaporation at sea

## Condensates

### Chemical intervention guide

#### Spreading

Condensates with a low viscosity and a density lower than the water's spread very quickly on its surface in the absence of barriers (dam, bank, coast, etc.). Depending on the nature of the chemical, the film can quickly transform into iridescence, which then disappears as an effect of evaporation.

#### Solubilisation

In the family of petroleum products, condensates are the most likely to cause contamination of the water column through solubilisation. Monoaromatic hydrocarbons (BTEXes) are relatively abundant there and are the most soluble (but equally toxic) hydrocarbons. The most soluble (and toxic) is benzene, with a solubility in the order of 1.8 g/L.

Some polycyclic aromatic hydrocarbons (PAHs) of low molecular weight, like naphthalene or benzothiophene, which are abundant in some condensates such as Akpo, may also solubilise rapidly in the aqueous phase. Studies conducted at Cedre on Akpo have shown that dissolved naphthalene contributes 60% of the total PAHs analysed.

In the longer term, because of their low vapour pressure, compounds solubilised in water can gradually return to the atmosphere in the form of steam.

#### Dispersion

Dispersion (suspension in the water column) only appears in the event of violent agitation (surf, waterfall, torrential speed). Furthermore, due to the low density of condensates relative to water, dispersion is fairly unstable and a surface coalescence is rapidly observable, as soon as the agitation conditions subside sufficiently.

#### Emulsification

The condensates studied all exhibit initial asphaltene content lower than the generally accepted threshold for emulsion formation (around 0.2 to 0.3%). However, the expected evaporation at sea is very significant, from 50% to 80%, which has the effect of concentrating the asphaltenes. Also, for the condensates studied at Cedre, this maximum value was calculated as shown in Figure 13. It appears that the levels are very often beyond the threshold of 0.2 to 0.3% and that emulsions formed, the viscosity of which is proportional to these same levels.

Name	Maximum level of asphaltenes (%)	Viscosity of the emulsion At 250°C +/75% water (MPa.s at 26°C)
<i>South Pars Puit ASSALUYEH</i>	0.21	-
<i>Maharaja Lela Brunei</i>	0.39	49
<i>Dolphin Qatar</i>	0.18	-
<i>Absheron</i>	0.23	38
<i>Myanmar</i>	0.07	-
<i>Handil</i>	1.02	493
<i>Akpo</i>	0.43	125

Figure 13: Maximum asphaltene levels in condensates after ageing at sea and viscosity of emulsions formed in the laboratory (source: Cedre)

These laboratory data were confirmed for the condensate Akpo during the Polludrome® test. The viscosity and density values in Figure 14 show that emulsification only starts after four hours

of ageing, which is consistent with the initial low value for asphaltenes, which gradually increases with the evaporation of the light fractions.<sup>1</sup>

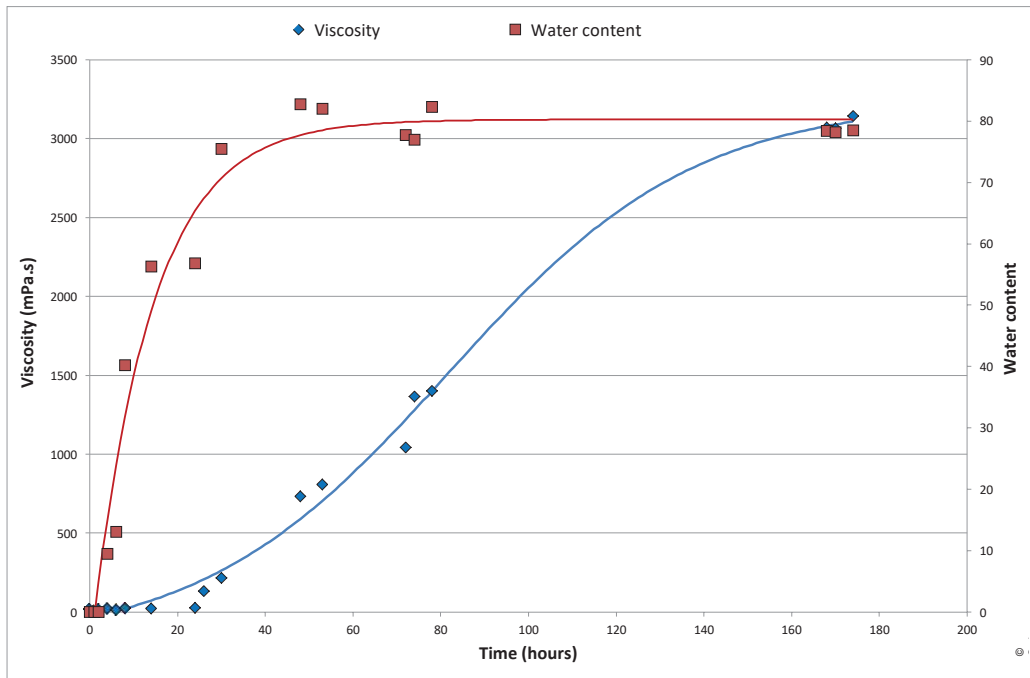


Figure 14: Change in density and viscosity of the Akpo condensate during the Polludrome® test

<sup>1</sup> Note: The higher viscosity obtained in these Polledrome® tests compared to laboratory tests is a testament to the limit of small-scale (beaker) tests for chemicals with very low viscosity.



## Condensates

### Chemical intervention guide

The Vega condensate was also tested at the Polludrome®, but at lower temperatures (5°C and 13°C). Despite its low level of asphaltenes (0.02%), the chemical emulsified with water levels in the order of 80% to 90%. The viscosities were low, however, up to a maximum of 1,000 mPa.s and the emulsions were not very stable, as evidenced by rapid settling in the absence of stirring (photo).



Rapid settling of the Vega condensate in the absence of agitation

## Biodegradation

The constituent molecules of condensates are light hydrocarbons which are partly biodegradable in the absence of inhibitory effects (very cold temperature, presence of chemicals having a biocidal effect, etc.).

Tests carried out on several condensates in the Cedre laboratory showed that their theoretical biodegradation amounts to about 60%<sup>2</sup>. So, for an evaporation rate of 50% to 75%, the amount of chemical remaining in the environment at the end of the biodegradation process is in the order of 10% to 20% of the initial volume.

## Adsorption

The hydrocarbons in condensates are liable to adsorb onto sediments, as well as suspended mineral and organic particles. This fixation phenomenon is favoured when the pollutant is dispersed in the water column, the pollutant-particle contact then being facilitated (e.g., plume at the estuary exit). This phenomenon is amplified for heavy condensates.

Hydrocarbons may be trapped on clay particles, resulting in significant slowing down of their biodegradability. When concentrations are high, the mechanism for fixing hydrocarbons on the suspended particles can lead to a gradual transfer of the pollutant to the drop areas.

<sup>2</sup> Value calculated by quantifying the levels of saturates, aromatics, resins and asphaltenes (SARA compounds) at the end of the Polludrome® ageing study. These levels are affected by a rate of biodegradability depending on their chemical family and defined by the IMO (*Guidance Document for Decision Making and Implementation of Bioremediation in Marine Oil Spills*. London: International Maritime Organization, 2004).

## Persistence in the aquatic environment

The persistence of condensates in the aquatic environment is low, since most of the chemical evaporates (from 50% to 90% by volume). If a part emulsifies, it can be manually or mechanically recovered or chemically dispersed.

Pollution by condensates can persist if circumstances lead them to infiltrate sediments (bank, shoreline) where evaporation can no longer occur. In very particular conditions, cold climates and in anoxic zones, condensates can remain permanently.

Persistence in the environment mainly consists in compounds with little or no degradability, which represent a small proportion of the chemical and the hydrocarbons "trapped" on the particles in suspension. When these charged particles settle on the bottom, they can, in some specific cases, lead to accumulations. Groundwater can be

contaminated when, in land-based facilities, the chemical enters the soil.

### Example of persistence

The Vega condensate, after evaporation at 72% of its initial volume, is biodegradable at a rate of 60%. The persistent fraction, given these two phenomena, is in the order of 10% of the initial volume.

### Potential bioaccumulation data (SDS Total)

The potential for bioaccumulation in the environment is low; the bioconcentration factor (BCF) is such that  $\log BCF = 0.7-4.15$ .

# Environmental impacts following a spill

**Firstly, condensate pollution creates safety problems for people. These issues, not addressed in this document specifically dedicated to the environmental aspects in aquatic settings, must be addressed as a priority.**

Condensates, chemicals in the aquatic environment that are not highly persistent, can lead to a significant environmental impact through direct contact or exposure to their soluble compounds.

