

Kubota UDT and Super UDT

Physical Chemistry and Performance Tests

Daniel Allen - 10/28/2021

What is UDT/Super UDT?

UDT and Super UDT are trademarks of Kubota tractor corporation and identify their proprietary formulations of a Universal Tractor Transmission Oil (UTTO). UTTO is an informal industry “standard” formulation of a multipurpose lubricant intended for use in common sump agricultural tractors. These oils are fundamentally an API GL4 gear lubricant that also functions as a wet brake and clutch lubricant and a hydraulic fluid. Other OEMs such as John Deere, Case-New Holland, Massey Ferguson, et.al. also have proprietary formulations of UTTO. There are also hundreds of third-party formulations including ones from major oil companies like Castrol, Shell, Mobil and generic house brands from parts supply houses and distributors. Unlike engine and gear oils API and SAE have no performance standards or certification test programs for UTTO and blenders keep the details of their formulations a well protected secret while making broad claims about their suitability for use in equipment of all types and makes. Evaluating those claims without a formal industry testing and certification program is a daunting task.

This paper will attempt to fill in those gaps in regard to UDT/SUDT in the hopes it will provide a sounder factual basis for evaluating competing products for use in Kubota equipment. The material presented here is derived from an SAE Technical note authored by two lubrication engineers at Kubota Corporation:

SAE Technical Paper Series
1997-09-08

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**Development of High Performance Transmission/Hydraulic Fluid (KUBOTA Super-UDT)
Establishing the Specification and New Test Method**

Nobushige Ichikawa, Tsunejiryo Seno - Kubota Tractor Corporation

The paper was authored in 1997 and a lot has changed in the lubrication industry over the ensuing years but it still provides a unique insight into Kubota’s in house testing regimen and what performance factors they felt were of greatest concern. The SAE paper is copyright protected and cannot be reproduced in full or part so the discussion of its findings and claims here will be of a summary nature. Anyone wishing to review the source document can purchase a copy (\$33) from the SAE:

<https://www.sae.org/publications/technical-papers/content/972788/>

It should also be noted that Kubota now has a third formulation of UTTO which they sell under the brand name Super UDT². Super UDT is now obsolete and Super UDT² is the only formulation currently supplied by Kubota. Kubota provides only very basic details of the Super UDT² formulation and it will only be addressed briefly in the final section.

Basic Industry Test Specifications for UDT and Super UDT

The reference document provides a fairly comprehensive set of standard test data for UDT and Super UDT which is shown in Table 1.

Table 1 – Industry Standard Test Metrics for UDT and Super UDT

Parameter	UDT	Super UDT	Test Method
Flash Point	>= 200° C	>= 200° C	JIS K2265
Kinematic Viscosity @ 40°C	<= 55 cSt	<= 45 cSt	JIS K2283
Kinematic Viscosity @ 100°C	>= 8.8 cSt	>= 8.8cSt	JIS K2283
Viscosity Index	>= 137	>= 179	ASTM D2270
Brookfield Viscosity @ -20°C	<= 4800 cP	<= 3000 cP	ASTM D2983
Brookfield Viscosity @ -40°C	<= 70000 cP	<= 30000 cP	ASTM D2983
Pour Point	<= -37.5°C	<= -40°C	JIS K2269
Total Acid Number (TAN)	1.5 mgKOH/g min	1.5 mgKOH/g min	JIS K2501-5-1-2
Total Base Number (TBN)	6 to 10 mgKOH/g inclusive	6 to 10 mgKOH/g inclusive	JIS K2501-5-2-3
Copper corrosion	Class 1 max	Class 1 max	JIS K2513
Foaming Sequence I Sequence II Sequence III	<=25/0 <=30/0 <=25/0	<=25/0 <=30/0 <=25/0	JIS K2516
Seal Compatibility Volume change Hardness change Tension change	-5 to 5 % inclusive -5 to 5 % inclusive <= 15 %	-5 to 5 % inclusive -5 to 8 % inclusive <= 15 %	JIS K6301 Material NOK A727 100° C for 70 Hours
Shear stability	<= 20% decrease	<= 20% decrease	ASTM D2603 10K hz @ 100°C
IAE Gear Wear Test – Procedure B	60 minutes	90 minutes	IP166 @ 120°C

Kubota Specific Performance Categories

The Kubota paper identifies three distinct performance categories and associated test procedures developed specifically for validating performance of their new Super UDT formulation.

