(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 710 295 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.10.2006 Bulletin 2006/41

(51) Int Cl.:
C10M 177/00 $^{(2006.01)}$ ***C10M 171/00*** $^{(2006.01)}$

(21) Application number: **06006607.3**

(22) Date of filing: **29.03.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **04.04.2005 US 98629**

(71) Applicant: **Afton Chemical Corporation**
Richmond,
VA 23219 (US)

(72) Inventors:
- **Milner, Jeffrey L.**
  Chesterfield, VA 23838 (US)
- **Clague, Nicholas**
  Bracknell, Berkshire RG12 9YB (GB)

(74) Representative: **Schüssler, Andrea et al**
Patentanwälte Huber & Schüssler,
Truderinger Strasse 246
81825 München (DE)

(54) Tractor fluids

(57) The present disclosure relates to a method for making a Universal Tractor Transmission Oil (UTTO) from a Super Tractor Universal Oil (STUO).

EP 1 710 295 A1

Printed by Jouve, 75001 PARIS (FR)

Description

FIELD

[0001] The present disclosure relates to a method for making a Universal Tractor Transmission Oil (UTTO) from a Super Tractor Universal Oil (STUO).

BACKGROUND

[0002] Universal Tractor Transmission Oils (UTTOs) and Super Tractor Universal Oils (STUOs) are multi-application lubricants that are used to lubricate the moving parts of off-highway mobile equipment, such as tractors, off-highway equipment, and construction equipment. Such fluids are designed to lubricate all of transmissions, differentials, final-drive planetary gears, wet-brakes, and hydraulic systems of such equipment. Such fluids, generally called tractor fluids, are designed to meet specific manufacturer requirements.

[0003] Super Tractor Universal Oils (STUOs) combine the performance of engine oils with transmissions, differentials, final-drive planetary gears, wet-brakes, and hydraulic performance. While many of the additives used to formulate a UTTO and a STUO fluid are similar in functionality, they may have deleterious effect if not incorporated properly. For example, some anti-wear and extreme pressure additives used in engine oils can be extremely corrosive to the copper components in hydraulic pumps. Detergents and dispersants used for gasoline or diesel engine performance may be detrimental to wet brake performance. Friction modifiers specific to quiet wet brake noise, may lack the thermal stability required for engine oil performance.

[0004] Generally, tractor fluids are designed as first intent fluids to meet specific manufacturer requirements. UTTOs generally meet the specification requirements of, and are thus preferred for use in, North America. UTTO formulations are generally used at a lower treat rate, i.e., about 5 to 8 wt %. STUOs generally meet the specification requirements of, and are thus preferred for use in, Europe and some other foreign regions. STUO formulations are generally used at a higher treat rate, about 8 to 15 wt %, to accommodate the extra engine performance requirements. These treats could be higher if the additive package incorporates viscosity index improvers and or pour point depressants to provide an additive package for multi-grade oils. Since the specifications for these two applications differ, it is not the current practice to substitute one for another. It would be of benefit to equipment manufacturers and users to have a single fluid that could easily be converted from a UTTO to a STUO and vice versa.

BRIEF DESCRIPTION

[0005] According to an embodiment, a method for making a Universal Tractor Transmission Oil (UTTO) from a Super Tractor Universal Oil (STUO) may comprise reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification (Annex 1) and the Ford M2C134D performance specification (Ford New Holland M2C134D performance specification, Annex 2).

[0006] According to another embodiment, a method for making a Super Tractor Universal Oil may comprise top treating a Universal Tractor Transmission Oil with an aftermarket additive package comprising one or more additives selected from the group consisting of an ashless dispersant, a detergent, a corrosion inhibitor, a friction modifier, and an antioxidant.

[0007] According to another embodiment, a Universal Tractor Transmission Oil (UTTO) having improved extreme pressure properties, wherein the UTTO is made from a Super Tractor Universal Oil (STUO) may comprise reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification and the Ford M2C134D performance specification.

[0008] According to another embodiment, a Universal Tractor Transmission Oil (UTTO) having improved brass wear properties, wherein the UTTO is made from a Super Tractor Universal Oil (STUO) may comprise reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification and the Ford M2C134D performance specification.

[0009] According to another embodiment, a Universal Tractor Transmission Oil having (UTTO) improved friction properties, wherein the UTTO is made from a Super Tractor Universal Oil (STUO) may comprise reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification and the Ford M2C134D performance specification.

[0010] Additional objects and advantages of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the disclosure. The objects and advantages of the disclosure will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

[0011] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the present disclosure, as claimed.

BRIEF DESCRIPTION OF THE FIGURES

[0012] FIG. 1 is a diagram depicting inventive and comparative test results using a Falex D-2714 Ring on Block Test.

[0013] FIG. 2 is a diagram depicting inventive and comparative test results using a Falex D-2714 Ring on Block Test.

DETAILED DESCRIPTION

[0014] In accordance with the present disclosure, there is provided a method for making a Universal Tractor Transmission Oil (UTTO) from a Super Tractor Universal Oil (STUO). A UTTO may also be known as a Tractor Hydraulic Fluid (THF). A Super Tractor Universal Oil (STUO) may also be known as a Super Tractor Oil Universal (STOU). A UTTO differs from a STUO in the specification tests needed to qualify the fluid. For example, a STUO requires passing results in all of the UTTO performance specifications plus passing results in a series of engine performance tests. As such, the STUO formulation treat rates may be twice those of a UTTO. For example, about 40 to about 100% more. It has been discovered that fluids that meet STUO performance tests can be modified in a particular way to provide a lower treat formulation that still meets all UTTO performance tests. Further, it has been discovered that such modified fluid can again be top treated with those omitted or reduced amounts of additive to again prepare an STUO.

[0015] Since the specifications for UTTOs and STUOs differ, it is not the current practice to substitute one for another. The present disclosure provides equipment manufacturers and users with a single fluid that could easily be converted from a UTTO to a STUO and vice versa. In addition, additive companies will benefit by reducing their development costs. By utilizing the same additive platform and by selectively reducing or omitting additives in the preparation of a STUO that only impact the engine oil performance, the treat rate will be reduced, and UTTO performance will be maintained.

[0016] The tractor fluids according to the present disclosure provide such versatility. Furthermore, the present formulations provide improved performance in the areas of extreme pressure, brass wear, and friction over conventional or commercially available tractor fluids.

[0017] Top treat, as used throughout, is a fluid composition that may be added to a partially or a fully formulated (finished) power transmitting fluid, such as an aftermarket product. A top treat may be added at any time. For example, a top treat may be added by the manufacturer, e.g., as a factory fill; by the end user, e.g., as a service fill; or by any other party desiring to impart the properties of the top treat to a fluid.

[0018] In some embodiments, an STUO that meets the John Deere J20-C performance specification and the Ford M2C134D performance specification (which is similar to CNH MAT 3525 specification) can be modified to maintain UTTO performance by reducing or omitting components that are only necessary for engine performance. In particular, the modification may comprise reducing the amount of one or more additive components in the preparation of a STUO to provide the UTTO-only formulation.