## **Direct contact**

Since condensates are low density, floating chemicals, the impact is primarily on the fauna and flora living on the surface of the water or on the shores. Bottom-dwelling (benthic) organisms can be exposed to the pollutant at shallow depths or when the pollutant trapped on suspended matter settles. When there is agitation (waves, surf, etc.) of fine sediments on the shores, there may be mixing or even surface burial. This contact can harm organisms living in the sediment (burrowing organisms).

## **Dissolution of toxic compounds**

The compounds in the condensates are very significantly dissolved and readily volatilised after having experienced an aqueous phase. The contamination of the water column is therefore transitory but not to be ruled out in shallow depths (from a few metres to a few tens of metres, depending on the importance of the pollution). When water renewal is low and/or the environment is confined, all aquatic organisms can be locally impacted.

## **Light aromatics**

The light aromatic compounds are degradable and not highly bioaccumulative but present a significant toxicity. The most toxic of these compounds is benzene, with a CL<sub>50</sub> of five to a few tens of ppm depending on the aquatic species (3.7 ppm for the leopard frog to 31.2 ppm for the *Daphnia magna* freshwater species).

Benzene and its derivatives are relatively abundant in the different condensates studied. This is evidenced by the levels measured in comparison with a light crude from the Middle East, the Al Khalij crude oil produced by Total E&P Qatar.

The ecotoxicological data obtained from condensates on marine species are presented in **B8**.

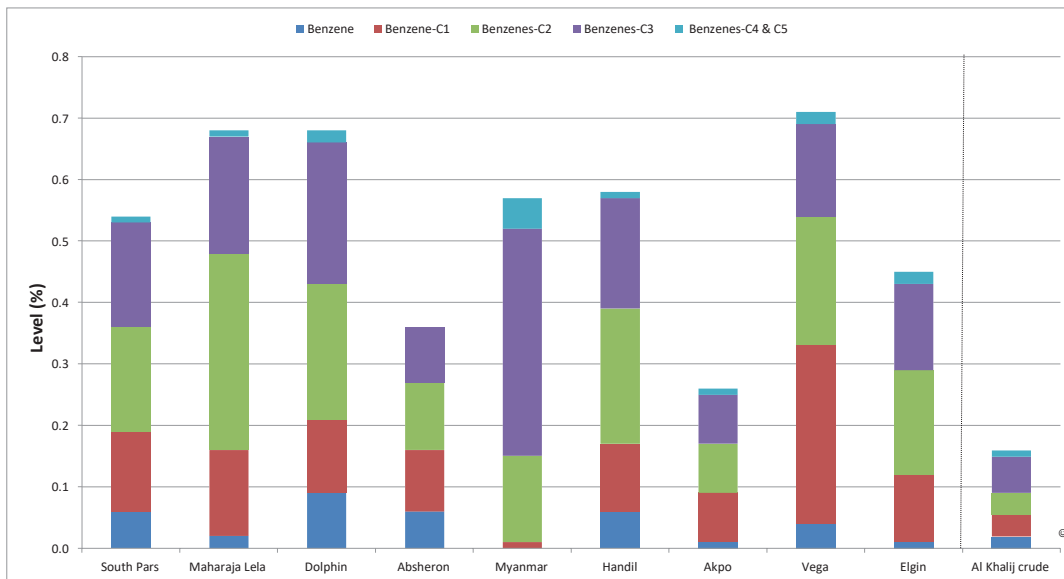


Figure 15: Monoaromatic compound levels in the condensates studied compared to a light Arabic crude oil, Al Khalij crude

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# Potential impacts on different environments

## Spills at sea

Evaporation will affect the majority of the spilled chemical, which, depending on its composition, can then be emulsified. The lightest condensates will not persist in the environment and will not have a significant impact on it. The heaviest condensates have similar impacts as light crude oils, mainly on avifauna. Condensates can affect seabirds coming in contact with surface slicks. Like all greasy chemicals, they alter the plumage of birds, which then die from hypothermia or ingestion of the pollutant from cleaning themselves.

## Cold or frozen water

In cold environments, evaporation may be slowed, which involves wider contact with the pollutant and increases the risk of infiltration into the substrate or ice layer. In this case, the pollutant may eventually remain trapped until thawing.

Studies conducted by Cedre in arctic conditions on a very light chemical of the condensate type have shown that a chemical spill in a body of water that is ready to freeze leads, after ice formation, to migration through the entire thickness of the dissolved compounds.

## Coastal spill

### Spawning grounds and nurseries

A spill can have serious repercussions if it occurs during the spawning or nursery season of a species. Reproduction

may be affected or larval growth or fry compromised. As in areas of seagrass, these phenomena are only observed in the event of significant pollution in shallow and/or fairly stagnant water.

### Benthic commercial species (including crustaceans)

In shallow areas of coastal waters, a spill can affect the various species exploited commercially in a more or less visible sense. Possible effects include the alteration of the flesh of these species, which may become unfit for consumption.

### Mudflats, lake and sea marshes

For marshes, damage through direct contact of the pollutant with the affected vegetation is foreseeable. It is possible that condensate will pollute the sediment for both mudflats and marshes, especially if the body of water is agitated or if the tide causes the pollutant to settle on the substrate. In this case, the contamination that affects the surface layer can extend deeper due to the effect of burrowing organisms (bioturbation for mudflats) or by transfer along the root networks for marshes. The buried pollutant can constitute a lasting contamination, because evaporation is no longer possible. In addition, muddy and marshy substrates are most often anaerobic, which limits the pollutant's biodegradation.

### Mangroves

Condensates can affect the mangrove cover by simple contact with the adventitious roots of the mangroves and also damage the associated fauna (crustaceans, etc.).



In addition, as in the case of marshes and mudflats, if there is direct and prolonged contact with the sediment, there may be a risk of substrate contamination.

### Seagrasses

Only dissolved toxic compounds can affect seagrasses during a condensate spill. This is possible only for a massive spill into narrow, shallow, coastal waters.

### Rocky foreshores

A condensate spill, *a priori*, has only limited repercussions if the condensate is barely or not at all aged when it arrives at the coast. The mixing of water that is favourable for the continual remobilisation of the pollutant thus allows its evaporation and dispersion. However, a direct impact on the fixed organisms is possible (e.g., limpets). Aged and emulsified, the condensates would not be highly persistent and would have a very limited impact over time.

### Sandy foreshores

Wave agitation and tides can lead to penetration into the sediment of substantial amounts of condensates. In this case, the impact of pollution depends on the ecological richness of the site, which, with exceptions, is generally low (e.g., turtles' egg-laying sites). If the chemical tends to emulsify, a deposit can form on the surface of the foreshore, requiring a clean-up operation.

### Coral reefs

Since mostly submerged, exposure to the pollutant is due mainly to the dissolving of the toxic condensate compounds. This impact is all the more important because the corals are close to the surface in still waters. Corals remain fragile and vulnerable animals whose mucus can attach to toxic organic compounds.

### Spill on an industrial site or in a river

For industrial sites on land, condensates will spread rapidly due to their low viscosity and will penetrate sediments rapidly. Well-sealed structures will create areas of accumulation that will limit evaporation, creating a risk of ignition of vapours.

If the spill reaches a river, the impact will be on the banks and deep in the sediments at once, as well as throughout the entire water column, due to the abundance of light and soluble elements.



Mudflat



Seagrass habitat



Mangrove

# Potential impacts on economic resources

## Aquaculture

With pollution, the presence of dissolved compounds (BTEX) or the presence of condensates dispersed in the subsurface by agitation can provoke various effects on cultivated species ranging from lethal effects to changes in the flesh, making the product unsuitable for consumption.

## Salt marshes

The polycyclic aromatic hydrocarbons (PAHs) of condensates, in particular naphthalenes, can contaminate the salt produced in these marshes in the event of a petroleum spill. Yet the risk remains low to the extent that a salt marsh is a partitioned space that can be closed to prevent the entry of a floating pollutant.



Muddy-sandy foreshore

## Tourist beaches

Beyond the issue of health safety, condensate pollution on a beach can cause a momentary interruption of tourism activity. If a condensate seeps into the sand, evaporation can become difficult and require aeration of the sediment (e.g., through the harrowing technique) to accelerate the process. If the chemical emulsifies at sea and settles on beaches, they may be closed for cleaning.

