Designation: D7752 – 18

Standard Practice for Evaluating Compatibility of Mixtures of Hydraulic Fluids[1]

This standard is issued under the fixed designation D7752; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice covers the compatibility of mixtures of hydraulic fluids as defined by Specifications D6158, DIN 51524, ISO 11158, and ISO 15380.

1.2 This practice can be used to evaluate new (unused) lubricant compatibility or the effects of combining new (replacement) lubricant with in-service (original) lubricant in the system.

1.3 To evaluate primary compatibility using this method, the replacement fluid must pass the ISO 13357-1 Stage II filterability test. The original fluid is not required to pass ISO 13357-1 filterability test, Stage I or II.

1.4 Primary testing is conducted on fluid mixtures in 2:98, 10:90, and 50:50 ratios using the ISO 13357-1 Filterability Test, Stage II.

1.5 Secondary testing is suggested when circumstances indicate the need for additional testing.

1.6 This practice does not evaluate the wear prevention characteristics, load carrying capacity, or the mechanical shear stability of lubricant mixtures while in service. If anti-wear (AW), extreme pressure (EP), or shear stability are to be evaluated, further testing of these parameters may be required.

1.7 This practice does not purport to cover all test methods that could be employed.

1.8 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D665 Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water

D892 Test Method for Foaming Characteristics of Lubricating Oils

D974 Test Method for Acid and Base Number by Color-Indicator Titration

D1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids

D2270 Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 °C and 100 °C

D3427 Test Method for Air Release Properties of Hydrocarbon Based Oils

D6158 Specification for Mineral Hydraulic Oils

D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

2.2 *ISO Standards:*[3]

11158:2009 Lubricants, industrial oils and related products (class L)—Family H (hydraulic systems)—Specifications for categories HH, HL, HM, HR, HV and HG

13357-1:2002(E) Petroleum Products—Determination of the filterability of lubricating oils—Part 1: Procedure for oils in the presence of water

13357-2:2005(E) Petroleum Products—Determination of the

[1] This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.N0 on Hydraulic Fluids.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**

filterability of lubricating oils—Part 2: Procedure for dry oils
15380:2011 Lubricants, industrial oils and related products (class L)—Family H (Hydraulic systems)—Specifications for categories HETG, HEPG, HEES, and HEPR
4788 Laboratory glassware—Graduated measuring cylinders

2.3 *DIN Standards:*[4]
DIN 51524 Pressure fluids—Hydraulic oils—Parts 1–3

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *2:98 mixture, n*—a uniform blend of 2 % by weight of original fluid with 98 % by weight of replacement fluid.

3.1.2 *10:90 mixture, n*—a uniform blend of 10 % by weight of original fluid with 90 % by weight of replacement fluid.

3.1.3 *50:50 mixture, n*—a uniform blend of 50 % by weight of each of two component fluids.

3.1.4 *compatibility, n*—of hydraulic fluids, the ability of hydraulic fluids to mix together without significant degradation of properties or performance.

3.1.4.1 *Discussion*—Compatibility will be determined using the ISO 13357-1 filterability test. When a mixture passes the Stage II filterability designation as specified in the ISO 13357-1 test, the mixture is considered compatible at the tested ratio by the primary testing procedure. If this practice is to be used for adding new (replacement) to in-service (original) and the system is not drained (for example, top-up), two additional ratios will be required, 10:90 and 2:98. Depending on the ratios that have passed the test, flush quantities are given in Annex A1.

3.1.5 *fail, n—in secondary compatibility testing of hydraulic fluid mixtures*, a test result that is inferior to that of the poorer of the two constituent fluids.

3.1.6 *original fluid, n*—fluid that the system is being converted from.

3.1.7 *pass, n—in secondary compatibility testing of hydraulic fluid mixtures*, a test result that is equal to or better than that of the poorer of the two constituent fluids.

