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An American National Standard

Standard Test Method for Evaluation of Fluids for Effects on Friction of Wet, Bronze-Faced, Friction Brakes[1]

This standard is issued under the fixed designation D 4999; 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 test method evaluates fluids for effects on friction of oil cooled brakes with bronze friction material in combination with steel disks.

1.2 The values stated in SI units are to be regarded as standard.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific hazard statement, see 7.4.

2. Referenced Document

2.1 *ASTM Standard:*

D 235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)[2]

3. Terminology

3.1 *Description of Terms Specific to This Standard:*

3.1.1 *capacity*—the amount of torque that a brake can absorb without slipping.

3.1.2 *chatter*—changing frictional characteristics that occur during the application of the brake measured by observing torque variation. These changing frictional characteristics result in an audible noise.

4. Summary of Test Method

4.1 A modified transmission/final drive unit containing fluid-wetted brakes is used as the test machine for this test method (see Figs. A1.1, A1.2, A1.3, and A1.4). Prior to starting a test, new brake facings (see A1.5) and a brake disk are measured. After installing the measured parts in the test machine, a break-in is run consisting of 1000 cycles of operation using a reference fluid. The brake parts are removed, measured, and re-installed. A 100-cycle flush procedure is performed using a fluid containing no additives. The test proceeds with 200 cycles of operation with new reference fluid, then a chatter test. The brake parts are removed, measured, and re-installed in the test machine. A 100-cycle flushing procedure is performed using a fluid containing no additives. Test fluid is introduced into the system and a conditioning run of 200 cycles is performed prior to running a chatter/capacity test. After completion of the chatter/capacity test, the brake parts are again measured.

5. Significance and Use

5.1 This test method measures the chatter/capacity characteristics of fluids used in multi-purpose power transmission systems of on-off highway equipment.

5.2 This test method was developed for this purpose referencing John Deere Standards JDQ40 and JDQ41.[3]

6. Apparatus

6.1 *Test Machine Configuration*—This test method requires the use of a John Deere (JD) 4250 tractor.[4]

6.2 *External Fluid Control Systems*—External systems will be required to maintain proper operating conditions (see Figs. A1.6 and A1.7). In this system, use no brass or copper in components contacted by the test fluid.

6.3 *Monitoring and Control Equipment*—Speed, torque, pressure, and temperature monitoring/control instrumentation is required.

6.3.1 *Axle Restraint*, one side (see Fig. A1.8).

6.3.2 *Auxiliary Hydraulic System*, capable of providing 16.0 MPa pressure.

6.3.3 *Strain Gage* (see Figs. A1.9 and A1.10).

6.3.4 *Heater/Cooler System*, to maintain fixture fluid temperature.

6.3.5 *Electronic Slip Ring Assembly.*

6.3.6 *Reservoir*, 20-L capacity.

6.3.7 *Pressure Transducer.*

6.4 *Cycle Controls*—A timer and mechanism to control the brake engagement.

6.5 *Recording Equipment*—A means of recording pressure, temperature, and torque simultaneously with a minimum frequency response of 120 Hz.

6.6 *Measurement Equipment*—A device capable of measuring friction pad groove depth of 0.01 mm.

6.7 *Speed Measurement*—Any suitable speed measuring device capable of measuring axle speed within 0.5 r/min (with a range from 10 to 60 r/min).

7. Reagents and Materials

7.1 *Test Fluid*, approximately 20 L.

7.2 *Reference Fluid*, approximately 95 L.[5]

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[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.B on Automotive Fluids.

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[2] *Annual Book of ASTM Standards*, Vol 06.03.

[3] Available from John Deere and Company, Corporate Standards, John Deere Road, Moline, IL 61265.

[4] A product of John Deere and Company, John Deere Road, Moline, IL 61265.

[5] Reference Fluid(s) available from Southwest Research Institute, 8500 Culebra Road, San Antonio, TX 78284.