[0019] The one or more additive components may comprise one or more additives selected from the group consisting of an ashless dispersant, a detergent, a corrosion inhibitor, a friction modifier, an antiwear/extreme pressure additive, an antifoamant, a defoamant, and an antioxidant. Further, the method may comprise reducing or omitting any one of these additives, all of these additives, or any combination thereof. For example, the method may comprise reducing or omitting one or more of an ashless dispersant, a detergent, and an antioxidant in the preparation of a STUO to provide a UTTO.

[0020] The one or more additives reduced or omitted may include those additives necessary for engine performance. Such additives that may be necessary for engine performance but not necessary to meet UTTO specifications may include, but are not limited to, a dispersant, a detergent, an antiwear/extreme pressure agent, a corrosion inhibitor, an antifoamant, a defoamant, a friction modifier, and/or an antioxidant.

[0021] Further, in a formulation that contains more than one of a particular additive, some or all of that additive may be reduced or omitted. For example, if the fluid comprises more than one antioxidant, all antioxidants may be reduced or omitted. Or only one or some of the antioxidants may be reduced or omitted.

[0022] For example, reducing or omitting an ashless dispersant additive in the preparation of a STUO to provide a UTTO may comprise reducing the amount of the ashless dispersant by about 5% to about 100%. As a further example, reducing the amount of ashless dispersant by about 10% to about 100%.

[0023] Reducing or omitting a detergent additive of in the preparation of a STUO to provide a UTTO may comprise reducing the amount of the detergent sufficient to improve the water tolerance of the UTTO. As another example, reducing or omitting a detergent additive may comprise reducing the amount of the detergent by about 50% to about 100%.

[0024] Reducing or omitting a corrosion inhibitor additive in the preparation of an STUO to provide a UTTO may comprise reducing the amount of the corrosion inhibitor by about 10% to about 100%. As a further example, the amount of the corrosion inhibitor may be reduced by about 25% to about 100%.

[0025] Reducing or omitting a friction modifier additive in the preparation of an STUO to provide a UTTO may comprise reducing the amount of the friction modifier sufficient to improve wet brake noise. As another example, reducing or omitting a friction modifier additive may comprise reducing the amount of the friction modifier by about 25% to about 100%.

[0026] Reducing or omitting an antioxidant additive in the preparation of an STUO to provide a UTTO may comprise reducing the amount of the antioxidant by about 25% to about 100%.

[0027] Embodiments may comprise a UTTO made from the method described herein. Further embodiments may comprise use of a UTTO made from the method described herein to lubricate moving parts of off-highway mobile equipment, such as a tractor, off-highway equipment, or construction equipment. For example, the UTTO may be used to lubricate one or more of a transmission, a hydrostatic transmission, a gear-box, a final drive, a hydraulic system, and a wet brake of such equipment. Further the UTTO may be used to lubricate all of these parts.

[0028] In some embodiments, a STUO may be made from a UTTO as described herein by top treating a UTTO with an additive package comprising one or more of the reduced and/or omitted additives. For example top treating an aftermarket UTTO with one or more of an ashless dispersant, a detergent, a corrosion inhibitor, a friction modifier, and an antioxidant.

Ashless Dispersant

[0029] An additive that may be omitted or reduced when making a UTTO from an STUO is a dispersant. The dispersants as described herein may comprise one or more dispersants, such as an oil-soluble dispersant selected from the group consisting of succinimide dispersants, succinic ester dispersants, succinic ester-amide dispersant, Mannich base dispersant, phosphorylated forms thereof, and boronated forms thereof. The dispersants may be capped with acidic molecules capable of reacting with secondary amino groups. The molecular weight of the hydrocarbyl groups may range from about 600 to about 3000, for example from about 750 to about 2500, and as a further example from about 900 to about 1500.

[0030] Oil-soluble dispersants may include ashless dispersants such as succinimide dispersants, Mannich base dispersants, and polymeric polyamine dispersants. Hydrocarbyl-substituted succinic acylating agents are used to make hydrocarbyl-substituted succinimides. The hydrocarbyl-substituted succinic acylating agents include, but are not limited to, hydrocarbyl-substituted succinic acids, hydrocarbyl-substituted succinic anhydrides, the hydrocarbyl-substituted succinic acid halides (especially the acid fluorides and acid chlorides), and the esters of the hydrocarbyl-substituted succinic acids and lower alcohols (e.g., those containing up to 7 carbon atoms), that is, hydrocarbyl-substituted compounds which can function as carboxylic acylating agents.

[0031] Hydrocarbyl substituted acylating agents are made by reacting a polyolefin or chlorinated polyolefin of appropriate molecular weight with maleic anhydride. Similar carboxylic reactants can be used to make the acylating agents. Such reactants may include, but are not limited to, maleic acid, fumaric acid, maleic acid, tartaric acid, itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride, mesaconic acid, ethylmaleic anhydride, dimethylmaleic anhydride, ethylmaleic acid, dimethylmaleic acid, hexylmaleic acid, and the like, including the corresponding acid halides and lower aliphatic esters.

[0032] The molecular weight of the olefin can vary depending upon the intended use of the substituted succinic anhydrides. Typically, the substituted succinic anhydrides will have a hydrocarbyl group of from about 8 to about 500 carbon atoms. However, substituted succinic anhydrides used to make lubricating oil dispersants will typically have a hydrocarbyl group of about 40 to about 500 carbon atoms. With high molecular weight substituted succinic anhydrides, it is more accurate to refer to number average molecular weight (Mn) since the olefins used to make these substituted succinic anhydrides may include a mixture of different molecular weight components resulting from the polymerization of low molecular weight olefin monomers such as ethylene, propylene, and isobutylene.

[0033] The mole ratio of maleic anhydride to olefin can vary widely. It may vary, for example, from about 5:1 to about 1:5, or for example, from about 1:1 to about 3:1. With olefins such as polyisobutylene having a number average molecular weight of about 500 to about 7000, or as a further example, about 800 to about 3000 or higher and the ethylene-alpha-olefin copolymers, the maleic anhydride may be used in stoichiometric excess, e.g. about 1.1 to about 3 moles maleic anhydride per mole of olefin. The unreacted maleic anhydride can be vaporized from the resultant reaction mixture.

[0034] Polyalkenyl succinic anhydrides may be converted to polyalkyl succinic anhydrides by using conventional reducing conditions such as catalytic hydrogenation. For catalytic hydrogenation, a suitable catalyst is palladium on carbon. Likewise, polyalkenyl succinimides may be converted to polyalkyl succinimides using similar reducing conditions.

[0035] The polyalkyl or polyalkenyl substituent on the succinic anhydrides employed herein is generally derived from polyolefins, which are polymers or copolymers of mono-olefins, particularly 1-mono-olefins, such as ethylene, propylene, and butylene. The mono-olefin employed may have about 2 to about 24 carbon atoms, or as a further example, about 3 to about 12 carbon atoms. Other suitable mono-olefins include propylene, butylene, particularly isobutylene, 1-octene, and 1-decene. Polyolefins prepared from such mono-olefins include polypropylene, polybutene, polyisobutene, and the polyalphaolefins produced from 1-octene and 1-decene.