3.1.8 *primary testing, n*—Two constituent fluids are combined at 2:98, 10:90, and 50:50 ratios by weight. The fluid mixtures are prepared, aged, and evaluated for changes in filterability using the procedure described in ISO 13357-1.

3.1.9 *replacement fluid, n*—fluid that the system is being converted to.

3.1.10 *secondary testing, n*—Mixtures of the fluids are prepared following ISO 13357-1 samples and sampling section and evaluated for changes in the parameters detailed in 7.4.

3.1.11 *type, n*—type refers to lubricant base stock and additive composition. For example, Rust and Oxidation Inhibited fluid (R & O) versus antiwear (AW).

[4] Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, http://www.din.de.

4. Summary of Practice

4.1 *Option 1*—Prepare a 2:98 mixture of two fluids to be evaluated for compatibility. This mixture and the two neat, constituent fluids are tested using the primary compatibility test. If the 2:98 does not pass ISO 13357-1 Stage II requirement, secondary tests may be run or a different replacement fluid should be considered. If the 2:98 mixture passes, the 10:90 and 50:50 ratios should be tested.

4.2 *Option 2*—Instead of testing mixtures in sequential order, 50:50 and 10:90 mixtures are tested at the same time the 2:98 mixture is evaluated. Such tests can be run concurrently, if desired. If all mixtures pass the primary ISO 13357-1 test, no further testing is required. If the 2:98 mixture does not pass, or the application requires the evaluation of specific properties, secondary compatibility tests can be employed for further evaluation.

5. Significance and Use

5.1 Hydraulic fluid compatibility is important to hydraulic equipment users because a mixture of incompatible fluids may produce a substance that is markedly inferior to its constituents. Even in identical base stocks, the formation of a precipitate may occur as a result of additive interactions. In this practice, compatibility will be determined using ISO 13357-1 filterability test method. Since hydraulic systems utilize fine-filtration to protect components from wear, incompatibility often exhibits itself as premature filter plugging.

5.2 Because of such occurrences, suppliers recommend evaluating the compatibility of hydraulic fluids prior to mixing. A flowchart is provided in Annex A1 to aid in interpretation of the test results and hydraulic system conversion.

5.3 Although new hydraulic fluids may be compatible, in-service fluid of the same type may be degraded or contaminated to such an extent that the new fluid added may not be compatible with the system fluid. In-service fluid compatibility with new fluid additions should be evaluated on a case by case basis.

5.4 The oxidation resistance and wear protection of different fluids of the same type can vary widely, and compatibility does not imply equivalent performance.

6. Apparatus

6.1 The equipment and materials required for this practice shall be those required by the test methods used to evaluate compatibility.

6.1.1 *Laboratory Oven,* static-air or stirred-air type, capable of maintaining the test temperature within ±2 °C and equipped with one or more grill-type wire shelves.

6.1.2 *Filtration Apparatus,* stainless steel, consisting of a lidded funnel of at least 350 mL capacity and a funnel base with filter support, such that a membrane filter (6.1.3) can be clamped between the sealing surfaces of the funnel and the base by means of a metal clamp or other suitable gas-tight closure. The apparatus shall be grounded (earthed), and suitable electrical bonding of the parts shall be provided. The effective filtration area shall be 1130 mm^2 ± 60 mm^2. A suitable schematic may be found in the ISO 13357 standard.

6.1.3 *Membrane Filters,* of mixed cellulose esters, diameter 47 mm and mean pore size 0.8 µm. Membranes of an equivalent specification to Millipore filter membranes, catalogue number AAWP 04700, have been found satisfactory.

6.1.4 *Measuring Cylinders,* of 250 mL capacity, of borosilicate glass, conforming to the requirements of ISO 4788. This cylinder shall be permanently marked with further graduation marks at 10 mL and 300 mL. A second cylinder, capable of measuring 330 mL ± 5 mL, is also required for sample transfer. The procedure for adding extra graduations to a cylinder can be found in ISO 13357, Annex A.

