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Hydraulic fluid power — Method for evaluating water separation performance of dehydrators

Déshydrateurs fluides hydrauliques — Méthode d'évaluation des performances de séparation de l'eau

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

Introduction

In hydraulic fluid power systems, one of the functions of the hydraulic fluid is to separate and lubricate the moving parts of components. The presence of water contamination in the lubricant causes corrosion, loss of lubrication properties, increased oxidation rates, worse filterability, reduced filter service life and produces wear, resulting in loss of efficiency, reduced component and hydraulic fluid life and subsequent unreliability.

Hydraulic fluid dehydration equipment is used to remove the water contamination from these hydraulic fluids to well below the hydraulic fluid's water saturation level. Hydraulic fluid dehydrators are usually self-contained systems, designed to perform the function of water removal from a body of hydraulic fluid using different types of principles and methodologies. This document provides a procedure by which to evaluate the water removal performance of the various types of hydraulic fluid dehydrators in a well-defined, repeatable manner. This enables the purchaser of the hydraulic fluid dehydrator to compare the available products evaluated using the same test procedure.

Hydraulic fluid power — Method for evaluating water separation performance of dehydrators

1 Scope

This document specifies:

— test equipment, test circuit and a procedure for the evaluation of the water separation capabilities of a dehydrator;

— a procedure for preparing test fluid;

— a procedure for obtaining and analysing the test fluid samples.

This document applies only to those dehydration units that can dry a hydraulic fluid to less than 20 % of the hydraulic fluid's water saturation level at the test temperature.

This document provides a test procedure that yields reproducible results for dehydrator water removal performance so that the performance of candidate units is compared on the same basis using the same test fluid.

This procedure can be used to test the dehydrator's capabilities on different types of hydraulic fluids at different conditions. Parts of the procedure might need to be changed to suit the hydraulic fluid's characteristics. For example, the testing of hydraulic fluids with high water solubility (many synthetic and fire-resistant fluids) needs higher concentrations of water at the start of the test; the testing of hydraulic fluids with zinc-based additives needs modifications to the Karl Fischer analysis procedure. However, comparison of performance can be made under the conditions defined in this document.

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.

ISO 760, *Determination of water — Karl Fischer method (General method)*

ISO 1219-1, *Fluid power systems and components — Graphical symbols and circuit diagrams — Part 1: Graphical symbols for conventional use and data-processing applications*

ISO 4021, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6743-5, *Lubricants, industrial oils and related products (class L) — Classification — Part 5: Family T (Turbines)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and the following apply.

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

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

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

3.1
hydraulic fluid dehydrator
self-contained system designed to perform the function of water removal from a bulk supply of hydraulic fluid

3.2
hydraulic fluid water saturation level
water concentration level, at a given temperature, beyond which the hydraulic fluid is unable to dissolve any additional water

Note 1 to entry: Any addition of water beyond this limit results in free water or an emulsion formed.

3.3
safety data sheet
SDS
specification sheet defining physical aspects, characteristics and health and safety data for a substance

3.4
relative hydraulic fluid water saturation level
% saturation
hydraulic fluid actual water concentration divided by its water saturation level

Note 1 to entry: Expressed as a percentage.

4 Symbols

The graphical symbols used in this document are in accordance with ISO 1219-1.

5 Principle of test

The hydraulic fluid dehydrator is connected to the test rig containing a volume of test fluid that is related to the rated flow of the dehydrator. The dehydrator and a circulating pump are switched on and the test fluid temperature is raised to the test temperature of 50 °C. With the dehydrator isolated and the circulation pump on, a portion of the test fluid is contaminated to give a water concentration in the rig of 3 % by weight. The test fluid and water are emulsified using a water mixer and then added to the reservoir. Dehydration of the test fluid is initiated and samples of test fluid are regularly taken for water content analysis and the dry-up is monitored. The process continues until the moisture level is below 20 % of the test fluid saturation level. The test is carried out in an environment controlled to a temperature of between 22 °C and 25 °C and moisture content of (55 ± 15) % relative humidity (RH). The performance of the dehydrator is based upon the time required to remove free and dissolved water expressed in a three-part code.