[0036] In some embodiments, the ashless dispersant may include one or more alkenyl succinimides of an amine having at least one primary amino group capable of forming an imide group. The alkenyl succinimides may be formed by conventional methods such as by heating an alkenyl succinic anhydride, acid, acid-ester, acid halide, or lower alkyl ester with an amine containing at least one primary amino group. The alkenyl succinic anhydride may be made readily by heating a mixture of polyolefin and maleic anhydride to about 180°C-220°C. The polyolefin may be a polymer or copolymer of a lower mono-olefin such as ethylene, propylene, isobutene, and the like, having a number average molecular weight in the range of about 300 to about 3000 as determined by gel permeation chromatography (GPC).

[0037] Amines which may be employed in forming the ashless dispersant include any that have at least one primary amino group which can react to form an imide group and at least one additional primary or secondary amino group and/or at least one hydroxyl group. Representative examples include: N-methyl-propanediamine, N-dodecylpropanediamine, N-aminopropyl-piperazine, ethanolamine, N-ethanol-ethylenediamine, and the like.

[0038] Suitable amines may include alkylene polyamines, such as propylene diamine, dipropylene triamine, di-(1,2-butylene)triamine, and tetra-(1,2-propylene)pentamine. A further example includes the ethylene polyamines which can be depicted by the formula $H_2N(CH_2CH_2NH)_nH$, wherein n may be an integer from about 1 to about 10. These include: ethylene diamine, diethylene triamine (DETA), triethylene tetramine (TETA), tetraethylene pentamine (TEPA), pentaethylene hexamine (PEHA), and the like, including mixtures thereof in which case n is the average value of the mixture. Such ethylene polyamines have a primary amine group at each end so they may form mono-alkenylsuccinimides and bis-alkenylsuccinimides. Commercially available ethylene polyamine mixtures may contain minor amounts of branched species and cyclic species such as N-aminoethyl piperazine, N,N'-bis(aminoethyl)piperazine, N,N'-bis(piperazinyl) ethane, and like compounds. The commercial mixtures may have approximate overall compositions falling in the range corresponding to diethylene triamine to tetraethylene pentamine. The molar ratio of polyalkenyl succinic anhydride to polyalkylene polyamines may be from about 1:1 to about 3.0:1.

[0039] In some embodiments, the ashless dispersant may include the products of the reaction of a polyethylene polyamine, e.g., triethylene tetramine or tetraethylene pentamine, with a hydrocarbon substituted carboxylic acid or anhydride made by reaction of a polyolefin, such as polyisobutene, of suitable molecular weight, with an unsaturated polycarboxylic acid or anhydride, e.g., maleic anhydride, maleic acid, fumaric acid, or the like, including mixtures of two or more such substances.

[0040] Polyamines that are also suitable in preparing the dispersants described herein include N-arylphenylenediamines, such as N-phenylphenylenediamines, for example, N-phenyl-1,4-phenylenediamine, N-phenyl-1,3-phenylenediamine, and N-phenyl-1,2-phenylenediamine; aminothiazoles such as aminothiazole, aminobenzothiazole, aminobenzothiadiazole, and aminoalkylthiazole; aminocarbazoles; aminoindoles; aminopyrroles; amino-indazolinones; aminomercaptotriazoles; aminoperimidines; aminoalkyl imidazoles, such as 1-(2-aminoethyl) imidazole, 1-(3-aminopropyl) imidazole; and aminoalkyl morpholines, such as 4-(3-aminopropyl) morpholine. These polyamines are described in more detail in U.S. Patent Nos. 4,863,623 and 5,075,383. Such polyamines can provide additional benefits, such as anti-wear and antioxidancy, to the final products.

[0041] Additional polyamines useful in forming the hydrocarbyl-substituted succinimides include polyamines having at least one primary or secondary amino group and at least one tertiary amino group in the molecule as taught in U.S. Patent Nos. 5,634,951 and 5,725,612. Examples of suitable polyamines include N,N,N",N"-tetraalkyldialkylenetriamines (two terminal tertiary amino groups and one central secondary amino group), N,N,N',N"-tetraalkyltrialkylenetetramines (one terminal tertiary amino group, two internal tertiary amino groups and one terminal primary amino group), N,N,N', N",N"'-pentaalkyltrialkylenetetramines (one terminal tertiary amino group, two internal tertiary amino groups and one terminal secondary amino group), tris(dialkylaminoalkyl)-aminoalkylmethanes (three terminal tertiary amino groups and one terminal primary amino group), and like compounds, wherein the alkyl groups are the same or different and typically contain no more than about 12 carbon atoms each, and which may contain from about 1 to about 4 carbon atoms each. As a further example, these alkyl groups may be methyl and/or ethyl groups. Polyamine reactants of this type may include dimethylaminopropylamine (DMAPA) and N-methyl piperazine.

[0042] Hydroxyamines suitable for use herein include compounds, oligomers or polymers containing at least one primary or secondary amine capable of reacting with the hydrocarbyl-substituted succinic acid or anhydride. Examples of hydroxyamines suitable for use herein include aminoethylethanolamine (AEEA), aminopropyldiethanolamine (APDEA), ethanolamine, diethanolamine (DEA), partially propoxylated hexamethylene diamine (for example HMDA-2PO or HMDA-3PO), 3-amino-1,2-propanediol, tris(hydroxymethyl)aminomethane, and 2-amino-1,3-propanediol.

[0043] The mole ratio of amine to hydrocarbyl-substituted succinic acid or anhydride may range from about 1:1 to about 3.0:1. Another example of a mole ratio of amine to hydrocarbyl-substituted succinic acid or anhydride may range from about 1.5:1 to about 2.0:1.

[0044] The foregoing dispersant may also be a post-treated dispersant made, for example, by treating the dispersant with maleic anhydride and boric acid as described, for example, in U.S. Patent No. 5,789,353, or by treating the dispersant with nonylphenol, formaldehyde and glycolic acid as described, for example, in U.S. Patent No. 5,137,980.

[0045] The Mannich base dispersants may be a reaction product of an alkyl phenol, typically having a long chain alkyl substituent on the ring, with one or more aliphatic aldehydes containing from about 1 to about 7 carbon atoms (especially formaldehyde and derivatives thereof), and polyamines (especially polyalkylene polyamines). For example, a Mannich base ashless dispersants may be formed by condensing about one molar proportion of long chain hydrocarbon-substituted phenol with from about 1 to about 2.5 moles of formaldehyde and from about 0.5 to about 2 moles of polyalkylene polyamine.

[0046] Hydrocarbon sources for preparation of the Mannich polyamine dispersants may be those derived from substantially saturated petroleum fractions and olefin polymers, such as polymers of mono-olefins having from about 2 to about 6 carbon atoms. The hydrocarbon source generally contains, for example, at least about 40 carbon atoms, and as a further example, at least about 50 carbon atoms to provide substantial oil solubility to the dispersant. The olefin polymers having a GPC number average molecular weight between about 600 and about 5,000 are suitable for reasons of easy reactivity and low cost. However, polymers of higher molecular weight can also be used. Especially suitable hydrocarbon sources are isobutylene polymers and polymers made from a mixture of isobutene and a raffinate I stream.