NOTE 1—The 250 mL measuring cylinder has a capacity in excess of 300 mL, allowing the extra graduations to be added. The use of a larger measuring cylinder for the filtration process would not give adequate precision for the test.

6.1.5 *Pressure Gauge,* dial or digital type, capable of reading the required delivery pressure ±5 kPa.

6.1.6 *Forceps,* spade-ended.

6.1.7 *Timing Device,* electronic or mechanical, capable of reading to the nearest 0.2 s, and fitted with a dual-stop facility.

6.1.8 *Petri Dishes,* loosely covered.

6.1.9 *Bottles,* of 500 mL capacity with screw caps. The exact shape of the bottle is not important; however the cap shall have the ability to seal tightly to prevent water evaporative loss. The neck should be fairly narrow, but shall be wide enough to accept the stirrer (6.1.10). The base of the bottle shall be fairly flat.

6.1.10 *Motor and Stirrer*—conforming to the requirements of Test Method D1401, subsection 5.3.

6.1.11 *Pipettes:*

6.1.11.1 Pasteur or dropping pipettes.

6.1.11.2 1 mL graduated pipettes.

6.1.12 *Laboratory Hot Plate,* with temperature probe and magnetic stirring mechanism to constantly stir mixtures at 70 °C ± 2 °C.

7. Procedure

7.1 Either of two testing options can be used-the sequential testing protocol described in Option 1 (4.1), or the concurrent testing protocol described in Option 2 (4.2). Using Option 1, a 2:98 mixture and the two constituent fluids are tested using the primary compatibility test. If this mixture passes the Stage II filterability test, tests must be conducted on the 10:90 mixture (Annex A1). If the 2:98 mixture does not pass the Stage II filterability test, secondary testing is optional but no more primary testing should be done. Using Option 2, all mixtures (2:98, 10:90, and 50:50) and the two constituent fluids are tested concurrently. By using Annex A1, the results can be analyzed and flushing requirements can be determined.

7.2 *Preparation of Mixtures (Primary and Secondary)*—Prepare mixtures similarly, regardless of whether one or three mixtures of differing ratios will be tested sequentially or concurrently.

7.2.1 Heat the constituent fluids separately in a laboratory oven at 70 °C ± 2 °C for 1 h. Remove the fluids from the oven. Stir and allow them to cool, to <50 °C. Combine the fluids in the weight ratios (2:98, 10:90, and 50:50) required by the test. Stir each mixture on a hot plate at 70 °C for 1 h.

7.2.2 Store the mixtures in a dark, room temperature environment for at least 24 h before following the procedure described in ISO 13357-1.

NOTE 2—A longer storage time may be employed with agreement between the parties involved.

7.3 *Primary Testing*—Follow the procedure described in ISO 13357-1 to determine the filterability of the mixture. Use steps 7.3.1 – 7.3.3 in conjunction with the flowchart in Annex A1 to analyze test results and make flushing decisions.

7.3.1 If the 2:98 mixture fails, no further testing is required unless the option to perform secondary testing is desired.

7.3.2 If the 2:98 passes the ISO 13357-1 Stage II filterability test , the 10:90 and 50:50 mixtures must be evaluated.

7.3.3 If all tested ratios pass the Stage II filterability test, the results should be reported as compatible at the tested ratios, that is, the replacement fluid is compatible with the original fluid at 2:98, 10:90, and 50:50 ratios.

7.3.4 Use the decision tree in Annex A1 to evaluate the results.

7.4 *Secondary Testing*—If resources permit, the specified tests can be performed concurrently. Otherwise, any sequence of these tests may be used.

7.4.1 *Viscosity*—Determine and record the viscosity of the mixture as described in Test Method D445 or D7042.

7.4.1.1 The mixture is considered to be compatible, and its results shall be recorded as *pass* if the viscosity is that of either constituent fluid or if it is between them. If the viscosity of the mixture is less than the lower viscosity fluid or greater than higher viscosity fluid by an amount greater than repeatability of the test method, record as *fail*. The temperature at which the viscosity is performed to determine the ISO Viscosity Grade is 40 °C. To obtain the viscosity index, in accordance with Practice D2270, an additional viscosity determination must be performed at 100 °C.