7.3 *Flush Fluid*—Approximately 20 L of an additive free lubricating oil. The viscosity of this fluid is to be similar to the test fluid.

7.4 *Cleaning Materials*—Specification D 235 Type 1 solvent or equivalent for cleaning the brake fluid system.

NOTE 1: **Warning**—Combustible, toxic.

7.5 *Parts Listing*—A complete parts list is shown in Annex A2 for JD 4250.[5]

8. Preparation of Apparatus

8.1 *Cleaning*—Flush all parts with Specification D 235 Type 1 solvent, or equivalent, and blow dry with compressed air free of oil and water.

8.2 *Brake Facing Preparation*—The brake facing and brake disk should be measured in order to determine wear during the test (radial profile traces of the brake disk have proven satisfactory). Brake facing location should be indicated so they may be re-installed in the same position when removed for inspection or measurement, or both.

8.3 *Assembly Instructions*—All parts must be assembled as illustrated in the proper tractor service manual,[6] except where otherwise noted.

8.3.1 *Axle Clamp Screw Torque*—The means of holding the restrained axle must be checked periodically to ensure proper restraint is provided. Any relaxation of the restraint tends to reduce chatter levels.

8.3.2 *Axle Drag Torque*—Since axle drag torque affects brake chatter, the axle drag torque must be checked before each test. Axle drag torque must be kept as constant as possible in order to evaluate a fluid based on a comparison of chatter values (between 13.5 and 27 N·m for JD 4250).[4]

9. Calibration

9.1 *Instrumentation*—The instruments are to be calibrated prior to test initiation and be checked according to good laboratory practices.

9.2 *Reference Fluids*—Because chatter is of a comparative nature, a reference test is to be conducted before every candidate fluid test.

10. Pre-Test Procedure

10.1 *Initial Fluid Fill*—Introduce 20 L of reference fluid into the separated brake reservoir. Operate the test unit at 1500 r/min input speed for 10 min to circulate the fluid through the system.

10.2 *Break-In*—Operate the test stand for a minimum of 1000 cycles controlling the following parameters: brake compartment test temperature; 93°C ± 6°C, Axle r/min; 22 ± 0.5, Brake apply pressure; 15.86 MPa, and Cycle time; 2 s on, 20 s off.

10.2.1 The operator is to maintain a log indicating test cycles, temperatures, and capacity level readings at hourly intervals.

10.2.2 Every hour, make five non-consecutive brake torque recordings, at 12 min intervals.

10.2.3 Calculate the capacity level as follows every hour:

10.2.3.1 Determine the torque occurring at the mid-point (1 s) of each recording made in 10.2.2.

10.2.3.2 The average of the five torque values is the capacity level.

NOTE 2—If the capacity level has not stabilized by 1000 cycles, continue break-in until the capacity has stabilized.

10.2.3.3 The capacity is considered stabilized when the difference of each of four consecutive capacity values is not more than 0.0100 kN·m from the average of the same four readings.

10.2.4 When the capacity level has stabilized, the break-in is complete. Drain the fluid and disassemble the test unit for inspection and measurements.

10.3 *Flush*—Reassemble the test unit and introduce a 20-L charge of flush fluid (fluid containing no additives) into the system. Conduct 100 cycles of operation at the conditions listed in 10.2. At the completion of 100 cycles, drain and save flush fluid.

11. Procedure

11.1 *Conditioning*—Introduce 20 L of new reference fluid into the test unit. Operate the unit under the conditions shown in 10.2, for a total of 200 cycles. Do not drain the test unit.

