SLOVENSKI STANDARD
oSIST prEN 17763:2021

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Centrifuge - Centrifuge za ladijska goriva - Določanje učinkovitosti ločevanja delcev in certificirane stopnje pretoka (CFR) pod določenimi preskusnimi pogoji

Centrifuges - Marine fuel centrifuges - Determination of particle separation performance and certified flow rate (CFR) under defined test conditions

Zentrifugen - Zentrifugen für Schiffskraftstoffe - Bestimmung der Partikelabscheideleistung und der zertifizierten Durchflussrate (CFR) unter definierten Testbedingungen

Centrifugeuses - Centrifugeuses à combustible pour la marine - Détermination des performances de séparation des particules et du débit certifié (CFR) dans des conditions d'essai définies

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Centrifuges - Marine fuel centrifuges - Determination of particle separation performance and certified flow rate (CFR) under defined test conditions

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 17763:2021) has been prepared by Technical Committee CEN/TC 313 “Centrifuges”, the secretariat of which is held by SIS.

This document is currently submitted to the CEN Enquiry.

Introduction

In general, diesel engines for propulsion of ships burn marine residual fuels. Marine residual fuels contain the residue remaining after lighter fractions have been extracted from the crude oil during various processes in the oil refinery. They are a blend of this heavy fraction to which other refinery stream products are added to obtain the desired viscosity grade. Marine residual fuel oils contain elements inherent to the product itself but they also contain some contaminants, which either are due to an external contamination or enter into the fuel at the refinery during production, such as catalyst fines which are small fragments of a catalyst, used in the catalytic cracking stage in order to cut long molecule chains into smaller molecule chains. The catalyst fines are extremely hard and abrasive, and, if not removed from marine residual fuel, can damage diesel engines with severe economic and, in extreme cases, safety consequences. The normal way of removing catalyst fines and other contaminants from marine residual fuel is by centrifugal separation.

It is important that all fuels are centrifuged efficiently to minimize the level of contaminants, including catalyst fines.

In bunkered oil the maximum content of catalyst fines, expressed as the total content of Aluminium and Silicon, is 60 mg/kg according to ISO 8217. Engine builders expect the level of catalyst fines to be reduced to below 10 mg/kg, only reaching to 15 mg/kg for short amounts of time in the fuel entering the engine. As the level of catalyst fines in the bunkered fuel is lowered, the engine builders expect a related reduction in the amount of catalyst fines in the fuel entering the engine.

For many years now there has been a demand from engine builders, ship builders, ship owners and classification societies for reliable performance criteria for the centrifuges' ability to remove abrasive particles from marine residual fuels. The purpose of this document is to meet this demand by specifying a repeatable method to determine separation performance with specific test particles in specific test oil.

1 Scope

This document specifies the procedure for the determination of the certified flow rate (CFR), a performance parameter for centrifuges, at specific fuel oil viscosities using a defined test oil and a defined test procedure.

This document is applicable to marine fuel centrifuges.

All values reported as CFR capacities are verified measured values on a defined CFR test bench.

Scaling based on Stoke's law and disc stack design is excluded from this document.

Separation efficiency is determined by a defined particle counting method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN ISO 3104, *Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity (ISO 3104)*

EN ISO 3675, *Crude petroleum and liquid petroleum products - Laboratory determination of density - Hydrometer method (ISO 3675)*

EN ISO 3838, *Crude petroleum and liquid or solid petroleum products - Determination of density or relative density - Capillary-stoppered pyknometer and graduated bicapillary pyknometer methods (ISO 3838)*

EN ISO 12185, *Crude petroleum and petroleum products - Determination of density - Oscillating U-tube method (ISO 12185)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
separation efficiency
measure of a centrifuge's capability to remove test specific contaminants

Note 1 to entry: The separation efficiency, η, is calculated as follows:

$$\eta = 100 \cdot (1 - C_{out}/C_{in}) \tag{1}$$

where

η is separation efficiency in %;

C_{out} is number of the test specific particles in cleaned test oil;

C_{in} is number of the test specific particles in test oil before centrifuge.

3.2
certified flow rate
CFR
rate of flow under defined conditions

Note 1 to entry: Certified Flow Rate is determined at a certain time after sludge discharge, at which the separation efficiency of the centrifuge is 85 %, using a specific test oil and specific test particles under specific test conditions. The Certified Flow Rate is expressed in l/h.

