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Ships and marine technology — Marine environment protection: performance testing of oil skimmers —

Part 3: High viscosity oil

Navires et technologie maritime — Protection de l'environnement marin: essais de performance des écumeurs du pétrole —

Partie 3: Pétrole haute densité

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21072-3 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

ISO 21072 consists of the following parts, under the general title *Ships and marine technology — Marine environment protection: performance testing of oil skimmers:*

— *Part 1: Moving water conditions*

— *Part 2: Static water conditions*

— *Part 3: High viscosity oil*

Introduction

ISO 21072 standardizes performance testing of oil skimmers used in marine pollution control.

Some oil skimmers have previously been performance tested under non-standard conditions and procedures, with declared performance parameters being of limited value to the end user, especially under field conditions.

ISO 21072 provides for carrying out and recording the results of full-scale tests for a skimmer under a variety of test conditions.

Ships and marine technology — Marine environment protection: performance testing of oil skimmers —

Part 3: High viscosity oil

1 Scope

This part of ISO 21072 specifies a methodology for establishing quantitative performance data for oil skimmers for recovery of oil with high viscosity, so the end user can objectively judge, compare and evaluate the design and performance of different skimmers. The methodology applies to testing in a basin and requires control of oil properties and oil slick characteristics.

The method is applicable to all types of skimmer provided that the equipment dimensions are within the physical limitations of the test basin. The test procedure provides full-scale test results for the unit tested, under controlled conditions, and for one or more classes of highly viscous oil. Attention is drawn to the care required when applying the test results to predict a realistic skimmer performance under field conditions.

For dedicated/inbuilt systems the test procedures outlined in this part of ISO 21072 are only applicable to the skimming device as such, not the entire skimming system.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16165, *Ships and marine technology — Marine environment protection — Terminology relating to oil spill response*

ISO 21072-1, *Ships and marine technology — Marine environment protection: performance testing of oil skimmers — Part 1: Moving water conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16165, ISO 21072-1 and the following apply.

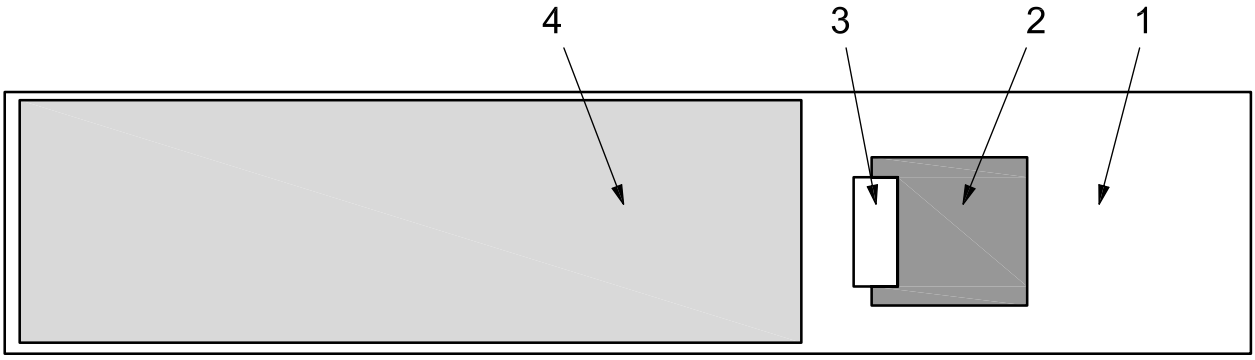
3.1
high viscosity oil
oil that due to its properties does not readily flow to a skimmer