[0047] Suitable Mannich base dispersants may be Mannich base ashless dispersants formed by condensing about one molar proportion of long chain hydrocarbon-substituted phenol with from about 1 to about 2.5 moles of formaldehyde and from about 0.5 to about 2 moles of polyalkylene polyamine.

[0048] Polymeric polyamine dispersants suitable as the ashless dispersants are polymers containing basic amine groups and oil solubilizing groups (for example, pendant alkyl groups having at least about 8 carbon atoms). Such materials are illustrated by interpolymers formed from various monomers such as decyl methacrylate, vinyl decyl ether or relatively high molecular weight olefins, with aminoalkyl acrylates and aminoalkyl acrylamides. Examples of polymeric polyamine dispersants are set forth in U.S. Patent Nos. 3,329,658; 3,449,250; 3,493,520; 3,519,565; 3,666,730; 3,687,849; and 3,702,300. Polymeric polyamines may include hydrocarbyl polyamines wherein the hydrocarbyl group is composed of the polymerization product of isobutene and a raffinate I stream as described above. PIB-amines and PIB-polyamines may also be used.

[0049] Methods for the production of ashless dispersants as described above are known to those skilled in the art and are reported in the patent literature. For example, the synthesis of various ashless dispersants of the foregoing types is described in such patents as U.S. Patent Nos. 2,459,112; 2,962,442, 2,984,550; 3,036,003; 3,163,603; 3,166,516; 3,172,892; 3,184,474; 3,202,678; 3,215,707; 3,216,936; 3,219,666; 3,236,770; 3,254,025; 3,271,310; 3,272,746; 3,275,554; 3,281,357; 3,306,908; 3,311,558; 3,316,177; 3,331,776; 3,340,281; 3,341,542; 3,346,493; 3,351,552; 3,355,270; 3,368,972; 3,381,022; 3,399,141; 3,413,347; 3,415,750; 3,433,744; 3,438,757; 3,442,808; 3,444,170; 3,448,047; 3,448,048; 3,448,049; 3,451,933; 3,454,497; 3,454,555; 3,454,607; 3,459,661; 3,461,172; 3,467,668; 3,493,520; 3,501,405; 3,522,179; 3,539,633; 3,541,012; 3,542,680; 3,543,678; 3,558,743; 3,565,804; 3,567,637; 3,574,101; 3,576,743; 3,586,629; 3,591,598; 3,600,372; 3,630,904; 3,632,510; 3,632,511; 3,634,515; 3,649,229; 3,697,428; 3,697,574; 3,703,536; 3,704,308; 3,725,277; 3,725,441; 3,725,480; 3,726,882; 3,736,357; 3,751,365; 3,756,953; 3,793,202; 3,798,165; 3,798,247; 3,803,039; 3,804,763; 3,836,471; 3,862,981; 3,872,019; 3,904,595; 3,936,480; 3,948,800; 3,950,341; 3,957,746; 3,957,854; 3,957,855; 3,980,569; 3,985,802; 3,991,098; 4,006,089; 4,011,380; 4,025,451; 4,058,468; 4,071,548; 4,083,699; 4,090,854; 4,173,540; 4,234,435; 4,354,950; 4,485,023; 5,137,980; and Re 26,433, herein incorporated by reference.

[0050] An example of a suitable ashless dispersant is a borated dispersant. Borated dispersants may be formed by boronating (borating) an ashless dispersant having basic nitrogen and/or at least one hydroxyl group in the molecule, such as a succinimide dispersant, succinamide dispersant, succinic ester dispersant, succinic ester-amide dispersant, Mannich base dispersant, or hydrocarbyl amine or polyamine dispersant.

[0051] Methods that can be used for boronating the various types of ashless dispersants described above are described in U.S. Patent Nos. 3,087,936; 3,254,025; 3,281,428; 3,282,955; 2,284,409; 2,284,410; 3,338,832; 3,344,069; 3,533,945; 3,658,836; 3,703,536; 3,718,663; 4,455,243; and 4,652,387.

[0052] The borated dispersant may include a high molecular weight dispersant treated with boron such that the borated dispersant includes up to about 2 wt. % of boron. As another example the borated dispersant may include from about 0.8 wt. % or less of boron. As a further example, the borated dispersant may include from about 0.1 to about 0.7 wt. % of boron. As another example, the borated dispersant may include from about 0.25 to about 0.7 wt. % of boron. As a still further example, the borated dispersant may include from about 0.35 to about 0.7 wt. % of boron. The dispersant may be dissolved in oil of suitable viscosity for ease of handling. It should be understood that the weight percentages given here are for neat dispersant, without any diluent oil added.

[0053] A dispersant may be further reacted with an organic acid, an anhydride, and/or an aldehyde/phenol mixture. Such a process may enhance compatibility with elastomer seals, for example. The borated dispersant may further include a mixture of borated dispersants. As a further example, the borated dispersant may include a nitrogen-containing dispersant and/or may be free of phosphorus.

[0054] In some embodiments a dispersant may be used alone or in combination of one or more species or types of dispersants.

Detergent

[0055] An additive that may be omitted or reduced when making a UTTO from an STUO is a detergent. The detergents as described herein may comprise one or more metallic detergents. A suitable metallic detergent may include an oil-soluble neutral or overbased salt of alkali or alkaline earth metal with one or more of the following acidic substances (or mixtures thereof): (1) a sulfonic acid, (2) a carboxylic acid, (3) a salicylic acid, (4) an alkyl phenol, (5) a sulfurized alkyl phenol, and (6) an organic phosphorus acid characterized by at least one direct carbon-to-phosphorus linkage, such as a phosphonate. Such an organic phosphorus acid may include those prepared by the treatment of an olefin polymer (e.g., polyisobutylene having a molecular weight of about 1,000) with a phosphorizing agent such as phosphorus trichloride, phosphorus heptasulfide, phosphorus pentasulfide, phosphorus trichloride and sulfur, white phosphorus and a sulfur halide, or phosphorothioic chloride.

[0056] Suitable phosphonates include thiophosphonates and thiopyrophosphonates. These may be overbased to make overbased metal salts using methanol or phenol as the promoter.

[0057] Suitable salts may include neutral or overbased salts of magnesium, calcium, or zinc. As a further example, suitable salts may include magnesium sulfonate, calcium sulfonate, zinc sulfonate, magnesium phenate, calcium phenate, and/or zinc phenate. See, e.g., US 6,482,778.

[0058] Oil-soluble neutral metal-containing detergents are those detergents that contain stoichiometrically equivalent amounts of metal in relation to the amount of acidic moieties present in the detergent. Thus, in general the neutral detergents will have a low basicity when compared to their overbased counterparts. The acidic materials utilized in forming such detergents include carboxylic acids, salicylic acids, alkylphenols, sulfonic acids, sulfurized alkylphenols, and the like.

