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Standard Test Method for Evaluation of Fluids for Effects on Friction and Wear of Wet Clutches¹

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1. Scope

1.1 This test method evaluates fluids for effects on friction retention, capacity, and traction clutches utilizing fluid wetted friction surfaces.

1.2 The values stated in SI (metric) units are to be regarded as the 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 specific hazard statements, see 7.4 and 8.3.

2. Referenced Document

2.1 ASTM Standard:

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

3. Terminology

3.1 Descriptions of Terms Specific to This Standard:

3.1.1 *apply pressure*—fluid pressure supplied to the hydraulic clutch actuating mechanism that causes clutch engagement.

3.1.2 *hold position*—a partially engaged condition where the clutch slips and does not transmit full engine r/min to the output shaft.

3.1.3 *stall test*—a procedure for determining the length of time required to stop an internal combustion engine after a clutch application is made with a fixed output shaft.

3.1.4 *stall time*—the time required for the tractor engine to stop when the power-take-off (PTO) clutch is engaged with a locked PTO shift.

3.1.5 *wear*—the loss of friction material during the test.

4. Summary of Test Method

4.1 A modified tractor is used in conducting this test method. The tractor's power-take-off (PTO) shaft is connected to a load fixture. While the engine is running at wide open throttle, the PTO clutch is engaged in two steps while monitoring engine speed, PTO clutch apply pressure, and PTO shaft output torque. Periodic stall tests are conducted to determine the fluid dynamic friction characteristics. After

2000 cycles, the PTO clutch is inspected and measured.

5. Significance and Use

5.1 This test method measures the friction retention, capacity, and effects on clutch wear of fluids used in traction clutches of on-off highway equipment.

5.2 This test method was developed for this purpose referring to John Deere Standard JDQ42.³

6. Apparatus

6.1 A John Deere (JD) 4250 tractor⁴ equipped with a quadrange transmission is required.

6.2 *External Fluid Cooling/Heating System*—External systems are required to maintain proper operating temperatures for both engine and transmission fluids. Do not use brass or copper in the system that will come in contact with the test fluid.

6.3 *Load Absorption Equipment*—The laboratory load fixture must be equipped as follows:

6.3.1 *Inertia Flywheel*, (14.90 kg·m²).

6.3.2 *Hydraulic Brake*, or equivalent, on the input shaft, (3.4 kN m torque capacity).

6.3.2.1 *Hydraulic Pump*, capable of 15 L/min at 9.0 MPa, to provide hydraulic brake operations (if required).

6.3.2.2 Manner of regulating fixture system pressure (if required).

6.3.2.3 *Electric Solenoid Valve* (normally open), connected to apply the brake pressure when de-energized and release the brake when energized (if required).

6.3.3 *Cooler*, of sufficient capacity to maintain the fixture fluid temperature below 65°C (if required).

6.3.4 *Driveline Torquemeter*, of 4000 N·m minimum capacity.

6.3.5 *Driveshaft*, for connecting the tractor PTO to the load absorption equipment.

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

6.5 *Recording Equipment*—A means of recording PTO shaft torque simultaneously with PTO clutch pressure and engine r/min.

6.6 *Measurement Equipment*—A device capable of measuring friction disk thickness to 0.01 mm.

7. Reagents and Materials

7.1 *Parts Listing*—A complete parts list is shown in

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 Lubricants.

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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.

 D 5005

Annex A1 (John Deere 4250 tractor).⁴

7.2 *Reference Fluid*—Approximately 95 L.⁵

7.3 *Test Fluid*—Approximately 95 L.

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

NOTE 1: Warning—Combustible, toxic.

8. Preparation of Apparatus

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

8.2 *Measurements*:

8.2.1 Measure and record total PTO clutch disk thickness across the facing material, 120° apart, 10 mm maximum in from both the inner and outer edge of the facing material. The locations for taking these measurements should be marked so the measurements after test may be taken at the exact same place, (see Annex A2).

8.2.2 *Disk Identification*—Identify the disks by stamping or etching on the core section of the disk for identification of disk location in the clutch assembly.

8.3 *Clutch Assembly*—Assemble the clutch and adjust in accordance with the tractor technical repair manual.⁶

NOTE 2: Caution—Careful clutch adjustment is critical to ensure even clutch plate loading and to prevent high wear.