## Industrial water intake

- Cooling water intake: Condensates have *a priori* little risk of entering en masse into circuits, the inlets of which are generally deep. However, water quality can be quite significantly affected by the presence of dissolved aromatic compounds.
- Catchment, intake from tanks: In case of significant pollution, there is a risk of contamination of the water intake by soluble compounds, which may require closure (as a preventive measure).

# Examples of real cases and modelling of different accident scenarios

■ Examples of real cases

C1

■ Modelling of different accident scenarios

C2

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## Examples of real cases

Three major accidents have occurred on offshore oil platforms (Uniacke G-72 and Elgin) and more recently on board an oil tanker carrying a condensate (the *MT Sanchi*). There have been several notable accidents in sensitive coastal areas (marshes, etc.).

Renewed experience with condensate accidents shows their principal characteristics:

- Condensate leaks are primarily a safety issue in terms of fire and explosion.
- Evaporation of the released condensates seems very fast, in that an estimate gives an evaporation rate of 75% within 24 hours of the leak.
- The impact of spills on aquatic wildlife is small. However, some birds may be affected.

### **Uniacke G-72 oil drilling, Nova Scotia, 1984**

On this platform situated on the continental shelf, an uncontrolled eruption of gas and condensate took place below the water's surface. It ran for 10 days at a maximum rate of 48 m<sup>3</sup>/day (the flow decreasing with time). The operator, Shell, triggered its emergency plan, organised aerial monitoring of the slicks to track their drift and evaluate their thickness and breadth, proceeded to air sampling of condensate in the slick and in fish and checked for possible deposits and the impact on nearby Sable Island. Thanks to the numerous storms at the time of the leak, the condensate slick was rapidly dispersed. The evaporation of the condensate was estimated at 75% after 24 hours. The rest formed a surface slick or was driven into the water column. The slick persisted for several days and was observed up to 10 km from the drilling. The part dissolved in the water column undoubtedly persisted for longer because of its reduced evaporation.

Yet hydrocarbon concentrations detected up to a depth of 21 m were low and no effect was observed for marine wildlife.

### **Montara offshore oil field, Timor Sea, 2009**

On 21 August 2009, approximately 230 km off the coast of northwest Australia on the *Montara* offshore oil field in the Timor Sea, an uncontrolled eruption of hydrocarbons occurred from a well head drilled by the West Atlas mobile platform.

The hydrocarbon increase consists of:

- light crude oil (but with a paraffin level of 11% and pour point rising to 27°C) immediately forming surface slicks;
- a mixture of condensates and gas released into the atmosphere, posing a risk of explosion near the platform.

The spill into the sea was estimated at 4,800 tonnes. The leak continued until 3 November 2009. The slick generated reached 40 km wide by 136 km long. Aerial reconnaissance was initiated from the beginning of the crisis to follow the slick drift and guide the nautical resources in the area (recovery vessels, aircraft for spreading dispersants, etc.).

From the second day after the spill, hydrocarbon slicks were treated by spreading dispersants by aircraft and ships. The large paraffinic component of crude tends to solidify the slicks as the temperature decreases and affected the time window for using the most efficient dispersants in the afternoon. Even so, chemical dispersion proved effective.

Oceanic weather conditions (at low agitation) are not conducive to the natural dispersion of crude oil but favourable to containment and recovery operations. As with dispersion operations, a particular constraint appeared in connection with the high paraffin content of the spilled crude, which solidified overnight. Overall, 844 m<sup>3</sup> of emulsion was recovered, the proportion of crude oil of which AMSA (the Australian Maritime Safety Authority) estimated at 58% (493 m<sup>3</sup>).

At the same time, a group of experts mobilised to develop a strategy to halt the leak. The option chosen was to drill a bypass well joining the main well, at a depth of 2,600 m. The interception of the main well, a true technical challenge, was carried out on 3 November, stopping the leak with the injection of 540 m<sup>3</sup> of heavy sludge.

The antipollution reaction was considered a success. No appearance on the coast, with its ecologically sensitive sectors, was observed.

### **Elgin production platform, North Sea, 2012**

A gas and condensate leak occurred on a closed well that had been shut down and isolated for a year. The leak was due to the unpredictable corrosion of a well casing. Facing risks of fire and explosion, all personnel were evacuated and a safety perimeter was established. A nearby platform was also evacuated. The condensate spreads to the surface of the water, forming a very large, very thin, iridescent slick, the majority of which evaporated in a few hours. The maximum evaporation rate at sea could be estimated at about 75%. The operator, Total, used satellite, air and naval resources to observe the situation and establish, with international experts, the most suitable intervention strategies to control the leak. Heavy mud was injected at the well head from a semi-submersible drilling rig. After 12 hours of injection, the methane leak was halted. The well was carefully monitored in the following days to ensure the success of the intervention. In two months the leak released up to 200,000 m<sup>3</sup> of natural gas per day. The British authorities put the platform back into service almost 12 months after the accident. There were no victims to mourn, but the cost of this accident amounted to several hundred million euros.

C1

## Condensates

### Chemical intervention guide

#### **MT Sanchi, East China Sea, 2018**

Following a collision with the Hong Kong bulk carrier *CF Crystal*, sailing towards China, the Iranian oil tanker *MT Sanchi*, en route to South Korea, caught fire on 6 January 2018 about 300 km off Shanghai. On 10 January, part of the oil tanker exploded, and the Chinese government's fire-fighting operations were interrupted. On the 13th, further attempts to stop the fire were made, but on the 14th, the oil tanker exploded entirely and sank to a depth of 115 m off Japan's Ryukyu archipelago.

After the shipwreck, some of the 136,000 tonnes of leaching condensate burns rapidly at the surface, causing impressive air pollution. On 15 January, the fire ceased and, given its low viscosity, the condensate evaporated and/or spread on the surface of the sea, forming a thin, iridescent film, the size of which was estimated to be as high as 300 km<sup>2</sup> by the Chinese authorities. Despite strong water agitation in the area, which favours natural dispersion, on 16 January, fragmented slicks were observed by the Japanese coast guard 27 km north of the collision site. On 21 January, the polluted surface was judged to be about 330 km<sup>2</sup> by the national Chinese ocean authority. On 2 February, the first oil pellets, which could have come from residues from the burning of condensate or heavy fuel oil, hit the coast of the islands of southern Japan. On 23 February, at least 16 islands were affected and 90 tonnes of waste collected.

The Chinese government very quickly launched rescue operations in collaboration with South Korea and Japan to find the crew of the oil tanker, who unfortunately did not survive. About 15

vessels present in the area participated in the aid effort, hydrocarbon recovery and firefighting. On the basis of information from the national maritime rescue centre, some 60 control operations were carried out by boats of all kinds, for a result, as of 21 January, of 27 tonnes of dispersants used, 440 tonnes of absorbents used and 800 metres of dams deployed.

If it was above all a human catastrophe, it was also the largest condensate release into the environment observed to date, highly volatile crude oil having burned for about 10 days and causing major air pollution. Though the respective amounts of condensate that contaminated the atmosphere and the sea are difficult to estimate, the air pollution was likely more significant than the aquatic pollution.

#### **Other cases**

In addition to these four major accidents, several cases of pipeline or well-head leaks in coastal wetlands should be noted, notably in Louisiana (United States). The areas contaminated by these accidents are, however, very small (< 0.5 km<sup>2</sup>). Examples include the accidents at the Rockefeller Wildlife Refuge in 1995, the Atchafalaya Basin in 1996 or in Mosquito Bay in 2001. In these ecologically fragile areas, manual or mechanical recovery of the pollutant is difficult and has led to further deterioration of the sites. In two of the cases cited, Rockefeller Wildlife Refuge and Mosquito Bay, burning *in situ* was chosen as the control technique. This proved effective, the burned areas having returned to the same vegetation levels relatively quickly (from a few months to two to three years) as areas not affected by the pollution.

## Modelling of different accident scenarios

The accident scenarios presented here, simulated by the software OSCAR (SINTEF, Norway), are only indicative. In a real accident, the extent and fate of the pollution may be different because of the surrounding conditions, but also because of the very nature of the condensate.

The following examples were obtained from the test data from the Maharaja Lala condensate in Brunei.

Two scenarios with constant currents and winds were simulated:

Scenario 1: A deep (1,000 m) spill, continuing for 30 days at a rate of 4,770 m<sup>3</sup> of oil per day. The GOR (gas-oil ratio) was set at 2,000.