11.2 *Chatter Test*—A chatter test consists of 72 brake engagements with different axle speed, apply pressure, and fluid temperature. The basic sequence is conducted at 8.62 ± 0.03 MPa with axle speeds of 10 ± 0.5 through 60 ± 0.5 r/min in 5 r/min increments, then with 3.45 ± 0.03, 5.17 ± 0.03, 6.90 ± 0.03, 8.62 ± 0.03, 10.34 ± 0.03, 12.07 ± 0.03, and 13.80 ± 0.03 MPa at 15 ± 0.5 axle r/min. The above sequence is run at 32 ± 3°C fluid temperature and is repeated at 50 ± 3°C, 60 ± 3°C, and 70 ± 3°C fluid temperature. Record the temperature, brake pressure, and brake torque at each condition on electronic equipment with a minimum frequency response of 120 Hz, separate electronically and individually record. At the completion of the chatter test, drain the test unit and remove the test brake parts for measurements. Make measurements using a depth micrometer. Determine the depth of the grooves on each brake facing at five points on each facing: center, outer edge center, inner edge centers, center leading edge, and center trailing edge. Compare results calculated from the chatter test on the reference fluid with results of previous reference fluid tests prior to proceeding. Reference fluid total chatter value (see 12.3) must be within one standard deviation of the previous five reference fluid results for the results of the fluid being evaluated to be valid.

11.3 *Flush*—Reassemble the test unit using the same parts removed in 11.2. Introduce 20 L of flush fluid and operate the test unit for 100 cycles as described in 10.2. Drain and save the flush fluid. The flush fluid can be re-used until a total of 400 cycles of use is accumulated.

11.4 *Conditioning*—Repeat 11.1 using the fluid being evaluated.

11.5 *Chatter Test*—Repeat 11.2.

12. Calculation

12.1 Compare the results obtained from the fluid being evaluated to the results obtained with the reference fluid.

12.2 Read the temperature and pressure values directly from the recorded data. Divide each torque trace into separate traces, average torque and average chatter. The

[6] John Deere Model 4250 Service Manual is available from John Deere Co.

brake chatter value is defined as the maximum torque variation sustained for a duration of 0.2 s or more. The capacity is defined as the mean torque reading obtained after 1 s of brake application. Fig. X1.1 contains examples of brake chatter level and capacity.

12.3 Calculate the total chatter value and the total relative capacity value by summing the values of each of the 72 test points.

13. Report

13.1 Fig. X1.2 is an example of a recommended report sheet.

13.2 Report the following information:

13.2.1 Wear measurements for each of the three test phases, (break-in, reference, and test),

13.2.2 Break chatter capacity values for test and reference fluid, and

13.2.3 Total chatter value and total relative capacity values for test and reference fluids.

14. Multiple Runs

14.1 Multiple runs using this procedure and the same brake facings can be conducted. Following the initial reference and fluid evaluation run, additional fluids may be evaluated by repeating Section 11. After each reference and fluid evaluation run, the brake disk is to be replaced. A break-in cycle (see 10.2) is to be conducted prior to the resumption of testing. After a total of eight runs (reference and fluid evaluation), or if reference chatter results do not repeat, the brake facings and disk must be replaced. Measurements are recommended after each chatter/capacity test for determining wear rates.