[0059] The term "overbased" in connection with metallic detergents is used to designate metal salts wherein the metal is present in stoichiometrically larger amounts than the organic radical. The commonly employed methods for preparing the overbased salts involve heating a mineral oil solution of an acid with a stoichiometric excess of a metal neutralizing agent such as the metal oxide, hydroxide, carbonate, bicarbonate, or sulfide at a temperature of about 50°C, and filtering the resultant product. The use of a "promoter" in the neutralization step to aid the incorporation of a large excess of metal likewise is known. Examples of compounds useful as the promoter include phenolic substances such as phenol, naphthol, alkyl phenol, thiophenol, sulfurized alkylphenol, and condensation products of formaldehyde with a phenolic substance; alcohols such as methanol, 2-propanol, octanol, ethylene glycol, stearyl alcohol, and cyclohexyl alcohol; and amines such as aniline, phenylene diamine, phenothiazine, phenyl-beta-naphthylamine, and dodecylamine. A particularly effective method for preparing the basic salts comprises mixing an acid with an excess of a basic alkaline earth metal neutralizing agent and at least one alcohol promoter, and carbonating the mixture at an elevated temperature such as 60°C to 200°C.

[0060] Examples of suitable metal-containing detergents include, but are not limited to, neutral and overbased salts such as a sodium sulfonate, a sodium carboxylate, a sodium salicylate, a sodium phenate, a sulfurized sodium phenate, a lithium sulfonate, a lithium carboxylate, a lithium salicylate, a lithium phenate, a sulfurized lithium phenate, a magnesium sulfonate, a magnesium carboxylate, a magnesium salicylate, a magnesium phenate, a sulfurized magnesium phenate, a calcium sulfonate, a calcium carboxylate, a calcium salicylate, a calcium phenate, a sulfurized calcium phenate, a potassium sulfonate, a potassium carboxylate, a potassium salicylate, a potassium phenate, a sulfurized potassium phenate, a zinc sulfonate, a zinc carboxylate, a zinc salicylate, a zinc phenate, and a sulfurized zinc phenate. Further examples include a lithium, sodium, potassium, calcium, and magnesium salt of a hydrolyzed phosphosulfurized olefin having about 10 to about 2,000 carbon atoms or of a hydrolyzed phosphosulfurized alcohol and/or an aliphatic-substituted phenolic compound having about 10 to about 2,000 carbon atoms. Even further examples include a lithium, sodium, potassium, calcium, and magnesium salt of an aliphatic carboxylic acid and an aliphatic substituted cycloaliphatic carboxylic acid and many other similar alkali and alkaline earth metal salts of oil-soluble organic acids. A mixture of a neutral or an overbased salt of two or more different alkali and/or alkaline earth metals can be used. Likewise, a neutral and/or an overbased salt of mixtures of two or more different acids can also be used.

[0061] As is well known, overbased metal detergents are generally regarded as containing overbasing quantities of inorganic bases, generally in the form of micro dispersions or colloidal suspensions. Thus the term "oil-soluble" as applied to metallic detergents is intended to include metal detergents wherein inorganic bases are present that are not necessarily completely or truly oil-soluble in the strict sense of the term, inasmuch as such detergents when mixed into base oils behave much the same way as if they were fully and totally dissolved in the oil. Collectively, the various metallic detergents referred to herein above, are sometimes called neutral, basic, or overbased alkali metal or alkaline earth metal-containing organic acid salts.

[0062] Methods for the production of oil-soluble neutral and overbased metallic detergents and alkaline earth metal-containing detergents are well known to those skilled in the art, and extensively reported in the patent literature. See, for example, U.S. Pat. Nos. 2,001,108; 2,081,075; 2,095,538; 2,144,078; 2,163,622; 2,270,183; 2,292,205; 2,335,017; 2,399,877; 2,416,281; 2,451,345; 2,451,346; 2,485,861; 2,501,731; 2,501,732; 2,585,520; 2,671,758; 2,616,904; 2,616,905; 2,616,906; 2,616,911; 2,616,924; 2,616,925; 2,617,049; 2,695,910; 3,178,368; 3,367,867; 3,496,105; 3,629,109; 3,865,737; 3,907,691; 4,100,085; 4,129,589; 4,137,184; 4,184,740; 4,212,752; 4,617,135; 4,647,387; and 4,880,550.

[0063] The metallic detergents utilized in this invention can, if desired, be oil-soluble boronated neutral and/or overbased alkali of alkaline earth metal-containing detergents. Methods for preparing boronated metallic detergents are described in, for example, U.S. Pat. Nos. 3,480,548; 3,679,584; 3,829,381; 3,909,691; 4,965,003; and 4,965,004.

Corrosion Inhibitor

[0064] An additive that may be omitted or reduced when making a UTTO from an STUO is a corrosion inhibitor. The corrosion inhibitors as described herein may comprise thiazoles, triazoles, and thiadiazoles. Examples of such compounds include benzotriazole, tolyltriazole, octyltriazole, decyltriazole, dodecyltriazole, 2-mercapto benzothiazole, 2,5-dimercapto-1,3,4-thiadiazole, 2-mercapto-5-hydrocarbylthio-1,3,4-thiadiazoles, 2-mercapto-5- hydrocarbyldithio-1,3,4-thiadiazoles, 2,5-bis(hydrocarbylthio)- 1,3,4-thiadiazoles, and 2,5-bis(hydrocarbyldithio)-1,3,4-thiadiazoles. Suitable compounds include the 1,3,4-thiadiazoles, a number of which are available as articles of commerce, and also combinations of triazoles such as tolyltriazole with a 1,3,5-thiadiazole such as a 2,5-bis(alkyldithio)-1,3,4-thiadiazole. The 1,3,4-thiadiazoles are generally synthesized from hydrazine and carbon disulfide by known procedures. See, for example, U.S. Pat. Nos. 2,765,289; 2,749,311; 2,760,933; 2,850,453; 2,910,439; 3,663,561; 3,862,798; and 3,840,549.

[0065] Rust or corrosion inhibitors are another type of inhibitor additive for use in embodiments of the present disclosure. Such materials include monocarboxylic acids and polycarboxylic acids. Examples of suitable monocarboxylic acids are octanoic acid, decanoic acid and dodecanoic acid. Suitable polycarboxylic acids include dimer and trimer acids such as are produced from such acids as tall oil fatty acids, oleic acid, linoleic acid, or the like. Another useful type of rust inhibitor may comprise alkenyl succinic acid and alkenyl succinic anhydride corrosion inhibitors such as, for example, tetrapropenylsuccinic acid, tetrapropenylsuccinic anhydride, tetradecenylsuccinic acid, tetradecenylsuccinic anhydride, hexadecenylsuccinic acid, hexadecenylsuccinic anhydride, and the like. Also useful are the half esters of alkenyl succinic acids having 8 to 24 carbon atoms in the alkenyl group with alcohols such as the polyglycols. Other suitable rust or corrosion inhibitors include ether amines; acid phosphates; amines; polyethoxylated compounds such as ethoxylated amines, ethoxylated phenols, and ethoxylated alcohols; imidazolines; aminosuccinic acids or derivatives thereof, and the like. Materials of these types are available as articles of commerce. Mixtures of such rust or corrosion inhibitors can be used.