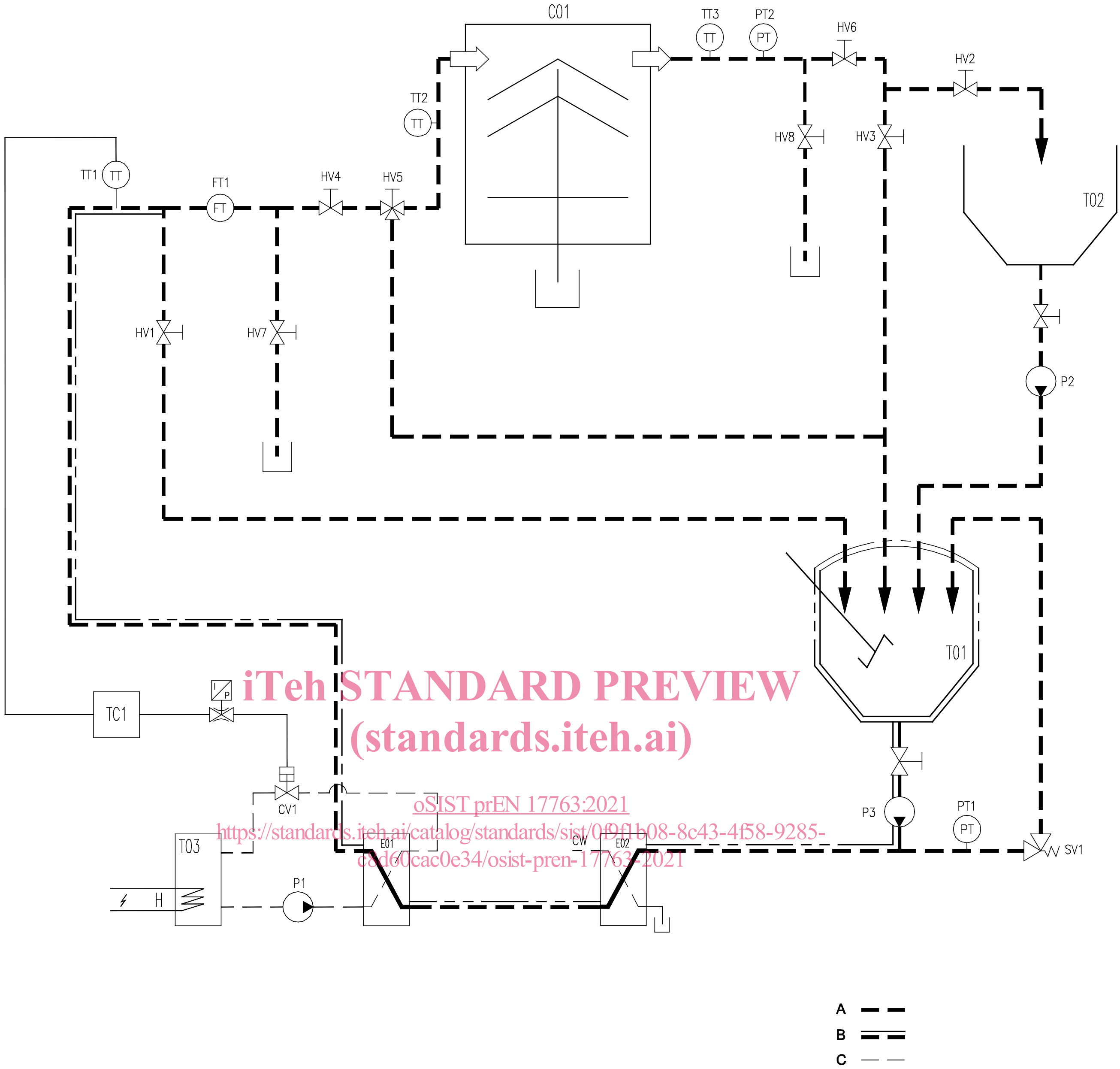
3.3
density difference
difference of density between particles and oil

Note 1 to entry: Where the difference of density deviates from the nominal values correction for the deviation shall be made as described in 6.3.

4 Test arrangements

4.1 Test equipment

General arrangement of the test equipment is shown in Figure 1.



Key

T01	system tank or mixing tank (sufficient size for test run without refilling) with stirrer
T02	reception tank (sufficient size to match T01)
T03	hot water tank
E01	heat exchanger (used for heating)
E02	heat exchanger (used for cooling)
P1	hot water pump (centrifugal type)
P2	regeneration pump
P3	system pump or circulation pump (adjustable screw pump)
C01	centrifuge
SV1	safety relief valve
CV1	control valve
I/P	I/P converter
TC1	temperature controller (PID type)