7.4.2 *Acid Number*—Determine and record the acid number of the mixture as described in Test Methods D664 or D974.

7.4.2.1 The mixture is considered to have passed if the acid number of the mixture is between or equal to either constituent fluid. Record as *pass*. If the acid number of the mixture is less than or greater than the constituent fluids by an amount greater than repeatability of the test method, record as *fail*.

7.4.3 *Foaming Characteristics*—Determine and record the foaming characteristic of the mixture as described in Test Method D892.

7.4.3.1 The mixture is considered to be compatible if the foaming characteristic of the mixture is equal to or less than either constituent fluid. Record as *pass*. If the foaming characteristic of the mixture is greater than the constituent fluids by an amount greater than repeatability of the test method, record as *fail*.

7.4.4 *Air Release Properties*—Determine and record the air release properties or the mixture as described in Test Method D3427.

7.4.4.1 The mixture is considered to be compatible if the air release properties of the mixture is equal to or less than either constituent fluid. Record as *pass*. If the air release properties of

the mixture is greater than the constituent fluids by an amount greater than repeatability of the test method, record as *fail*.

7.4.5 *Water Separability*—Determine and record the water separability results of the mixture as described in Test Method D1401.

7.4.5.1 The mixture is considered to be compatible if the water separability of the mixture is equal to or better than either constituent fluid. Record as *pass*. If the water separability of the mixture is worse than the constituent fluids by an amount greater than repeatability of the test method, record as *fail*.

7.4.6 *Oxidation Stability*—Select the appropriate oxidation stability test based on the type of lubricant being investigated.

7.4.6.1 Determine and record the oxidation stability as described in the selected test method. The mixture is considered to be compatible if the oxidation stability of the mixture is equal to or higher than either constituent fluid. Record as *pass*. If the oxidation stability of the mixture is lower than the constituent fluids by an amount greater than repeatability of the test method, record as *fail*.

7.4.7 *Rust Prevention*—Determine and record the rust prevention results as described in Test Method D665.

7.4.7.1 The mixture is considered to be compatible if the rust prevention characteristics test is a pass. Record as *pass*. If the rust prevention characteristic test of the mixture is a fail, record as *fail*.

7.4.8 *Copper Corrosion*—Determine and record the copper corrosion results as described in Test Method D130.

7.4.8.1 The mixture is considered to be compatible if the copper corrosion characteristics test is equal to or better than either of the constituent fluid alone. Record as *pass*. If the copper corrosion characteristics of the mixture is a fail, record as *fail*.

8. Report

8.1 Report the following information:

8.1.1 Identity of the constituent fluids and the ratios of the mixtures tested.

8.1.2 Whether the constituent fluids and mixtures passed the Stage II filterability, and if a passing result was found, report the average Stage II filterability for that mixture.

8.1.3 Using Annex A1, report the amount of flushes required based upon which mixtures passed the Stage II filterability tests.

8.2 If supplementary testing procedures were used, report the constituent fluids, ratios, and test methods whether the fluids passed or failed.

9. Precision and Bias

9.1 For complete precision and bias statements, see the pertinent test methods.

10. Keywords

10.1 compatibility; filterability; hydraulic fluid; mixtures

ANNEX

(Mandatory Information)

A1. FLOWCHART FOR PRIMARY TESTING FOR COMPATIBILITY OF HYDRAULIC FLUIDS

A1.1 See Fig. A1.1.