4 Test facility requirements

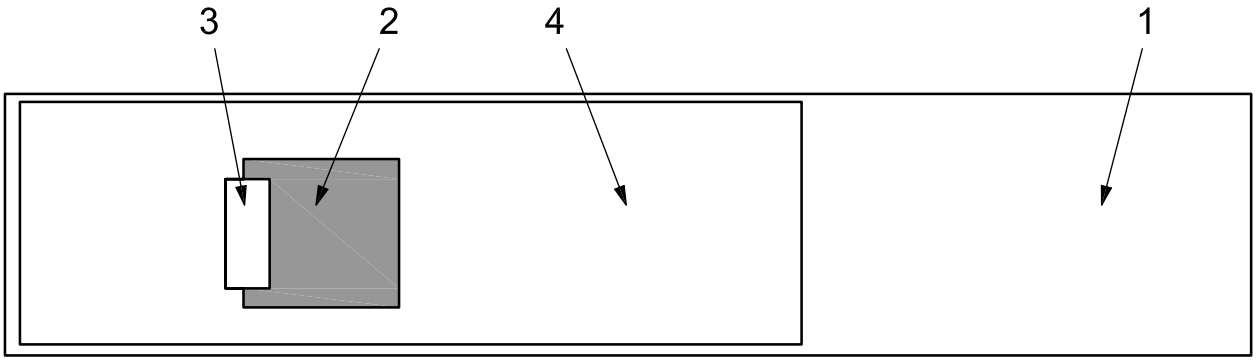
4.1 General

This part of ISO 21072 is applicable to any test arrangement that allows for the control and monitoring of the test conditions specified.

Figure 1 gives examples of test arrangements.



a) Test tank set-up prior to commencement of test and under test conditions



b) Skimmer moving through oil slick under test conditions

Key

1 skimmer body
2 pick-up/entrance of oil to skimmer
3 test oil
4 removable barrier

Figure 1 — Examples of test arrangements

The test facility shall be designed and equipped to control the parameters listed in 4.2 to 4.5.

4.2 Oil properties

The facility shall be able to maintain the oil properties for the duration of the test. Analytical equipment shall be available for measuring oil properties (see 9.1).

4.3 Air and water temperature

Testing may be carried out at any water temperature, provided that requirements with respect to oil properties are met. The facility shall be able to maintain the water temperature in the test basin at a selected test temperature with maximum variation of ± 2 °C throughout the testing period.

4.4 Oil slick thickness

The test facility shall incorporate means of measuring oil slick thickness before and after the test, with an accuracy of at least ± 20 %.

4.5 Measuring tanks

In order to provide for sufficient replicates during the test process, the test facility shall incorporate a sufficient number of calibrated tanks for accurately measuring fluid recovery rate, oil recovery rate, and water uptake. The tank volumes shall correspond to the expected recovery rate of the unit to be tested so as to provide data collection periods of sufficient duration and with sufficient measuring accuracy (see 10.1).

5 Clearance requirements

Throughout testing, to minimize any effect on oil flow to the unit or otherwise impede normal operation, there shall be sufficient clearance between the skimmer and the tank walls and any containment device.

The side clearance shall at all times be at least 50 % of the extreme width (diameter or equivalent dimension) of the skimmer under test.

The clearance between the unit and the tank floor shall be sufficient to not interfere with normal operation of the skimmer.

6 Test parameters

6.1 General

Testing shall establish quantitative performance data for the unit as a function of the following parameters:

— test oil properties;

— oil slick thickness;

— skimmer operating parameters;

— debris interference;

— forward movement of skimmer through slick.

6.2 Test oil properties

Viscosity is the main property for the test oil, regardless of the water content, provided that testing is carried out with oils meeting the specifications given in Table 1.

Oil and emulsion viscosity shall be reported at shear rates 1,10 s^{-1}.

All oils and emulsions may be reused provided that the properties of the test fluids remain within the ranges given in Table 1.

Table 1 — Ranges for oil properties and related slick parameters

Oil class	Target viscosity (cP)[a]	Viscosity range (cP)	Density (kg/l)	Slick thickness (mm)	Examples
7	100 000	50 000 to 200 000	0,96 to 0,99	100 ± 20	Emulsion of heavy fuel or clean heavy bitumen crude
8	500 000	200 000 to 700 000	0,96 to 0,99	100 ± 20	Emulsion of heavy fuel or clean heavy bitumen crude
9	1 000 000	700 000 to 1 500 000	0,96 to 0,99	100 ± 20	Bitumen

[a] At shear rate 1,10 s^{-1}.