Scenario 2: An instantaneous surface spill (one hour for the software) of 10,000 m<sup>3</sup>. The behaviour over time was simulated over a period of 20 days.

Parameters	Simulation characteristics
Constant current	0.07 m/s – northwest direction
Constant wind	10 knots – southeast to northwest
Surface sea temperature	22°C
Sea temperature at a depth of 1,000 m	4°C
Salinity	35 ppt
Air temperature	21°C
Dissolved oxygen content	10 mg/L
Suspended material	0 mg/L

Figure 16: Modelling parameters

## Scenario 1 Deep spill (blowout)

Some of the condensate is dispersed in the water column at the beginning of the event and this proportion remains roughly constant throughout the 30-day simulation. The quantities arriving at the surface are therefore similar over time, but then reduced in part by evaporation and biodegradation phenomena (about 10%), though the magnitude of this process is difficult to anticipate.

The surface slick therefore extends progressively, fed by the regular arrival of pollutant, but the area of high thickness, greater than 100  $\mu\text{m}$ , remains modest given the volumes involved (4,770  $\text{m}^3$  per day). After 30 days of blowout, the slick is approximately 100  $\text{km}^2$  in size, which from an operational point of view allows for containment/recovery or dispersal operations.

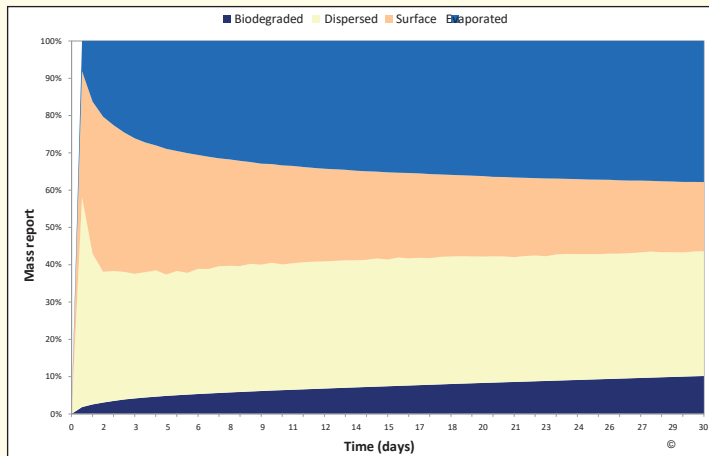


Figure 17: Material report of the "deep spill" scenario

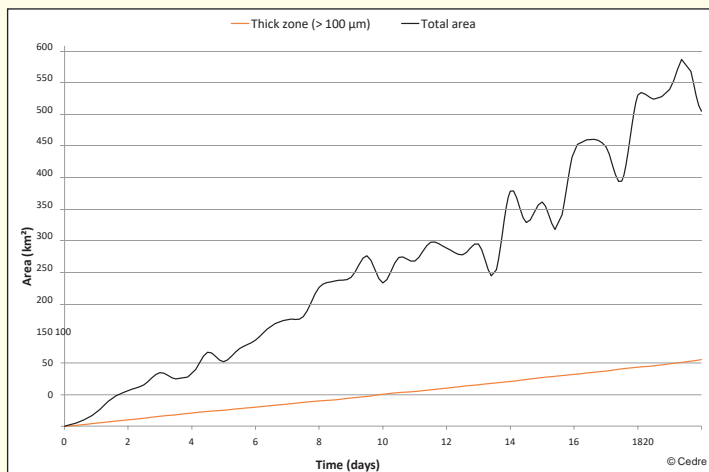


Figure 18: Changes in the size of the surface of the condensate slick for the "deep spill" scenario

C2



## Scenario 2 Surface spill

Most of the condensate will gradually disperse in the water column or evaporate, or even biodegrade (though this process is difficult to model). In the end, only about 150 m<sup>3</sup> of the pollutant will remain of the 10,000 m<sup>3</sup> initially spilled. (Taking into account the emulsification phenomenon, this volume could reach 750 m<sup>3</sup>, for a level in water of 80%).

For the thick part of the surface slick (greater than 100 µm), it spreads rapidly after a spill and almost disappears after two weeks. The maximum area is approximately 15 km<sup>2</sup> after four days, allowing for containment/recovery or dispersion. This could limit the thinner area, which would otherwise extend over 1,000 to 2,000 km<sup>2</sup> for several days and could result in very diffuse arrivals on a long coastline, depending on the spill area.

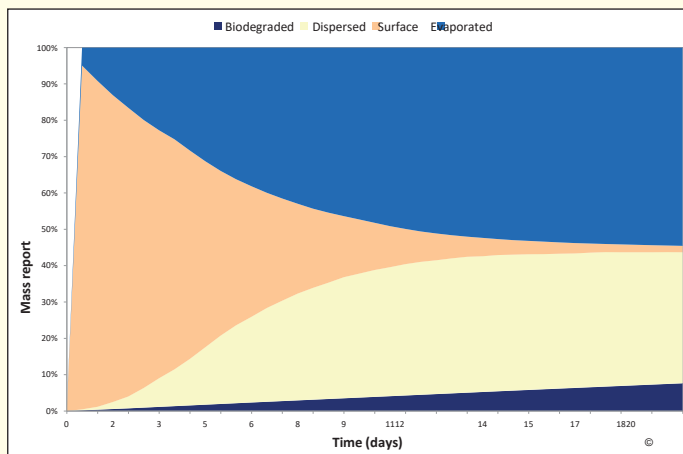


Figure 19: Material report of the "surface condensate spill" scenario

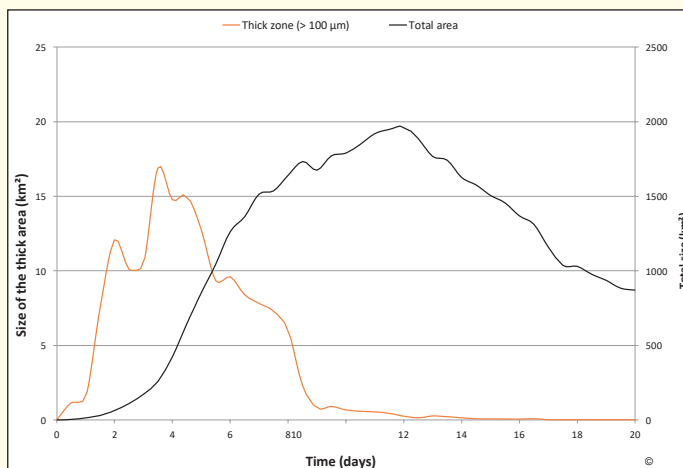


Figure 20: Changes in the size of the slick surface for the "surface condensate spill" scenario

C2

# Combating spills

- Recommendations related to intervention \_\_\_\_\_ **D1**
- Techniques to combat pollution \_\_\_\_\_ **D2**
- Choice of personal protective equipment (PPE) \_\_\_\_\_ **D3**
- Table of resistance of materials to condensates \_\_\_\_\_ **D4**
- Waste treatment \_\_\_\_\_ **D5**

## Recommendations related to intervention

Any control action must be preceded by in-depth reflection on people's safety (workers and third parties) in order to secure the area and protect people. The following paragraphs recall the basic elements of this reflection, which should be pursued throughout the operations. Condensates can be almost colourless chemicals, which makes operations tricky, because it is sometimes difficult to discern the contours and extent of a slick.

### First instructions

- Halt the spill, if possible.
- Establish a security perimeter.
- Secure the premises by prohibiting access to the polluted area and evacuating the people there.
- Eliminate any possible cause of ignition (use of explosion-proof equipment, bronze tools, etc.).
- Open and ventilate any more or less enclosed places in the area.
- Be sure to block any outlets in contact with the polluted body of water in order to prevent the chemical from rising and to minimise the risk of explosion in the pipes.

In all cases, seek the help of firefighting professionals.

In the event of a spill in a river, care will be taken to suspend the use of water downstream from the spill point (closure of water intakes, stall entrances, etc.).

### Vapour, explosiveness monitoring measures

When responding to a condensate spill, the first safety measure will be to control

the percentage of vapours in the air (see **B4**) using an explosimeter. A safety must be taken into account, and the intervention will continue for a threshold below 10% of the minimum threshold (1.4%) of flammability in air.

In the event of strong evaporation, the measurement of the VOC rate in the air (some are very toxic) using detection devices allows the safety of workers to be assured (e.g., HNU photoionisation detector or Draeger tube for BTEX aromatic vapours).