1. Low Temperature Fluidity

This performance category focuses on the ability of the fluid to pass through filtration at cold temperatures. The industry standard metric for this property is Brook Field viscosity as shown in Table 1. Kubota chose to devise their own in-house pumping test procedure and performance requirements. The Kubota test stand used for performing their in-house flow test is a simple closed loop hydraulic circuit composed of a hydraulic reservoir, a hydraulic pump with a 35u suction side filter and a flow meter on the tank return. The test procedure pumps oil through the closed loop while monitoring the change in flow rate as the oil circulates. The oil and test apparatus are first stabilized at -30C and then the pump is started. As the oil is pumped through the loop it gradually warms due to friction and pressure and the change in flow rate is shown by the flow meter. The Kubota requirement for UDT and Super UDT in their in-house testing is shown in Table 2

**Table 2 – Kubota Low Temperature Pumping Test
Requirements for UDT and Super UDT**

Elapsed time	UDT	Super UDT
2 minutes	≥ 1.0 l/min	≥ 3.5 l/min
10 minutes	≥ 1.8 l/min	≥ 5.5 l/min

2. Friction Characteristics

This set of performance metrics addresses wet brake and clutch slippage, squawk, and chatter. The test procedure is the standard SAE #2 test using a Kubota specific test apparatus and friction materials with low speed (1-100 RPM) characteristics as shown in Table 3. The Kubota test apparatus is a simple driveline apparatus consisting of a drive motor -> flywheel-> wet clutch -> flywheel -> load motor.

**Table 3 – Friction Properties of Materials Used
In Kubota Modified SAE #2 Friction Test**

Friciton material	Properties	Value
Paper	μ_s μ_D/μ_O	0.110 min 1.150 max
Sintered Metal	μ_s μ_D/μ_O	0.090 min 2.5 max

2.1 Slippage

Performance of friction material is evaluated using the SAE 2 low speed slippage test and Kubota wet clutch apparatus as described above. Table 4 shows the performance characteristics sintered metal test components must demonstrate.

**Table 4 – Super UDT Low Velocity Slippage Test Requirement
Kubota Modified SAE # 2 test procedure**

Friction Material	Limits
Sintered Metal	$\mu @ 5 \text{ RPM} \geq \mu @ 3 \text{ RPM}$ $\mu @ 5 \text{ RPM} \geq \mu @ 1 \text{ RPM}$

2.2 Coefficient of Friction Stability

During periods of extended operation the friction choefficient of a lubricant can change resulting in a degradation of performance. Kubota has established minimum performance requirements for Super UDT. The test is conducted using the sintered metal and Kubota test stand described above Table 5 shows the minimum acceptable performance in this test.

Table 5 – Super UDT Coefficient of Friction Stability Requirements

Friction Material	Limits (minimum value)	
	5000 cycles	20000 cycles
Sintered metal meeting friction coefficient requirements specified above.	0.9 x μ D @ Start	0.7 x μ D @ Start

3. Water Tolerance

3.1 Effects off Water on Super UDT Coefficients of Friction

As a final and definitive performance test of the effects of water on coefficients of friction an actual tractor is filled with a mixture of Super UDT containing 2% water by volume. When operated there must be no discernible clutch/brake squawk or shock on gear changes.,

3.2 Filterability

When water is introduced into a transmission and final drive lubricant there is a potential I for chemical reactions with lubricant additives and copper/zinc machinery components. These reactions can result in additive drop-out and O/W emulsions which form a sludge that can clog hydraulic filters. Kubota has established a filterability performance test for Super UDT. In this test 1% by volume of water is added to the oil, the mixture is stired, and then left to rest at room temperature for 168 hours. The oil is then passed through a 10mm Millipore filter to collect any sludge or precipitates that have formed. A maximum of .1 mg of sludge/precipitate is allowed.

3.3 Rust Prevention

In this test a brake /clutch disks are treated with oil and clamped to a similalrly treated steel plate to simulate brake makeup. The assembly is then placed in a humidity cabinet maintained at 49° C for 120 hours. At the end of the test period the components are inspected for any signs of rust. Presence of rust constitutes failure.

4. Super UDT²

Roughly 10 years after the introduction of Super UDT Kubota introduced an updated formulation sold under the label Super UDT² . The only data provided for this formulation are the changes in viscosity.

Table 6 – Kubota Super UDT² Viscosity Data

Property	Value
Kinematic Viscosity @ 100° C	8.1 cSt
Kinematic Viscosity @ 40° C	37 cSt
Brookfield Viscosity @ -40° C	13000 cP
Viscosity Index	199