6 Apparatus

6.1 General

The test set-up shall incorporate the following design characteristics. See Annex A for a typical test circuit that provides satisfactory results.

6.2 Test fluid reservoir, incorporating the following features.

6.2.1 It shall be of cylindrical form with a conical bottom whose included angle is between 60° and 90°.

6.2.2 The test fluid shall be drawn from the outlet at the centre of the conical bottom and returned via a hose or pipe to the reservoir. The return shall discharge below the fluid surface and be fitted with a diffuser.

6.2.3 It shall be of sufficient size to hold the test fluid volume required, based upon the dehydrator flow rate. The total test fluid volume, V, shall have a value in litres numerically equal to three times the dehydrator flow rate, q, expressed in l/min. A tolerance of ±10 % is permissible for the test fluid volume, but the actual volume shall be measured and recorded within an accuracy of ±3 %.

A number of reservoirs may be required to cover the range of dehydrators to be tested using this document.

NOTE The circulation time (time = V/q) is set at 3 min to be representative of service conditions and to provide a suitable time for the conduct of the test.

6.2.4 It shall have a lid to cover the opening, but with a suitable opening to allow for the returned sample flow.

6.3 Circulation pump

6.3.1 It shall be a positive displacement type suitable for the required circulation pressure and fitted with a relief valve, either integral or external.

6.3.2 It shall have a variable flow with a maximum of at least twice the flow rate of the dehydrator under test.

6.4 In-line heater, capable of maintaining the test fluid temperature within the limits detailed in Table 1. If the heating elements in contact with the test fluid are electric, the energy density at the surface of the elements shall be no more than 3 W/cm^2. It shall have a safety shut-off thermostat to prevent overheating the test fluid. The installation of a safety switch which disconnects the heater in case of no or low flow through the heater is recommended. Insufficient flow could lead to local overheating of the test fluid.

6.5 Temperature controller, incorporating a temperature sensor that drives a control circuit to maintain the test fluid temperature within 2 °C of the set point.

6.6 Temperature sensor, mounted in the suction line leading to the pump.

6.7 Water sensor (WS), of the thin-film capacitance type that is capable of detecting the relative water saturation level of the test fluid. The water sensor shall be installed through a port in a vertical section of the pipe work in the suction line to the pump.

6.8 Interconnecting pipe work, suitably sized to promote good mixing conditions and constructed such that dead zones or quiescent areas where water could settle out are eliminated. Mixing conditions are ensured when the Reynolds number (Re) is >3 000 in a multi-purpose rig; however, this might not be possible. In these cases, the pipe runs should be kept to a minimum and a mixer/valve interspersed where long pipe runs exist. The design of the reservoir and other test equipment should allow for easy draining of the system, including the installation of drain valves at the lowest points.

6.9 Water mixer, used in the preparation of the test contaminant and fitted with an emulsifying head. The size of the dispersion blade shall be suitable for the volume to be mixed.

NOTE A dispersion blade of 100 mm diameter, rotating at 5 000 r/min minimum, has proved satisfactory for mixing volumes of up to 10 l.

6.10 Karl Fischer (KF) titrator, for determining the absolute water concentration of the fluid samples obtained during the test. The compatibility of the KF reagent with the test fluid shall be confirmed before testing.

6.11 Sampling valve, for the extraction of test fluid samples during the test. The valve shall conform to ISO 4021 and be suitable for low pressure locations. It is recommended that the valve outlet be piped back to the reservoir to provide a continuous flow as this overcomes the need for repeated flushing cycles.

6.12 Sample bottles, for the analysis of samples of test fluid during the test.

They shall**:**

— have a threaded cap and internal seal;

— have a volume between 100 mL and 300 mL;

— be cleaned to remove all traces of previous fluids and be free of moisture;

— be a clear glass bottle with a flat bottom.

6.13 Syringe, for dispensing samples of test fluid into the KF titrator. It shall be clean and dry and calibrated if volumetric measurements are used.

6.14 Test fluid, ISO VG 32 grade mineral oil conforming to L-TSA in accordance with ISO 6743-5 (see Annex B for the specification). A SDS shall be made available. (See Annex C for test fluid quality check information.)