[0066] Further, corrosion inhibitors included in an STUO which may be removed to provide a UTTO include inhibitors suitable for use in a crankcase formulation, such as a polyethoxylated phenol. Examples of inhibitors suitable for use in a UTTO include neutral calcium sulfonate and basic calcium sulfonate.

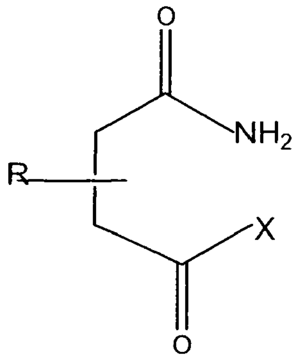
Friction Modifier

[0067] An additive that may be omitted or reduced when making a UTTO from an STUO is a friction modifier. The friction modifiers as described herein may comprise one or more of a succinimide, a bis-succinimide, an alkylated fatty amine, an ethoxylated fatty amine, an amide, a glycerol ester, and an imidazoline.

[0068] A suitable succinimide friction modifier may be prepared from an alkenyl succinic acid, such as an aliphatic carboxylic acid, or anhydride and ammonia. For example, the succinimide may comprise the reaction product of a succinic anhydride and ammonia. The alkenyl group of the alkenyl succinic acid may be a short chain alkenyl group, for example, the alkenyl group may comprise about 12 to about 36 carbon atoms. Further, the succinimide may comprise an about C_{12} to about C_{36} aliphatic hydrocarbyl succinimide. As a further example, the succinimide may comprise an about C_{16} to about C_{28} aliphatic hydrocarbyl succinimide. As another example, the succinimide may comprise an about C_{18} to about C_{24} aliphatic hydrocarbyl succinimide.

[0069] The succinimide may be prepared from a succinic anhydride and ammonia as described in European Patent 0 020 037, the disclosure of which is hereby incorporated by reference.

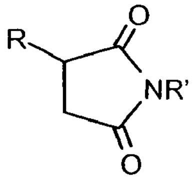
[0070] In some embodiments, the succinimide reaction product may comprise a minor amount of an unreacted olefin and an ammonium salt of acid amide of formula (II):



(II)

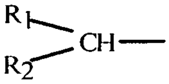
[0071] wherein R may be saturated or unsaturated, substituted or unsubstituted, and may be selected from the group consisting of linear, branched, and cyclic radicals comprising from about 5 to about 30 carbon atoms; and X may be selected from the group consisting of $O^-NH_4^+$ and NH_2.

[0072] The succinimide may be a compound represented by formula (I):



(I)

wherein R is saturated or unsaturated, substituted or unsubstituted, and is selected from the group consisting of linear, branched, and cyclic radicals comprising from about 5 to about 30 carbon atoms and R' is selected from the group consisting of hydrogen; alkyl, alkenyl, and aryl groups having from about 1 to 30 carbon atoms; and their heteroatom (nitrogen, oxygen or sulfur) containing analogues. Further, R may have the structure:



wherein either R_1 or R_2 may be hydrogen, but not both, and wherein R_1 and/or R_2 may be independently straight, branched, or cyclic hydrocarbon radicals comprising from about 1 to about 34, for example, from about 5 to about 30, carbon atoms such that the total number of carbon atoms in R_1 and R_2 may be from about 11 to about 35. R_1 and/or R_2 may also independently comprise functional groups such as alcohol, thiol, amide, amine, carboxylic acid, and derivatives thereof. In some embodiments, R_1 and/or R_2 may also independently be selected from the group consisting of oligomers and/or polymers derived from propylene isobutylene and higher olefins comprising terminal, internal, and vinylidene double bonds. The molecular weight of R_1 and R_2 may range from about 30 to about 200 amu, for example from about 50 to about 100 amu, and as a further example from about 60 to about 80 amu.

[0073] In some embodiments, the parent succinic anhydride may be formed by reacting maleic acid, anhydride, or ester with an internal olefin containing about 8 to about 500 carbon atoms. In some embodiments, the parent succinic anhydride may be formed by reacting maleic acid, anhydride, or ester with an internal olefin containing about 12 to about 36 carbon atoms, said internal olefin being formed by isomerizing the olefinic double bond of a linear α-olefin or mixture thereof to obtain a mixture of internal olefins., the parent succinic anhydride may be formed by reacting maleic acid, anhydride, or ester with an internal olefin containing about 12 to about 36 carbon atoms, said internal olefin being formed by isomerizing the olefinic double bond of a linear α-olefin or mixture thereof to obtain a mixture of internal olefins. The reaction may involve an equimolar amount of ammonia and may be carried out at elevated temperatures with the removal of water.

Antiwear Additive

[0074] An additive that may be omitted or reduced when making a UTTO from an STUO is an antiwear additive. The antiwear additives as described herein may comprise one or more of a zinc dialkyl dithio phosphate (ZDDP), an alkyl phosphite, a trialkyl phosphite, and amine salts of dialkyl and mono-alkyl phosphoric acid.

Antioxidant

[0075] An additive that may be omitted or reduced when making a UTTO from an STUO is an antioxidant. The antioxidants as described herein may comprise phenolic antioxidants, aromatic amine antioxidants, sulfurized phenolic antioxidants, and organic phosphites, among others. Examples of phenolic antioxidants include 2,6-di-tertbutylphenol, liquid mixtures of tertiary butylated phenols, 2,6-di-tert-butyl-4-methylphenol, 4,4'-methylenebis(2,6-di-tert-butylphenol), 2,2'-methylenebis(4-methyl6-ter t-butylphenol), mixed methylene-bridged polyalkyl phenols, and 4,4'-thiobis(2-methyl-6-tert-butylphenol). N,N'-di-sec-butyl-phenylenediamine, 4-isopropylaminodiphenylamine, phenyl-.alpha.-naphthyl amine, phenyl-.alpha.-naphthyl amine, and ring-alkylated diphenylamines. Examples include the sterically hindered tertiary butylated phenols, bisphenols and cinnamic acid derivatives and combinations thereof.

[0076] An antioxidant that may be omitted or reduced when making a UTTO from an STUO is a high temperature antioxidant. An example of a high temperature antioxidant includes an organic phosphonate having at least one direct carbon-to-phosphorus linkage. Such an organic phosphorus acid may include those prepared by the treatment of an olefin polymer (e.g., polyisobutylene having a molecular weight of about 1,000) with a phosphorizing agent such as phosphorus trichloride, phosphorus heptasulfide, phosphorus pentasulfide, phosphorus trichloride and sulfur, white phosphorus and a sulfur halide, or phosphorothioic chloride. Further, sulfurized alkyl phenol and organic phosphites can provide high temperature antioxidant performance.