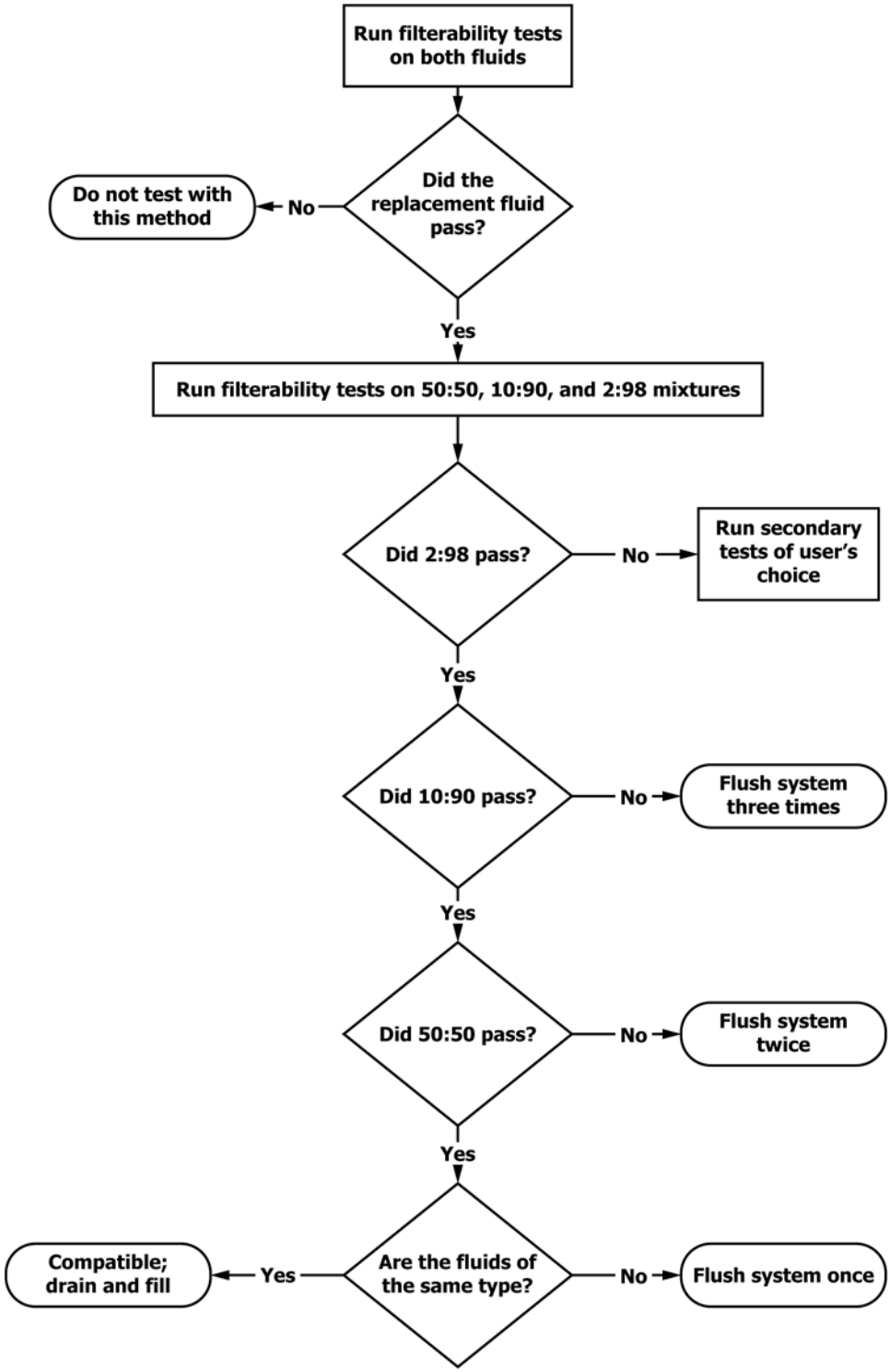

FIG. A1.1 Flowchart for Hydraulic Fluid Compatibility Testing

SUMMARY OF CHANGES

Subcommittee D02.N0 has identified the location of selected changes to this standard since the last issue (D7752 – 11) that may impact the use of this standard. (Approved March 1, 2018.)

(1) Added Test Method D7042 to Referenced Documents and to subsection 7.4.1.