NOTE This test fluid can be re-used.

7 Accuracy of measuring instruments and test conditions

7.1 Use and maintain measuring instrument accuracy and test condition variations within the limits given in Table 1.

Table 1 — Accuracy of measuring instruments and test conditions

Test parameter	**Unit**	**Instrument accuracy** (± of actual value)	**Permitted variations in test conditions** (± of target value)
Volume	l	3 %	10 %
Gauge pressure	kPa[a]	2 %	5 %
Flow rate	l/min	2 %	5 %
Test fluid temperature	°C	1 °C	2 °C
Environmental moisture content	% RH	1 %	(55 ± 15) %
Environmental temperature	°C	1 °C	22 °C to 25 °C
Water sensor	% saturation	3 %	n/a

[a] 100 kPa = 1 bar

8 Summary of information required prior to testing

8.1 Manufacturer, part number and serial number of the dehydrator unit to be tested and the effective flow rate.

8.2 Hydraulic fluid, used for the test if different to that specified in 6.14.

NOTE If a different fluid is used, then the performance obtained can only be compared to other dehydrators that have been tested using the same hydraulic fluid under identical conditions.

8.3 Test fluid temperature.

8.4 Vacuum setting and any other user-adjustable dehydrator parameter to be used for the test.

8.5 Sampling frequency for the test, the time interval between samples shall be selected so that at least four samples are obtained from the start to the 100 % saturation point. This is to ensure that this dry-up curve is adequately described. The period between samples can either be selected from previous tests or estimated from the presumed free water removal rate of the dehydrator.

NOTE 1 A sample at the 100 % saturation level is ideal, but not essential, as the time to this level is obtained by interpolation on to the dehydration curve (see 10.3).

NOTE 2 Although sampling below the 100 % saturation level is not required as the moisture level is measured by the water sensor, samples can be taken.

8.6 Temperature and relative humidity (% RH), in the vicinity of the dehydrator. If the dehydrator involves the introduction of air into the system, the air inlet to the dehydrator shall be used as the location for these measurements. See Table 1 for test conditions.

9 Dehydrator performance test

9.1 Preliminary preparation

9.1.1 Ensure that the total fluid volume that is required for the performance test has been accurately determined. If not, perform this function on the fill with test fluid in 9.1.6. Any filter element shall be removed from the purifier, as they could have a negative impact on the dewatering efficiency, e.g. due to cellulose-based elements that will absorb water. Only metal mesh suction strainers are acceptable.

9.1.2 If the dehydrator and test rig already contain either previously used test fluid or a hydraulic fluid meeting, the requirements as stated within 6.14, continue to 9.1.6, otherwise proceed to 9.1.3.

9.1.3 If the dehydrator and test rig contain any other hydraulic fluid, completely drain both the dehydrator and test rig. The fluid may be retained for other purposes, if required. Reconnect the purifier to the test rig and add sufficient test fluid (6.14) into the reservoir so that all internal wetted surfaces are flushed with test fluid when both pumps are running. Run the pumps and heater until the normal test temperature (50 °C) is reached. Ensure that all bypass lines, relief valve lines and sample lines are flushed.

NOTE If any of the apparatus contains hydraulic fluid of higher viscosity grade than the test fluid, it might be necessary to flush using the test fluid at the higher temperature of 60 °C.

9.1.4 After flushing, completely drain both the dehydrator and test rig, disconnect hoses and pipe work, if necessary and discard the fluid. Take the necessary precautions for handling hot liquid.

9.1.5 Repeat the drain and flush as per 9.1.3 and 9.1.4.

NOTE Failure to flush and clean thoroughly can lead to spurious results and problems such as foaming of the test fluid.

9.1.6 Reconnect all hoses and pipe work, isolate the dehydrator and fill into the reservoir the volume of test fluid calculated in 6.2.3 calibrating the test facility during this process if required.

9.1.7 Start the circulation pump on its lowest flow and purge the circulation loop of air by gradually increasing the flow rate to twice the dehydrator's rated flow.