The risks of ignition of condensate vapours and poisoning of operators are all the higher if the premises are poorly ventilated (closed area and pipes, absence of wind, etc.) or enclosed, allowing the vapours to accumulate.



Vapour measurement with an explosimeter

## Condensates

### Chemical intervention guide

#### Burning spills

If the fire is declared and too advanced, it is necessary to evacuate people within a sufficient radius. Firefighting will take precedence over pollution-control.

Any action taken will be:

- by approaching upwind of the spill and/or upstream of the current;
- by equipping workers with explosimeters and personal protective equipment (see **D3**).

The recommended extinguishing agents are chemical foam, dry ice or dry powder. Water may be ineffective in extinguishing the fire, but it can be used to cool walls and surfaces exposed to it. It is also possible to knock down the vapours by spraying water. Do not use a solid jet of water, as it will cause the flames to spread. The fuel source must be isolated: Allow it to burn under control until the fuel is exhausted or use the appropriate extinguishing agents.



Anti-fire dam

D1

**In all cases, secure the area and ensure the safety of workers and residents. For more safety/fire information, refer to the specialised literature.**

## Techniques to combat pollution

### Main strategies for responding to a condensate spill

The first steps, before any intervention with highly flammable condensates, should be dedicated to defining a safety perimeter and controlling the atmospheric explosivity while protecting the hot spots. These measures must be accompanied by monitoring pollution and its spread (marking of slick, drifting buoys), as well as its movements using modelling.

#### *Do nothing, let it be*

In most cases, the natural evaporation of condensates reduces pollution in the aquatic environment. This is probably the most common control option to adopt if security allows. This option does not preclude the use of floating dams or, under certain conditions, tailored dams to protect particular areas that may be contaminated with the slick. The presence or absence of soluble condensate compounds in the water column should also be assessed (in turbid waters, these molecules attach to the suspended matter and may settle).

#### **Mechanical containment/recovery**

This is the second control option when pollution cannot be allowed to evaporate on its own. When the situation permits, confinement of the slick by a floating dam towed at very low speed or placed in the current (< 0.7 knots) in order to contain and thicken the slick will greatly increase the efficiency of the recovery. This option therefore involves handling highly flammable chemicals, and draconian safety measures must be taken

throughout the treatment chain (explosive atmosphere, fire or poisoning, use of explosion-proof equipment). However, by virtue of ageing, the flashpoint of condensates increases, passing above 60°C in a few hours (one hour for Akpo, the heaviest condensate type, six hours for Vega, the lightest type at low temperature, or 5°C), making the product less dangerous. These same dams can also be used to divert the path of the slick to an area that is more favourable in terms of safety (avoidance of hotspots), calmer or more accessible for condensate recovery, or to prevent the condensate from migrating to an ecologically or socioeconomically sensitive area.

Light chemicals are characterised by low viscosity. So they do not pose particular problems for pumping, but tend on the other hand to spread rapidly into extremely thin slicks. The main difficulty then consists of making a good selection between the hydrocarbon and the water at the time of recovery, even if emulsions are generally not highly stable in the case of condensates and the water drawn with the hydrocarbons can, *a priori*, be easily separated through settling. As such, self-adjusting threshold scrubbers, as well as oleophiles will be suitable tools. The latter are characterised by high selectivity but a significantly lower recovery rate.

#### **Use of absorbents**

When the quantities of pollutant to be recovered are small (in the order of a few tens of litres maximum), which can nevertheless represent large polluted

## **Condensates**

### **Chemical intervention guide**

areas, recourse to absorbents will often be the most suitable solution for a fine cleaning after the lighter parts have evaporated, in order to avoid any risk of explosion at the storage point. They may also be recommended in the case of heavier condensates, which may emulsify, but the viscosity of which remains limited.

#### **Surface chemical dispersion**

Chemical dispersion must be considered in the light of what is recommended generally for crude and refined petroleum products, except that there is no limitation, *a priori*, due to high viscosities. One of the criteria for choosing this strategy will be the evaporation rate.

The lightest condensates, comparable to a cut kerosene (e.g., Elgin, Myanmar, South Pars or Dolphin Qatar), have expected evaporation rates at sea in the range of 80% to 85% (most evaporation takes place in 24 to 48 hours). Although they were found to be dispersible in tests conducted at Cedre, chemical dispersion is not recommended for chemicals with low persistence at the surface of the sea, for evaporation rates greater than 70%.

In general, chemical dispersion can be recommended for condensates the evaporation of which is less than 70% and asphaltene content greater than 0.1% (e.g., Maharaja Lela, Absheron, Handil, Akpo). These products can emulsify at rates of 70 to 80%, which implies that the amount of pollutant remaining on the sea surface is similar to the volume initially spilled. As with light crude oils, time and precautions are necessary prior to any

Intervention, due to their flammability. Though their maximum viscosity is low, laboratory tests and tests aged samples at the Polludrome® showed a decrease in the effectiveness of treatment with ageing. This can thus be uncertain for Absheron for a simulated time of 36 hours, even very reduced for Handil or Akpo.<sup>3</sup> Conversely, dispersibility may increase in the first few hours due to a small increase in viscosity associated with an increase in density. Given the risks associated with the application of dispersants by boat within the first few hours of a spill, it may be necessary to delay the use of this technique by a few hours.

Finally, notable differences in effectiveness have been identified for several dispersants. As much as possible, it is therefore necessary to conduct comparative studies of the efficiency of upstream dispersants in order to optimise the response strategy.

#### **Underwater dispersion**

The advantage of underwater injection of dispersant is to limit the arrival of hydrocarbons, usually highly flammable, at the surface vertical to the leak, where most of the anti-pollution control is concentrated. This option can reduce the risks linked to the nature of the chemical. As with surface dispersion, the relevance of this technique is to be considered and put in perspective with respect to surface evaporation and chemical persistence.

#### **Burning *in situ***

This technique can, *a priori*, be applied to condensates, mostly highly flammable, in very particular situations, notably in deserted places, because of the

<sup>3</sup> The Handil condensate dispersibility study shows that, according to the IFPEN test, the dispersion efficiency becomes uncertain for a viscosity of 300-400 mPa.s and reduced according to the MNS test from 100 mPa.s.

associated risks (fire and smoke). The possible consequences must be studied beforehand on a case-by-case basis, incorporating any beneficial or harmful effects on the environment. For example, in some special cases, burning *in situ* may be recommended in ecologically sensitive areas (marshes, seagrass habitats) where trampling and the passage of mechanical recovery tools may further degrade ecosystems. The fate of the burning residue, however small, must also be incorporated into the decision process.

Studies conducted at Cedre have shown that 85 to 90% of a light chemical of the condensate type can be burned, but these values are to be seen relative to the evaporation rate, which can reach 80% in some cases. As with dispersants, it is possible to define a window of opportunity upstream knowing that the effectiveness of burning decreases over time. A study conducted in the Cedre burn bench showed the possibility of setting fire to a condensate slick, regardless of the degree of simulated evaporation (residues at 150°C, 200°C and 250°C). It was also possible to set various emulsified residues on fire at 50% water.

### **Spill context and response decision**

#### **In open sea**

In the context of low-volume spills, and given condensates' evaporation rate, one of the most appropriate solutions is to let the condensate spread and evaporate naturally. The definition of these small volumes, in the order of a few m<sup>3</sup>, is a function in particular of the endangered area, national regulations, the possibility of deviations and the potential

environmental and socioeconomic consequences.

For medium to major pollution, the lightest condensates, which demonstrate an evaporation of more than 70%, close to petrol and kerosene, have a low persistence, while the risk for workers is high. The "do nothing, let it be" option is therefore also recommended in this case. For lower evaporation rates, the intervention strategies described above are possible, with recovery being prioritised.

#### **In a coastal area**

Pollution control operations should be carried out when the pollutant's drift points to the coast or ecologically or socio-economically sensitive areas, whatever the volume spilled (in general, a slick moves with the current and under the influence of the wind – 100% from the current and 3% from the wind). Protecting these areas with dams may be considered, fireproof if possible. It is important to note that these measures involve the use of nautical resources which are not easily compatible with ATEX certifications and which must therefore be used well before the arrival of the pollutant. The use of dispersants or in burning *in situ* is necessarily more delicate than recovery, which must be prioritised. Geographical limits apply generally to the use of dispersants in proximity to coasts, sometimes nuanced according to the volume spilled. In the case of burning, the first question is regulatory, since this technique is banned in many countries. The next question then arises regarding smoke and its harmfulness.