6.3 Oil slick thickness

For each specific test, the slick thickness shall be within the range defined in Table 1. Slick thickness shall be measured before and after test.

6.4 Skimmer operating parameters

There are a number of operating parameters that can affect the skimmer performance, such as

— adhesion surface speed and its direction of rotation,

— inclination angles,

— pump flow rates, and

— skimmer draft.

From these parameters, the main operational parameters affecting performance shall be identified in order of importance. A minimum of three tests inclusive of the main operating parameter shall be conducted.

6.5 Debris interference

Testing shall be carried out at one of the speeds listed in 6.6, to assess the skimmer's ability to operate in the presence of various forms of debris in the oil slick. This test is qualitative in nature, assessed by a visual examination, and is intended to provide the end user with a general indication of the effects of different materials that are often found in oil spill recovery situations. Of particular interest would be the effects of the debris on oil intake, essential mechanical elements of the unit (e.g. scrapers, wringers, pumps), and overall processing of the recovered oil.

The following groups of materials shall be introduced into the oil slick individually. Their impacts shall be observed and reported. Then the material shall be cleared from the testing area before the next group is introduced.

Table 2 — Materials to be introduced into oil slick

Materials	Specifications
Ropes	Two 1,0 m × ⩾ 25 mm diameter polypropylene ropes; Two 1,0 m × ⩾ 8 mm diameter polypropylene ropes; Four 0,6 m × ⩾ 75 mm diameter polypropylene ropes
Soft wood pieces	One board (1,0 m × 50 mm × 100 mm); Ten blocks (10 mm × 25 mm × 40 mm)
Loose materials	Five litres shredded of wood bark or wood shavings (size ⩾ 5 mm ⩽ 25 mm)
Plastic containers	Four 0,5 litre plastic soft-drink bottles; Two 3,0 litre open-top plastic containers
Plastic bags	Four plastic bags (of the "disposable" type used for groceries), approximately 300 mm × 300 mm; Two large plastic bags (of the type used for domestic garbage), approximately 500 mm × 1 000 mm

6.6 Skimmer movement through slick

Testing investigates the effect of the movement of the unit through the oil slick. Testing shall be carried out at the following relative forward-velocities.

— 0 m/s

— 0,04 m/s

— 0,1 m/s

In addition, testing may be carried out at higher relative forward-velocities.

7 Test procedures

7.1 Preparations prior to testing

a) Prepare the required quantity of test oil ensuring that the oil properties are according to Table 1.

b) Measure and record oil properties as described in 9.2.

c) Locate skimmer in tank, as indicated in Figure 1 a).

d) Install oil-retaining barrier, or other means of keeping oil away from skimmer, prior to start.

e) Ensure that the requirements with respect to clearances specified in Clause 5 are met.

f) Preload the tank with the test oil, until the thickness required in Table 1 is obtained behind the oil-retaining barrier, ensuring that the skimmer remains in clear water.

g) The towing arrangement to provide forward motion for carrying out the motion test [see Figure 1 b)], should be installed in such a way that it does not adversely influence the test.

NOTE This does not apply when using a self-propelled skimmer.

7.2 Actions during testing period

a) Start the skimmer, offloading pump(s), and associated equipment; control and adjust the operating parameters to desired settings (speed, draft, etc).

b) Remove or open the oil-retaining barrier to allow the skimmer to fully access the oil.

c) For skimmer movement tests at relative forward-velocities in excess of 0 m/s, start the towing/propelling mechanism and adjust it to provide a relative forward-velocity as specified in 6.6.

d) When steady state is achieved, divert flow of the recovery fluid to the first measuring tank and maintain until the testing cycle is completed (see 10.1). Record the time at the start of the measuring period.

e) Subject to test tank length, and a steady state being maintained, divert the recovery flow to the next measuring tank.

f) Throughout the testing period, regularly monitor skimmer operating settings. Record any deviations from the required test conditions.

g) Once the measuring period is ended, divert flow away from the measuring tank. Record the time at the end of the measuring period.

h) Stop skimmer operation.