TT	temperature transmitter
TT1	temperature transmitter and sensor (combined accuracy ±0,1 °C)
TT2	temperature transmitter and sensor (combined accuracy ±0,1 °C)
TT3	temperature transmitter and sensor (combined accuracy ±0,1 °C)
PT	pressure transmitter
PT1	pressure transmitter (accuracy ±0,1 bar)
PT2	pressure transmitter (accuracy ±0,1 bar)
FT	flow meter
FT1	flow meter (screw type) (accuracy ±1 %)
H	heating coil
CW	cold water
HV1	regulating valve
HV2	stop valve
HV3	stop valve
HV4	regulating valve
HV5	3-way valve
HV6	regulating valve
HV7	sample valve
HV8	sample valve (always open during test)
A	oil pipe
B	oil pipe, insulated
C	water pipe

Figure 1 — Test rig

4.2 Test media

4.2.1 Test oil specification

The test oil shall be an automotive lube oil of type PAO 6.

NOTE PAO 6 is a polyalphaoleofin oil used as a base for synthetic lubricating oils.

4.2.2 Test oil kinematic viscosity

The kinematic viscosity of the test oil shall be measured according to EN ISO 3104. The kinematic viscosity shall be expressed as:

$$\upsilon = 10^{10^{A} / T} + C \qquad (2)$$

where

υ	the kinematic viscosity in mm²/s;
T	is the temperature in Kelvin (K);
A, B and C	are constants related to the actual test oil.

The formula shall be used with three accurately measured values of temperature and corresponding viscosities for finding A, B and C. The chosen temperatures should for practical reasons be one at each end of a measuring range of about 20 °C to 60 °C, and one in between. The formula shall then be used again for determining the two correct temperatures for the desired viscosities (see 5.1) for the tests. The viscosity shall be measured after adding the dispersant in 4.2.4. The calibration certificates of both viscosity and temperature meter shall be added to the final report.

4.2.3 Test oil density

The test oil density shall be measured according to EN ISO 3838 or EN ISO 3675 or EN ISO 12185 at the two temperatures at which tests are to be made, taking into account appropriate corrections. The choice of which document to be used shall be based on the equipment used by the laboratory that executes the test.

4.2.4 Test oil dispersing additive

To achieve the dispersing properties of the test medium, a minimum amount of an appropriate dispersing additive of borated bis-succinimide type can be added to the PAO 6 type oil base. No more additive than what is necessary to disperse the particles shall be added (suggested addition is 0,3 % by weight). The density and the viscosity of the test medium in tank T01, see Figure 1, shall be measured after the dispersing additive has been added.

4.2.5 Test particle specification

To simulate catalytic fines and other fuel contaminants, monodispersed plastic 5 µm particles (spheres) with a composition of 45 % polystyrene and 55 % divinylbenzene shall be used. The density of the spheres shall be (1 050 ± 10,5) kg/cm³. The size variation shall not be more than ± 2,5 %, equal to ± 0,125 µm. The actual density and size of the particles shall be measured. If the size deviates from the nominal 5,00 µm but is within the accepted limit 5,00 µm ± 0,125 µm, a correction for the deviation shall be made as described in 6.3.

5 Performance test

5.1 Oil viscosity

To simulate a typical heavy fuel of 380 mm²/s at 50 °C and a maximum density of 1 010 kg/m³, the test oil shall be heated to the temperature corresponding to a viscosity of 35 mm²/s ± 1,4 mm²/s according to the method described in 4.2.2. Where the viscosity during tests deviates from the nominal value of 35 mm²/s but is within the accepted limit 35 mm²/s ± 1,4 mm²/s, correction shall be made as described in 6.3.

To simulate a typical heavy fuel of 700 mm²/s at 50 °C and a maximum density of 1 010 kg/m³, the test oil shall be heated to the temperature corresponding to a viscosity of 55 mm²/s ± 2,2 mm²/s according to the method described in 4.2.2. Where the viscosity during tests deviates from the nominal value of 55 mm²/s but is within the accepted limit 55 mm²/s ± 2,2 mm²/s, correction shall be made as described in 6.3.

5.2 Particle concentration

For the purposes of this specification, the particle concentration in oil feed to the centrifuge shall be 30 g ± 3 g of test particles per 1 000 kg of oil.

5.3 Dispersing of particles into test medium

The particles shall first be dispersed into a small volume of oil using continuous stirring together with ultrasonic treatment. This stock solution shall then be blended into the oil in the test rig and further mixed to homogenous concentration in whole tank T01, see Figure 1, before starting the test.

For the verification of complete dispersion of the particles, microscopic analysis of the particles shall be used. If a total dispersion is not obtained, a dispersing agent should be used (see 4.2.4).