In the case of a spill in the order of a few m<sup>3</sup> very close to the coast or at the coast,

## Condensates

### Chemical intervention guide

if the slick is confined naturally, recovering the pollutant after covering it with a low- or medium-swell emulsifier foam mat can be considered, to limit the formation of flammable vapours. The recovery will then take place with a floating intake head adapted to recover the pollutant under the foam mat. Care should be taken to secure the storage tank by rendering it inert, and to ensure that there are no hotspots in the area. In this case, it is recommended that a "carp tail" or "manta" suction head be used with a sanitation truck or water sewage truck (which both allow vacuum pumping), provided that the combination is ATEX certified and follows the ADR regulations for storage and road transport. These operations must be performed by trained professionals equipped with suitable personal protection (respiratory and skin protection – see **D3**). For larger volumes, self-adjusting threshold collectors, as well as oleophiles are recommended, but their use may be limited by the flammability of the chemical.

### On land and in inland waters

In the case of a spill on land, taking into account the risk of ignition of the vapours, it is appropriate, first and foremost, to assess the extent of the pollution and to define a safety perimeter. The outlets (sewers, drains, collectors) must then be protected as a priority to avoid the spread of pollution in the aquatic environment and networks, while limiting, as far as possible, the spread of the pollutant by the creation of merlons (sand, earth, etc.).

If the spill reaches a river, it is appropriate, in the short term, to ensure the protection of downstream water intakes while controlling the risk of ignition. In the medium term, it will be necessary to clean the impacted banks after the evaporation process has been completed.

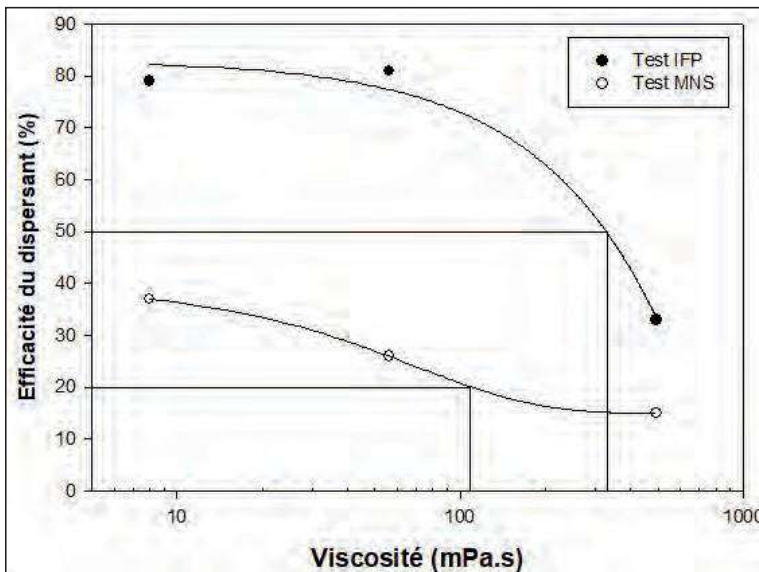


Figure 21: Evolution of dispersibility of the Handil condensate



# Choice of personal protective equipment (PPE)

## Choice of protective clothing

- Wear protective clothing covering, as much as possible, the whole body.
- **Face and eye protection:** Wear chemical protective goggles (do not use contact lenses in work areas). It may be necessary to wear a face mask. For handling low-concentration chemicals for a short time, a respirator with a type A filter is recommended. For higher concentrations or long-term exposure, use a self-contained breathing apparatus.
- **Skin protection:** Wear protective gloves resistant to aromatic hydrocarbons: nitrile rubber (contact by spraying), fluoropolymer (contact by immersion), boots, overalls and/or other hydrocarbon-resistant protective clothing.
- Promptly remove all contaminated clothing that would no longer provide complete skin protection.

## Choice of respiratory protection

- Mandatory use of a self-contained breathing apparatus in a confined atmosphere due to the abundance of gases released.
- Personal respiratory protection equipment must be worn as soon as there is a risk of inhalation of toxic vapours when concentrations are close to the mean exposure value (MEV = 200 mg/m<sup>3</sup>).



Full breathing mask with cartridges

## Condensates

### Chemical intervention guide

# Table of resistance of materials to condensates

The constituent elements of protective equipment and the materials used must be resistant to condensates.

The table below lists the compatibility of various plastomers and elastomers with respect to condensates.

		Unleaded petrol	Ethanol
Acrylonitrile butadiene styrene	ABS	D	B
Ethylene propylene diene monomer rubber	EPDM	D	A
Fluorocarbon rubber	FKM - Viton	A	B
Natural rubber		D	A
Nitrile rubber	NBR - Buna Nitrile	A	C
Perfluorinated rubber	FFKM - Chemraz		A
Perfluorinated rubber	FFKM - Kalrez	A	A
Polyester rubber	Hytrell		
Polyvinyl chloride	PVC	C	C
Chlorinated polyvinyl chloride	CPVC	C	B
Polyvinylidene chloride	PVDC - Kynar	A	
Polyamide	PA - Nylon	A	A
Polycarbonate		A	B
Polychloroprene	Neoprene	B	A
Polychlorotrifluoroethylene	PCTFE - Kel-F	A	A
Polyepoxide	Epoxy	A	A
Polyetheretherketone	PEEK		A
Chlorosulfonated polyethylene	CSPE - Hypalon	A	A
Conventional polyethylene	LDPE	D	B
High-density polyethylene	HDPE	C	A
Fluorinated polyethylene propylene	Tygon	C	C
Polyoxymethylene	Acetal	A	A
Polyphenylene oxide	Noryl	D	A
Polyphenylene sulphide	PPS - Ryton	A	
Polytetrafluoroethylene	PTFE - Teflon	A	A
Polyurethane			D
Silicone		D	B

**A** Excellent  
(durable for years)

**B** Good  
(withstands at least one month)

**C** Medium (signs of deterioration after one week)

**D** Not suitable

## Waste treatment

The control of condensate pollution can lead to the creation of various wastes.

### Polluted water

If it is a mixture with two distinct phases, water and condensate, the insoluble and superposing hydrocarbon phase should be separated by simple decanting.

If this water-condensate mixture is more or less dispersed, it can be filtered on hydrophobic absorbents that will remove the condensate. For example, on a small pollution site, feed the water-condensate mixture into a receptacle containing bulk absorbent materials, such as polypropylene "spaghetti".

If the water is contaminated by the soluble elements of the condensate, then the contamination depends on the initial composition of the condensate and the proportion of BTEX. Such water cannot be released into the natural environment. If quantities are low and storage is possible, the treatment of contaminated water may be entrusted to a specialised company.

Another alternative is to treat this water with activated carbon (1 kg per 3.5 kg of compounds in solution). If the quantities are large and no longer permit this, it is possible to lagoon the water, preferably by aeration, in order to allow time for these volatile compounds to evaporate into the atmosphere. This process can also speed up the biodegradability of the soluble and biodegradable compounds of the condensate, namely light aromatics.

If the condensate has emulsified over time, it can be recovered by pumping.

### Polluted sediments

Contaminated sediments will be sent into an industrial waste treatment channel where they will be incinerated or possibly made inert by special treatments (lime, clays, etc.). Given the biodegradability of condensates, the use of biopiles is not to be excluded.

If the condensate has emulsified over time and it arrives on the coast in the form of "chocolate mousse", potentially having stuck to natural and macro-waste debris, the removal of contaminated sediment may require very different solutions.

### Polluted absorbents

Polluted absorbents will be sent to an industrial waste treatment centre for incineration.

#### For waste disposal

##### Consult:

- DREAL, for local services (Regional Directorate for Environment, Planning and Housing)

##### More specifically:

- ADEME (Environment and Energy Management Agency)  
Tel.: 02 41 20 41 20 / Fax: 02 41 87 23 50  
[www.ademe.fr](http://www.ademe.fr) (sections on ADEME by region / our regional delegations)
- Cedre (Centre for Documentation, Research and Experimentation on Accidental Water Pollution)  
Tel.: 02 98 33 10 10 / Fax: 02 98 44 91 38  
[www.cedre.fr](http://www.cedre.fr) / e-mail: [contact@cedre.fr](mailto:contact@cedre.fr)

# Additional information

- Glossary E1
- Initialisms and acronyms E2
- Useful websites E3
- Bibliography E4

# Glossary

## **Absorption**

Penetration and retention of the pollutant (fluid or viscous) in the material composing the absorbent.