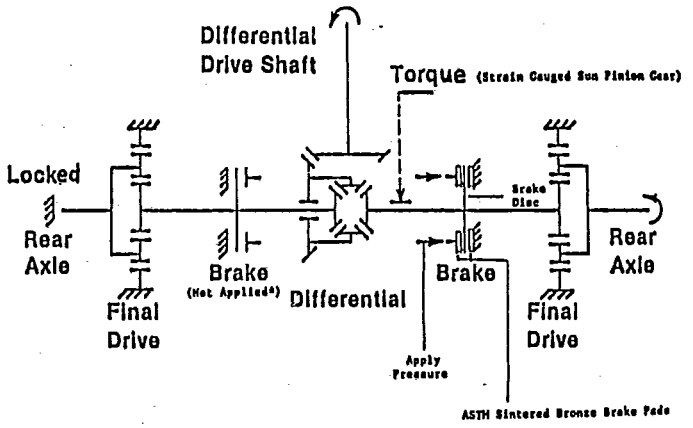
15. Precision and Bias

15.1 The precision and bias of this test method are being determined.

ANNEXES

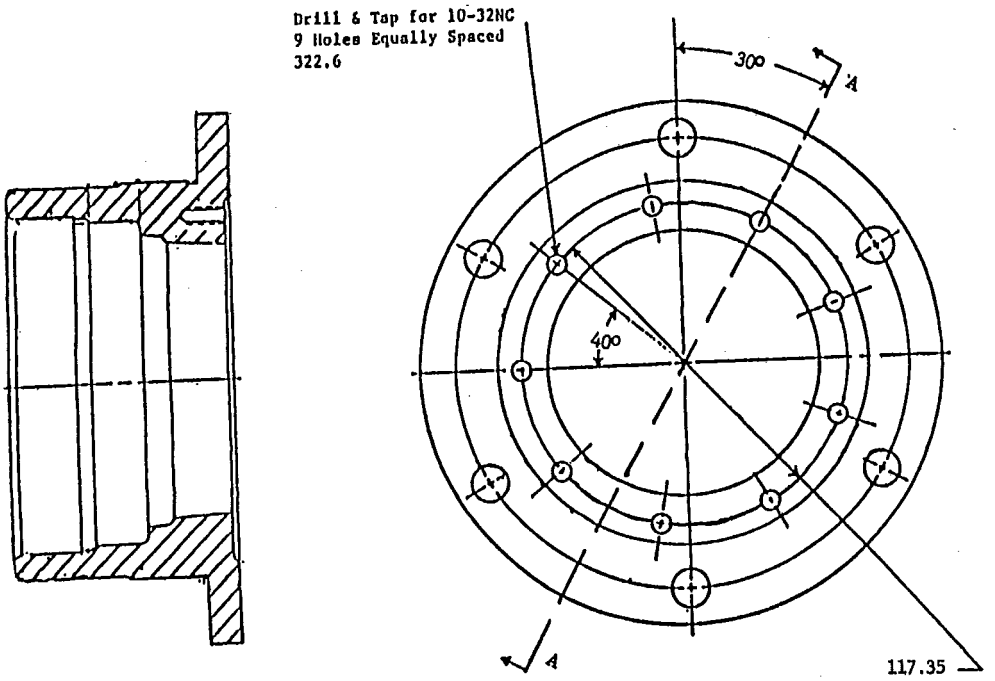
(Mandatory Information)

A1. TEST MACHINE



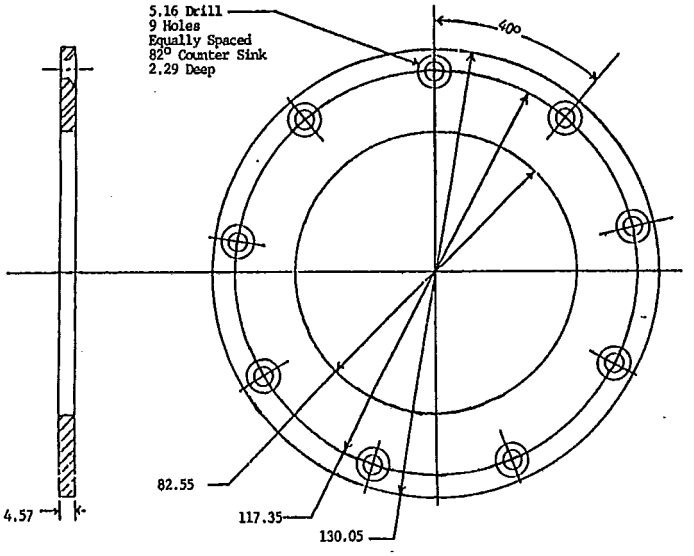
NOTE—Brake may be applied during break-in to reduce laboratory noise levels.

FIG. A1.1 Test Stand Diagram



NOTE 1—Use John Deere Part R 46448.[4]
NOTE 2— All linear dimensions in millimetres.

FIG. A1.2 Quill, Modified



NOTE—All linear dimensions in millimetres.

FIG. A1.3 Retainer, Brake Compartment Seal