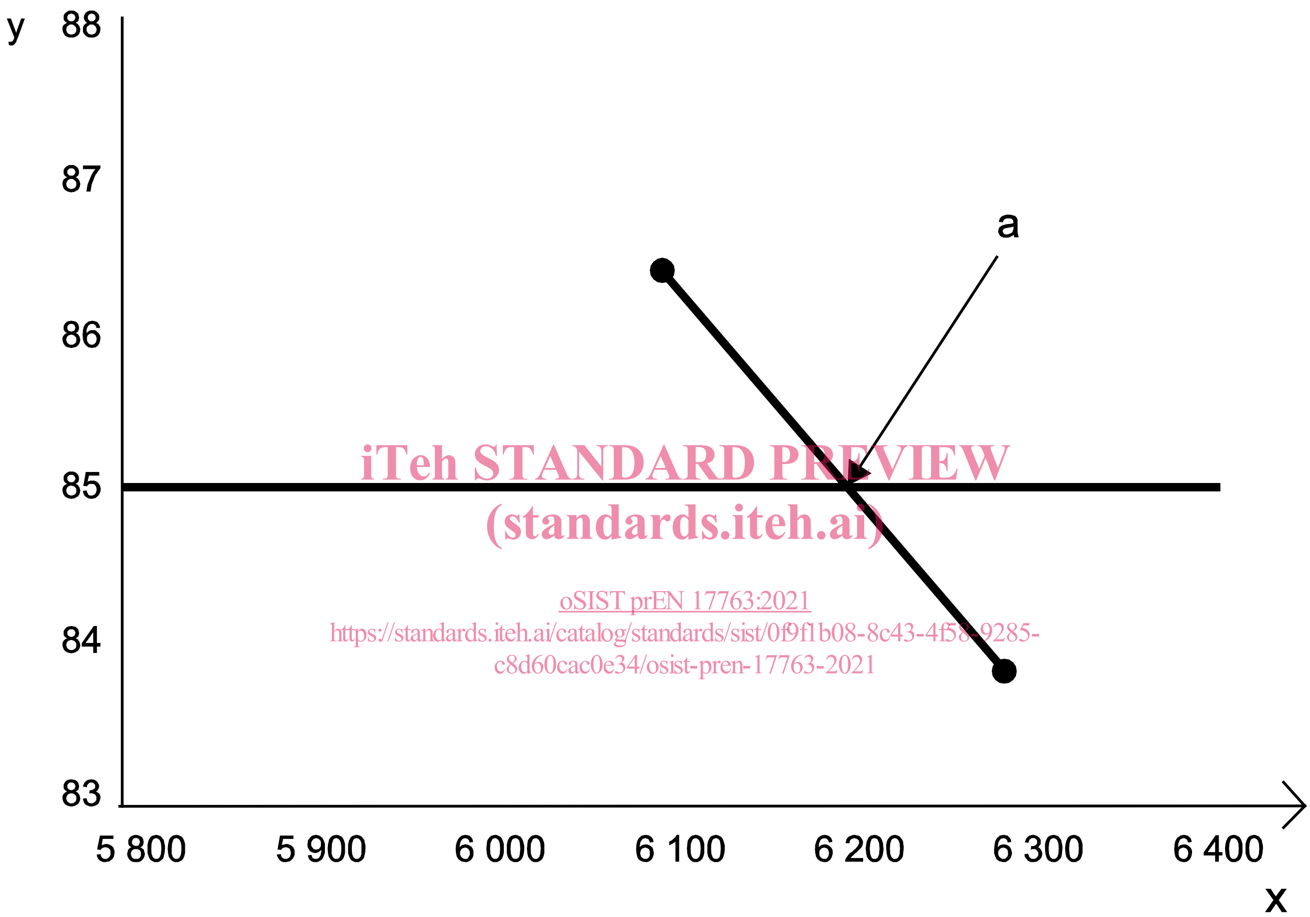
The lines shall be flushed at least two times with pump P3 via valve HV5 within 1 h before start of test.

An example of how to disperse the particles can be found in Annex A.

5.4 Test sequence

The objective of the testing is to find the CFR for the viscosity in question.

Testing shall be performed at two or more flow rates in order to determine the efficiency graph in way of the 85 % point. One or more points shall be positioned in the efficiency range from 85 % to 90 % and the other point(s) shall be positioned between 80 % and 85 %. The CFR shall be found by linear interpolation between these points, at the 85 % point, see Figure 2.



Key

a CFR at the 85 % efficiency

x flow through the centrifuge expressed in l/h

y separation efficiency expressed in %

Figure 2 — Separation efficiency/Flow rate

5.5 Test procedure

The following test procedure shall be performed, see Figure 1 for the references:

a) set the temperature controller to the correct value for the desired viscosity (see 4.2.2);

b) set valve HV5 to bypass;