## **Anoxic**

Absence of oxygen or very low permeability.

## **Biocidal**

Destructive of living organisms.

## **Effective concentration 50 (EC<sub>50</sub>)**

Concentration causing an effect (mortality, growth inhibition, etc.) for 50% of the relevant population for a given time period.

## **Median lethal concentration 50 (LC<sub>50</sub>)**

Concentration of a statistically deduced substance that should cause death for 50% of exposed animals during or after exposure for a defined period of time.

## **Relative density**

Density quotient of a substance and of the density of water for a liquid substance, or of air for a gaseous substance.

## **Lethal dose 50 (LD<sub>50</sub>)**

The dose of a statistically deduced substance that, administered to a living organism, should cause death for 50% of exposed organisms.

## **Personal protective equipment (PPE)**

This is a person's respiratory and physical protection. Levels of protection, including both protective clothing and respiratory protection devices, have been defined and accepted by professional agencies such as the United States Coast Guard:

- Level A: an APRA (self-contained breathing apparatus) and suits fully sealed against chemical agents.
- Level B: an APRA and clothing protective against liquids (splash-proof).
- Level C: a full or half-mask respirator and chemical-resistant (splash-proof) garment.

- Level D: full-body garment without respiratory protection.

## **Boiling point (measured at 1 ATM)**

Temperature at which a liquid begins to boil; more precisely, the temperature at which the saturated vapour pressure of a liquid is equal to the standard atmospheric pressure (1,013.25 hPa). The measured boiling point depends on atmospheric pressure.

## **Flashpoint**

The lowest temperature at which a substance emits a vapour that ignites or burns immediately upon ignition.

## **Marine pollutant**

A substance, object or material that, when released into the aquatic environment, may cause serious damage thereto.

## **Saturated vapour pressure**

The partial pressure of gas molecules in equilibrium with the liquid phase for a given temperature.

## **Tight areas (water)**

Areas with difficult access (straits, canals, ports, etc.), where the water is shallow.

## **Solubility**

Amount of substance dissolved in water. It is a function of salinity and temperature.

## **Ignition source**

Examples of ignition sources: heat, spark, flame, static electricity and friction. Sources of ignition must always be eliminated when handling flammable chemicals or working in hazardous areas.

## Initialisms and acronyms

**ADN:** European agreement on the international transport of dangerous goods by inland waterway.

**ADR:** European agreement on the international transport of dangerous goods by road.

**API:** *American Petroleum Institute.* API is an American standardisation agency.

**ASTM:** *American Society for Testing Material.* ASTM is an American standards agency that prepares and produces technical standards.

**ATEX:** explosive atmosphere.

**BTEX:** benzene, toluene, ethylbenzene, xylene. Light aromatic compounds.

**EC:** European Community.

**EC50:** effective concentration.

**IMDG:** International Maritime Dangerous Goods: international guide for the transport of dangerous packaged goods.

**LC50:** median lethal concentration

**CONCAWE:** European organisation of oil companies for the protection of the environment and health.

**VOC:** volatile organic compounds.

**SDS:** safety data sheet: a descriptive form containing data relating to the properties of a chemical product.

**GHS:** *Globally harmonised system.* A set of international recommendations developed within the United Nations, the aim being to harmonise the classification and labelling of chemical products worldwide.

**PAH:** polycyclic aromatic hydrocarbon.

**HESS:** an American oil company.

**IATA:** International Air Transport Association.

**IFPEN:** French institute of new petroleum energies

**IMO:** *International Maritime Organization:* an institution of the United Nations specialised in maritime matters.

**INERIS:** national institute of the industrial environment and risks.

**MNS:** Mackay Nadau Steelman, the name of a test used for dispersants.

**CAS no.:** Chemical Abstract Service number: a unique registration number in the American CAS database, which includes chemicals, polymers, biological sequences and alloys.

**UN no.:** United Nations number: a four-digit identification number for cargo for which transportation is regulated.

**EC no:** European Community number: a unique seven-digit identifier assigned to chemical substances for regulatory purposes in the European Union.

**OACI:** international civil aviation organisation.

**OSCAR:** *Oil Spill Contingency and Response:* oil accident modelling software developed by the Norwegian agency SINTEF.

**OSPAR:** The OSPAR Convention aims to prevent and eliminate marine pollution and thus protect the Northeast Atlantic from the harmful effects of human activity. As such, OSPAR develops many common tools, including tests.

**ppm:** part per million.

**RID:** regulations concerning the international transportation of dangerous goods by rail.

## Useful websites

**Cedre (Centre for Documentation, Research and Experimentation on Accidental Water Pollution)**

Accident reports (accessed 25.11.2020). Available on:

[wwz.cedre.fr/Ressources/Accidentologie](http://wwz.cedre.fr/Ressources/Accidentologie)

Operational guides (accessed 25.11.2020). Available on:

[wwz.cedre.fr/Ressources/Publications/Guides-operationnels](http://wwz.cedre.fr/Ressources/Publications/Guides-operationnels)

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[wwz.cedre.fr/Ressources/Publications/Guides-chimiques](http://wwz.cedre.fr/Ressources/Publications/Guides-chimiques)

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**INERIS (national institute of the industrial environment and risks)**

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**Cedre. Montara:** accident sheet. 2013

Available on: [wwz.cedre.fr/Ressources/Accidentologie/Accidents/Montara](http://wwz.cedre.fr/Ressources/Accidentologie/Accidents/Montara)

**Cedre. MT Sanchi:** accident sheet. 2018

Available on: [wwz.cedre.fr/Ressources/Accidentologie/Accidents/MT-Sanchi](http://wwz.cedre.fr/Ressources/Accidentologie/Accidents/MT-Sanchi)

**Central Intelligence Agency (US),** The World Factbook: lengths and types of pipelines for transporting products like natural gas, crude oil, or petroleum products.

Available on: [www.cia.gov/library/publications/resources/the-world-factbook/fields/383.html](http://www.cia.gov/library/publications/resources/the-world-factbook/fields/383.html)

**GILL, S.D., AC Bonke , Carter J.** Management of the Uniacke G-72 Incident. IN: *International Oil Spill Conference Proceedings 1 February 1985.* 1985, Volume 1, pages 311-313.

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**Zitko, V., L.E. Burridge, Woodside M. et al.** Low contamination of fish by hydrocarbon from the Uniacke G-72 (Shell Oil, Vinland) Wellsite Blowout in February 1984. 1984, page 43. (Canadian Technical Report of Fisheries and Aquatic Sciences, number 1305)

# APPENDIX

## Chemical products: classification, labelling and packaging EU classification according to EC Regulation no. 1272/2008 (Total SDS)

### Hazard categories

- Flammable liquids - Category 1.
- Aspiration hazard - Category 1.
- Skin corrosion/skin irritation - Category 2.
- Specific toxicity to certain target organs - single exposure - Category 3.
- Germ cell mutagenicity - Category 1B.
- Carcinogenicity - Category 1B.
- Reproductive toxicity - Category 2.
- Specific toxicity to certain target organs (repeated exposure) - Category 2.
- Aquatic environment hazard, long-term - Category 2.

### H grade "hazards"

- H224 - extremely flammable liquid and vapours.
- H304 - may be fatal if ingested and with respiratory tract penetration.
- H315 - causes skin irritation.
- H336 - may cause drowsiness or dizziness.
- H340 - may induce genetic abnormalities.
- H350 - may cause cancer.
- H361 - may harm fertility or the foetus.
- H373 - presumed risk of serious effects on organs after repeated

exposure or a prolonged exposure through contact with the skin.

- H411 - toxic to aquatic organisms, causes long-term adverse effects.

### P grades "prudence/prevention"

- P201 - Obtain instructions before use.
- P210 - Keep away from heat/sparks /open flames/hot surfaces. Do not smoke nearby.
- P243 - Take specific measures against electrostatic discharge.
- P260 - Do not breathe in dust/ fumes/ gases/mists/vapours/aerosols.
- P273 - Avoid discharge in the environment.
- P280 - Wear protective gloves/ protective clothing/eye or face protection equipment.
- P301/310 - IN CASE OF CONTACT WITH SKIN (or hair): Remove contaminated clothing immediately; rinse skin with water or shower.
- P309/311 - IN CASE OF EXPOSURE OR DISCOMFORT: Call a poison control centre or a doctor.
- P403/235 - Store in a well-ventilated environment. Keep cool.