8.4 *Test Fluid System*—Drain all fluid from the clutch housing, transmission case, fluid filter, and fluid cooler. Flush the system using approximately half the normal fill volume of test fluid and again drain the system. Install new fluid filter and fill transmission with test fluid (approximately 55 L).

9. Calibration

9.1 Test severity is initially determined by conducting three reference fluid tests. After the initial tests, a reference test is conducted every fifth test and the reference calibration is the average of the immediately prior three reference tests.

10. Procedure

10.1 *Startup*—Operate the engine 5 min at 1000 to 1500 r/min to circulate the fluid.

10.2 *Test Operation*:

10.2.1 *Initial Conditioning*—Increase engine speed to 2420 ± 25 r/min and start the timer initiating the test cycles.

10.2.2 *Control Adjustments*:

10.2.2.1 Engage clutch to *Hold* position in 1 s (700 ± 100 kPa/s pressure rise).

10.2.2.2 Adjust *Hold* pressure to maintain output torque of $900 \text{ N} \cdot \text{m} \pm 5\%$ for 2.0 ± 0.1 s. Adjust *Hold* pressure at the adjustable pressure switch (approximately 650 kPa).

10.2.2.3 Operate at rated engine speed (2200 ± 50 r/min) during the *Hold* period.

10.2.2.4 Adjust the timer(s) so the output brake load releases after 2.0 s of *Hold*, and rapid clutch engagement

occurs 2.5 s after the full start of *Hold* period.

10.2.2.5 After 25 s of the total cycle, disengage the PTO clutch.

10.2.2.6 After 27 s of the total cycle, apply the load fixture brake to stop the rotation of the inertia load.

10.2.2.7 Release the brake fixture load after 29.5 s of the total cycle.

10.2.2.8 Total cycle length is 30 s.

10.3 *Test*:

10.3.1 Repeat the cycle as outlined in 10.2.2 for a total of 2000 cycles.

10.3.2 Record engine speed, PTO shaft torque, and clutch apply pressure simultaneously at 50, 500, and every 500 cycles thereafter to failure or 2000 cycles.

10.3.3 Maintain transmission fluid temperature at $88 \pm 3^\circ\text{C}$ measured at the entrance to the clutch mechanism (clutch valve body).

10.3.4 At 500-cycle intervals, conduct a stall test as follows:

10.3.4.1 Shutoff cycle timer. The PTO actuator must be in the disengaged position and the PTO shaft stopped before proceeding.

10.3.4.2 Adjust brake function to ensure the PTO shaft will not turn during *Stall* test.

10.3.4.3 Set engine speed to 2420 ± 25 r/min.

10.3.4.4 A continuous recording of the engine r/min, PTO clutch pressure, and the PTO shaft torque is required during the *Stall* test.

10.3.4.5 Engage the PTO clutch.

10.3.4.6 Limit clutch application to 10 s. If the engine does not stop, terminate the test and consider the fluid a fail.

10.3.4.7 Return brake function to cycling configuration, providing the fluid did not fail the *Stall* test.

10.3.4.8 Restart tractor engine.

10.3.4.9 Restart test cycling.

10.3.4.10 Record two cycle traces to confirm proper cycling conditions.

NOTE 3—Adjustments can be required during the test to maintain proper cycling conditions, see 10.2.2.

10.3.5 At the completion of the test, disassemble the clutch and measure the disks, record the data on the form used to measure the disks before the start of the test.

11. Interpretation of Test Results

11.1 Test results are compared to reference fluid of predetermined minimum values.

11.2 *Coefficient of Friction*—The dynamic coefficient of friction is calculated using the data recorded during the stall test. The values to be used are those occurring 0.5 s after the stall test is initiated (Annex A3 gives the formula for this calculation).

11.3 *Wear*—The difference between the before test clutch disk measurements and the after test clutch disk measurements is the recorded wear (see Annex A2).

11.4 *Stall Time*—Stall time is measured using the recording of the *Stall* test in 10.3.4.4. Measure the time from the start of the rise of the clutch pressure curve to the point at which the driveline torque trace ceases to have any positive values.

⁵ Reference fluid is available from Southwest Research Institute, 8500 Culebra Road, San Antonio, TX 78284.

⁶ The John Deere Model 644-C and Model 4250 Service Manual, available from John Deere and Company, John Deere Road, Moline, IL 61265.