7.3 Actions after testing

a) Let the recovered fluid in the measuring tanks settle.

b) For each measuring tank, record

   1) total fluid quantity,

   2) quantity of free water, and

   3) quantity of oily phase.

c) Calculate the performance parameters given in Clause 8.

8 Performance parameters

8.1 General

Performance of the skimmer shall be defined by the parameters given in 8.2 to 8.4.

8.2 Fluid recovery rate

The fluid recovery rate (FRR) is given by

$$FRR = \frac{\text{recovered fluid}}{\text{time}}$$

where

"recovered fluid" is the total amount, in cubic metres, of fluid recovered;

"time" is the duration, in hours, of the collection period.

8.3 Oil recovery testing rate

The oil recovery testing rate (ORTR) is given by

$$\text{ORTR} = \frac{\text{recovered oily phase}}{\text{time}}$$

where

"recovered oily phase" is the total amount, in cubic metres, of oil recovered;

"time" is the duration, in hours, of the collection period.

8.4 Oil recovery efficiency

The oil recovery efficiency (ORE) is given by

$$\text{ORE} = \frac{\text{ORTR}}{\text{FRR}} \times 100\ \%$$

i.e. it is the ratio of ORTR to FRR, expressed as a percentage.

9 Measurements and reporting

9.1 General

This clause specifies those measurements to be recorded in the final report.

9.2 Oil properties

Measure the following test oil properties prior to testing:

a) viscosity, in centipoises, at the test temperature and at 20 °C (for comparison purposes) at shear rates of 1,10 s^{-1};

b) density, in kilograms per litre, at the test temperature and at 20 °C;

c) oil temperature, in degrees Celsius;

d) pour point, in degrees Celsius.

9.3 Environmental parameters

Measure and record the following environmental parameters for each test:

a) air temperature, in degrees Celsius;

b) water temperature, in degrees Celsius.

9.4 Skimmer operating parameters

The settings of the skimmer operating parameters shall be reported. Examples include

— speed of adhesion surface,

— pump speed,

— pump pressure,

— drafts, and

— angles of inclination.

9.5 Other test parameters

Other test parameters that shall be recorded include:

— oil quantity in the test tank, in cubic metres;

— clearances, in metres, to sides and tank bottom;

— slick thickness, in millimetres, before and after testing.

9.6 Recovery parameters

Record, for each test run, the following:

a) total recovered fluid, in cubic metres;

b) recovered oily phase, in cubic metres;

c) recovered water, in cubic metres;

d) duration, in minutes, of measuring period.

9.7 Performance parameters (calculated parameters)

Based on the recovery parameters (see 9.6), calculate and report the following performance parameters (see Clause 8):

— FRR;

— ORTR;

— ORE.

9.8 Equipment specification and test documentation

The test report shall include a technical specification of the skimmer unit tested and a narrative of the testing process. At a minimum, the technical specification shall include descriptions of the physical dimensions, construction materials, operating principle, power unit and power consumption.

10 Quality control

10.1 Test duration and fluid volume

The test measuring period (period that recovered liquid is collected in the measuring tank) shall be of sufficient duration to

a) even out possible variations in test conditions during the measuring period,

b) provide a sufficient volume of recovered fluid to allow for reliable readings of both oil and water volumes, and

c) perform the monitoring and recording requirements.

Table 3 specifies the minimum duration of the data collection period and the corresponding minimum recovered fluid volume for different expected skimming capacities (FRR). The prescribed fluid volumes and collection periods apply to each measuring tank.

Table 3 — Minimum duration of data collection period and recovered fluid volume for expected FRR

Expected FRR m^3/h	**Minimum recovered fluid volume** m^3	**Minimum data collection period** min
5	0,5	6
10	0,5	3
20	0,5	1,5
50	0,8	1
100	1,7	1
150	2,5	1
200	1,7	0,5
300	2,5	0,5

10.2 Repetitions

Performance data shall be based on a minimum of three tests performed under the same test conditions.

Bibliography

[1] ISO 21072-2, *Ships and marine technology — Marine environment protection: performance testing of oil skimmers — Part 2: Static water conditions*

[2] *Standard for Performance Testing of Oil Spill Skimmers*, Det Norske Veritas, 2002

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