Other Additive Components

[0077] The tractor fluid may also include conventional additives in addition to those described above. Such additives that may be omitted or reduced when making a UTTO from an STUO include, but are not limited to, viscosity index improvers, anti-rust additives, antiwear additives, pour point depressants, seal swell agents, colorants, metal deactivators, antifoam and defoamer additives, and/or air expulsion additives. Such additives may be added to provide, for example, viscometric multigrade functionality.

Base Oil

[0078] In some embodiments, the composition may also comprise a base oil. The base oil may be selected from, for example, any of the natural oils, synthetic oils, or mixtures thereof. The base oil may be present in the composition in a major amount. A "major amount" may be understood to mean greater than or equal to about 50 wt%.

[0079] Natural oils may include mineral oils, vegetable oils (e.g., castor oil, lard oil), animal oils, as well as mineral lubricating oils such as liquid petroleum oils and solvent treated or acid-treated mineral lubricating oils of the paraffinic, naphthenic or mixed paraffinic-naphthenic types. Oils derived from coal or shale are also suitable. The base oil typically has a viscosity of, for example, from about 2 to about 15 cSt and, as a further example, from about 2 to about 10 cSt at 100°C. Further, oils derived from a gas-to-liquid process are also suitable.

[0080] The synthetic oils may comprise at least one of an oligomer of an alpha-olefin, an ester, an oil derived from a Fischer-Tropsch process, and a gas-to-liquid stock. Synthetic oils include hydrocarbon oils such as polymerized and interpolymerized olefins (e.g., polybutylenes, polypropylenes, propylene isobutylene copolymers, etc.); polyalphaolefins such as poly(1-hexenes), poly-(1-octenes), poly(1-decenes), etc. and mixtures thereof; alkylbenzenes (e.g., dodecylbenzenes, tetradecylbenzenes, dinonylbenzenes, di-(2-ethylhexyl)benzenes, etc.); polyphenyls (e.g., biphenyls, terphenyl, alkylated polyphenyls, etc.); alkylated diphenyl ethers and alkylated diphenyl sulfides and the derivatives, analogs and homologs thereof and the like.

[0081] Alkylene oxide polymers and interpolymers and derivatives thereof where the terminal hydroxyl groups have been modified by esterification, etherification, etc., constitute another class of known synthetic oils that may be used. Such oils are exemplified by the oils prepared through polymerization of ethylene oxide or propylene oxide, the alkyl and aryl ethers of these polyoxyalkylene polymers (e.g., methyl-polyisopropylene glycol ether having an average molecular weight of about 1000, diphenyl ether of polyethylene glycol having a molecular weight of about 500-1000, diethyl ether of polypropylene glycol having a molecular weight of about 1000-1500, etc.) or mono- and polycarboxylic esters thereof, for example, the acetic acid esters, mixed C_{3-8} fatty acid esters, or the C_{13} oxo acid diester of tetraethylene glycol.

[0082] Another class of synthetic oils that may be used includes the esters of dicarboxylic acids (e.g., phthalic acid, succinic acid, alkyl succinic acids, alkenyl succinic acids, maleic acid, azelaic acid, suberic acid, sebacic acid, fumaric acid, adipic acid, linoleic acid dimer, malonic acid, alkyl malonic acids, alkenyl malonic acids, etc.) with a variety of alcohols (e.g., butyl alcohol, hexyl alcohol, dodecyl alcohol, 2-ethylhexyl alcohol, ethylene glycol, diethylene glycol monoether, propylene glycol, etc.) Specific examples of these esters include dibutyl adipate, di(2-ethylhexyl)sebacate, di-n-hexyl fumarate, dioctyl sebacate, diisooctyl azelate, diisodecyl azelate, dioctyl phthalate, didecyl phthalate, dieicosyl sebacate, the 2-ethylhexyl diester of linoleic acid dimer, the complex ester formed by reacting one mole of sebacic acid with two moles of tetraethylene glycol and two moles of 2-ethylhexanoic acid and the like.

[0083] Esters useful as synthetic oils also include those made from C_5 to C_{12} monocarboxylic acids and polyols and polyol ethers such as neopentyl glycol, trimethylol propane, pentaerythritol, dipentaerythritol, tripentaerythritol, etc.

[0084] Hence, the base oil used which may be used to make the tractor fluid compositions as described herein may be selected from any of the base oils in Groups I-V as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines.

[0085] Such base oil groups are as follows:

Base Oil Group[1]	Sulfur (wt. %)		Saturates (wt. %)	Viscosity Index
Group I	> 0.03	and/or	< 90	80 to 120
Group II	≤ 0.03	And	≥ 90	80 to 120
Group III	≤ 0.03	And	≥ 90	≥ 120
Group IV	All polyalphaolefins (PAOs)			
Group V	all others not included in Groups I-IV			
[1]Groups I-III are mineral oil base stocks.				

[0086] As set forth above, the base oil may be a poly-alpha-olefin (PAO). Typically, the poly-alpha-olefins are derived from monomers having from about 4 to about 30, or from about 4 to about 20, or from about 6 to about 16 carbon atoms. Examples of useful PAOs include those derived from octene, decene, mixtures thereof, and the like. PAOs may have a viscosity of from about 2 to about 15, or from about 3 to about 12, or from about 4 to about 8 cSt at 100°C. Examples of PAOs include 4 cSt at 100°C poly-alpha-olefins, 6 cSt at 100°C poly-alpha-olefins, and mixtures thereof. Mixtures of mineral oil with the foregoing poly-alpha-olefins may be used.

[0087] The base oil may be an oil derived from Fischer-Tropsch synthesized hydrocarbons. Fischer-Tropsch synthesized hydrocarbons are made from synthesis gas containing H_2 and CO using a Fischer-Tropsch catalyst. Such hydrocarbons typically require further processing in order to be useful as the base oil. For example, the hydrocarbons may be hydroisomerized using processes disclosed in U.S. Patent Nos. 6,103,099 or 6,180,575; hydrocracked and hydroisomerized using processes disclosed in U.S. Patent Nos. 4,943,672 or 6,096,940; dewaxed using processes disclosed in U.S. Patent No. 5,882,505; or hydroisomerized and dewaxed using processes disclosed in U.S. Patent Nos. 6,013,171; 6,080,301; or 6,165,949.

[0088] Unrefined, refined and rerefined oils, either natural or synthetic (as well as mixtures of two or more of any of these) of the type disclosed hereinabove can be used in the base oils. Unrefined oils are those obtained directly from a natural or synthetic source without further purification treatment. For example, a shale oil obtained directly from retorting operations, a petroleum oil obtained directly from primary distillation or ester oil obtained directly from an esterification process and used without further treatment would be an unrefined oil. Refined oils are similar to the unrefined oils except they have been further treated in one or more purification steps to improve one or more properties. Many such purification techniques are known to those skilled in the art such as solvent extraction, secondary distillation, acid or base extraction, filtration, percolation, etc. Rerefined oils are obtained by processes similar to those used to obtain refined oils applied to refined oils which have been already used in service. Such rerefined oils are also known as reclaimed or reprocessed oils and often are additionally processed by techniques directed to removal of spent additives, contaminants, and oil breakdown products.