## In the same collection

**Acrylic acid**, 2013 - 43 p.  
**Phosphoric acid**, 2008 - 76 p.  
**Sulphuric acid**, 2006 - 64 p.  
**Ethyl acrylate**, 2014 - 43 p.  
**Ammonia**, 2006 - 68 p.  
**Benzene**, 2004 - 56 p.  
**Chloroform**, 2011 - 44 p.  
**Vinyl chloride**, 2004 - 50 p.  
**1,2-Dichloroethane**, 2005 - 60 p.  
**Dimethyldisulphide**, 2007 - 54 p.  
**Unleaded petrol**, 2008 - 56 p.  
**Sodium hydroxide in 50% solution**, 2005 - 56 p.  
**Stabilised methyl methacrylate**, 2008 - 72 p.  
**Methanol**, 2012 - 47 p.  
**Methyl ethyl ketone**, 2009 - 70 p.  
**Styrene**, 2004 - 62 p.  
**Xylenes**, 2007 - 69 p.

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**ANNEX II**

**Condensate data Sheet**

**ANNEX II**

Etude sur les condensats  
*Condensate study*

Données à fournir au REMPEC  
*Condensate data to be provided to REMPEC*

	<b>Condensate 1</b>	<b>Condensate 2</b>	<b>Condensate 3</b>
Pays <i>Country</i>			
Nom du condensat <i>Name of the condensate</i>			
Localisation du gisement <i>Oil field location</i>			
Etat physique <i>Physical state</i>			
Couleur <i>Colour</i>			
Odeur <i>Odour</i>			
Masse volumique <i>Density (kg/m<sup>3</sup> or API)</i>			
Viscosité (mm <sup>2</sup> /s) à X°C <i>Viscosity</i>			
Pression de vapeur (hPa à 20°C) <i>Vapour pressure</i>			
Température d'ébullition (°C) <i>Boiling Temperature</i>			
Solubilité (mg/L) <i>Solubility</i>			
Taux d'évaporation (%) X°C <i>Evaporation in volume</i>			
Taux d'émulsification (%eau) <i>Emulsification rate (water %)</i>			
Biodégradation théorique (%) <i>Biodegradation</i>			
Asphaltènes (%) <i>nC7 Asphaltenes (% wt)</i>			
Paraffines (%) <i>Paraffins</i>			
Densité à 20°C <i>Density</i>			
250 °C+ (% vol.) <sup>1</sup>			
Benzène (µg/g) <i>Benzene</i>			
Toluène (µg/g) <i>Toluene</i>			

Ethylbenzène (µg/g) <i>Ethylbenzene</i>			
m,p-Xylène (µg/g) <i>m,p Xylene</i>			
o-Xylène (µg/g) <i>o-Xylene</i>			
Concentration H2S <i>H2S concentration</i>			
Point d'éclair ASTM D93 (°C) <i>Flash point ASTM D93</i>			
Point d'auto-inflammation (°C) <i>Auto-ignition point</i>			
Limites d'inflammabilité ou d'explosivité (% dans l'air) <i>Flammability or explosivity limit (% in air)</i>			
<i>Produits de décomposition dangereux Dangerous Chemicals with decomposition</i>			
Stabilité et réactivité <i>Stability and Reactivity</i>			
CL 50 96h poisson mg/L <i>CL50 - 96 hours – fish</i> CL50 48 h <i>Daphnia magna</i> mg/L <i>EC<sub>50</sub> 48 hours Daphnia magna</i>			
Facteur de bio-concentration (FBC) Log FBC <i>Bioconcentration factor (BCF) Log BCF</i>			
Adsorption Log KoC			

*Please attach SDS sheet, if available*

**ANNEX III**

**Contribution from the Mediterranean Technical Working Group**

## **ANNEX III**

### **Contribution from the Mediterranean Technical Working Group**

#### **Introduction**

1. This Annex presents the contribution of the four (4) Contracting Parties to the Barcelona Convention, to develop the Study on condensate spills based on the Condensates – Chemical Intervention Guide, Cedre (December 2020).

#### **Contribution from the Mediterranean Technical Working Group on the type of condensate**

2. One (1) country provided information on the condensate produced in 2019 and listed the Gasoline as condensate produced inshore and offshore.

3. One (1) country provided information on two Condensates having the name of the production Oil/Gas production field.

#### **Contribution from the Mediterranean Technical Working Group on the Guide:**

4. Three (3) Mediterranean coastal States provided comments on the Guide, as follows.

#### **Cover Page**

5. On the cover page of the Guide, the CAS no 64741-47-5 is referenced. There is a specific entry for this substance on the European Chemicals Agency (ECHA) webpage <https://echa.europa.eu/el/brief-profile/-/briefprofile/100.059.116> and scientific data resulting from a unique REACH Registration.

#### **Generalities**

6. The description of the substance is Natural gas condensates (petroleum) – Low boiling point Naphtha. This is considered important, as a first step to enable the correct identification of the condensates described in the Guide in relation to the registered substance. If sameness is achieved, then the information for spills in aquatic environments from this registration should be incorporated in the Guide. Some examples include the Bioaccumulation factors, the acute and chronic toxicity aquatic data, etc.

7. Publicly available information from the Registration dossier submitted by Gazprom Marketing and Trading France 24 is available in this link: <https://echa.europa.eu/el/registration-dossier/-/registered-dossier/13792/1>

8. In addition to the above, if the condensates are imported from a third country into the European Economic Area, their registration obligations, according to the REACH Regulation, should be assessed and, if needed, a registration dossier should be submitted to ECHA, along with all the required information, after undertaking data sharing with the already existing registrant.

#### **A. What You Need To Know About Condensates**

9. The Guide appears to be a useful tool, well organized and clear and a detailed review may be of a very limited extent/scope.

10. It is possible that underlining, even in the lines dedicated to “Behaviour in the aquatic environment” (page 7), the wide range of the main properties and characteristics of condensates may be useful for operators to maintain a cautious approach.

The statement on (page 8) should be amended: “...In case of blowout, chemical dispersion by submarine injection, after selection of an effective dispersant, can be a more efficient and safer technique, in terms of safety. In the event of accidents in sensitive coastal areas (marshes, for example), in situ burning could be envisaged”.



11. In terms of safety, the sentence could be acceptable, for the marine environment the release of dispersants near the seafloor can harm benthic organisms such as filter feeders, particularly in the concerned depths (where, quite often, nobody is aware of the specific diversity and organisms' sensibility to pollutants), with sub-millimetric particles of oil and in-situ burning generating persisted residuals on the sea bottom affecting the benthic biota and infauna. The following is suggested: "... In terms of safety, in case of blowout, in line with local regulations, having at hand data concerning the ecological characteristics of the benthic and pelagic ecosystems, and after selection of an appropriate dispersant, chemical dispersion by submarine injection is an option to be explored. In the event of accidents in sensitive coastal areas (marshes, for example), in situ burning could be envisaged taking into account the occurrence of resulting persistent residuals on the sea bottom affecting the benthic biota and fauna".

## **B. PRIMARY EMERGENCY DATA**

### - Environmental impacts following a spill

12. In relation to the paragraph "*Condensate pollution creates safety problems for people*": These issues, not addressed in this document" is that these are the issues that need to be addressed, people and hazards to them are part of the problem of a condensate spill and thus cannot be ignored.

### - Potential impacts on economic resources

- Tourist beaches

13. In response to the paragraph "*Beyond the issue of health safety*": This is exactly what is needed here to advice as to health issues. For example, measurement of volatile organics is of a prime importance.

- Industrial water intake

14. In responding to the "*Cooling water intake*". The most important sea water intake is ignored: desalination plants. They intake the water from a depth of 10-15m. What are the risks posed and what should be done?

## **E. COMBATING SPILLS**

### Recommendations related to intervention

15. Responding to the paragraph "*Any control action must be preceded by in-depth reflection on people's safety (workers and third parties), in order to secure the area and protect people*": There is importance on greater detail for the environmental conditions in which vapours may form a cloud that will move towards inhabited beaches and endanger the population.

### Vapour, explosiveness monitoring measures

16. Responding to the paragraph "*In the event of strong evaporation, the measurement of the VOC rate in the air*": It is important to add information about the use of remotely controlled tools such as drone's for measurements of VOC and the percentage of vapours in the air.

### Techniques to combat pollution

17. Responding to the paragraph "*Main strategies for responding to a condensate spill*": It is important to add information about the capabilities of remote sensing/ tracking systems to detect the Condensate on the sea surface (Radar, IR, UV), or to direct the operations.