[0089] In general, the additives may be employed in minor amounts sufficient to improve the performance characteristics and properties of the base fluid. The amounts will thus vary in accordance with such factors as the viscosity characteristics of the base fluid employed, the viscosity characteristics desired in the finished fluid, the service conditions for which the finished fluid is intended, and the performance characteristics desired in the finished fluid.

[0090] It will be appreciated that the individual components employed can be separately blended into the base fluid or can be blended therein in various subcombinations, if desired. Ordinarily, the particular sequence of such blending steps may not be crucial. Moreover, such components can be blended in the form of separate solutions in a diluent. According to various embodiments, however, the additive components may be blended in the form of a concentrate, as this simplifies the blending operations, reduces the likelihood of blending errors, and takes advantage of the compatibility and solubility characteristics afforded by the overall concentrate.

EXAMPLES

Example 1

[0091] A UTTO was formulated by modifying a STUO as follows in Table 1. Components needed for engine performance in the STUO were omitted or reduced to provide the UTTO.

Table 1.

Components	STUO Formulation	UTTO Formulation
Treat Rate	10 to 15 wt%	6 to 9 wt%
Dispersants	Present	Reduced by about 90%
Detergents	3536 ppm metal	Reduced by about 3% (i.e., reduced by about 100ppm metal) optimized for water sensitivity
Antiwear/EP	Present	Same type and amount
Corrosion Inhibitors	UTTO and Crankcase inhibitors	Omitted crankcase-type corrosion inhibitor
Antifoam	Present	Same type and amount
Friction Modifiers	Present	Same friction modifiers: Optimized level based on the amount of dispersant removed (about 50% reduction)
Antioxidants	UTTO antioxidant & Crankcase antioxidant	Reduced high temperature engine oil (crankcase) antioxidant by about 100%

[0092] The two formulations were then tested to determine performance in the John Deere J-20C specification. Results for the various tests are shown below in Table 2. Passing results were achieved for both formulations.

[0093] Information about these tests is publicly available from John Deere.

Table 2.

Rig Tests	STUO Formulations	UTTO Formulation
JDQ 96 Wet Brake	Pass	Pass
JDQ 94 Power Shifting Transmission	Pass	Pass
JDQ 84 Hydraulic Pump	Pass	Pass
JDQ 95 Final Drive	Pass	Pass
JDQ 102 Shear	Pass	Pass
John Deere Bench Tests	Pass	Pass
Allison C-4 Bench Tests	Pass	Pass
Allison Seal Tests	Pass	Pass
Vane Pump Wear	Pass	Pass
Allison C-4 Paper Friction	Pass	Pass
	Pass	Pass

Performance Examples

[0094] UTTOs formulated according to the present disclosure exhibit improved performance properties, for example, improved extreme pressure properties, improved brass wear properties, and improved friction properties. By removal of competitive interactions, the methods disclosed herein to make a UTTO provide a UTTO with such improved performance capabilities.

Example 2 - Extreme Pressure

[0095] The UTTO described in Table 1 was tested in three industry standard extreme pressure performance tests. A commercially available UTTO available from John Deere, under trade designation Hy-GARD® was tested as a comparative example. In all three tests, the UTTO according to the present disclosure showed an improvement in EP performance over the commercially available Hy-GARD® oil. The tests and results are shown in Table 3 below.

[0096] The 4-Ball Weld Test method is described in ASTM D-2783 D2783-88 (1998) Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method). The 4-Ball Method tests lubricant properties using a 1/2" diameter steel ball under a load rotating against 3 steel balls held stationary in a cradle. The test lubricant covers the lower 3 balls. A Series of 10 second tests are made at increasing loads until welding occurs.

[0097] The FZG designation describes the following test conditions: [Pinion type/Sliding Speed in meter*sec^{-1}/Temp] where the A is the pinion width (with 20mm inferred) or A-10 for a half width gear/8.3 m*sec^{-1} or 16.6R (Reverse) m*sec^{-1} sliding speed/90C temperature. For example A/8.3/90 describles a 20mm A profile gear/8.3 m*sec^{-1}/90°C.

[0098] The FZG Load Stage test is described in ASTM D 5182 Evaluating the Scuffing Load Capacity of Oils (also referred as the FZG Visual Method) (A/8.3/90). In the test, an "A" Profile pinion (20 mm width) is motored against a wheel gear at 1450 RPM for 21,700 revolutions. The teeth are rated for % Scuffing. The fail load stage is recorded when the sum total of scuffing equals 1 tooth width (20 mm). The FZG Scuffing test is used to identify GL-4 lubricants.

[0099] The FZG Stepwise test is a variant of the ASTM D-5182 scuffing test, and is described in FVA Information sheet #243 (designated as A-10/16.6R/90 or 120). The stepwise test increases the severity over the standard test as the pinion face is reduced to 10 mm width. The circumferential speed is doubled (16.6) and the direction of the drive speed is reversed where the wheel drives the pinion. This increases the test severity by at least 2 load stages. The stepwise test is similar to the standard scuffing test in that load is applied in increasing loads stages until the total scuffing equals one tooth width. The FZG stepwise test was designed to differentiate GL-4 lubricants from industrial lubes.

[0100] The FZG Sprung test is a variant of the FZG stepwise test above and is also described in FVA Information sheet #243 (designated as S- A-10/16.6R/90 or 120). The sprung or shock test differs from the stepwise test in that the load is applied to the gear without running in at subsequent stages. If the scuffing is not equal to one tooth width, the unit is dis-assembled and repeated on a new gear tooth surface. The FZG Sprung is a shock test designed to differentiate GL-5 type lubricants.

Table 3. Extreme Pressure Performance

Test	Test Procedure	Inventive UTTO Formulation	Hy-GARD®
4-Ball Weld Test	ASTM D 2783	220 Kg Weld	190 Kg Weld
FZG Load Stage Test	ASTM D 5182 FZG A/8.3/90	Failure at Stage 11	Failure at Stage 11
FZG Stepwise Test	CEC-L-84-A-04 FVA Info Sheet # 243 FZG A-10/16.6R/90	Failure at Stage 8	Failure at Stage 5
FZG Sprung Test	FVA Info Sheet # 243 FZG S-A-10/16.6R/90	Failure at Stage 7	Failure at Stage 5

[0101] Although both formulations are desiginated as GL-4 lubricants, improved EP performance is observed with the inventive UTTO, according the the above EP tests.

Example 3 - Brass Wear

[0102] The UTTO described in Table 1 was tested in industry standard brass wear performance tests - the SSP 180 B-80 Brass Friction & Wear test and the Falex ring on block test using a brass block face. Hy-GARD® was again tested as a comparative example. In the test, the UTTO according to the present disclosure showed a significant improvement in brass wear over the commercially available product. Further, the coefficient of friction in the presently disclosed UTTO was more stable over the test duration. The static/dynamic ratio was also more stable, indicating no change in performance over time. The test results are shown in Table 4 below.

[0103] The SSP-180 test stand, developed in the Gear Research Institute at the Technical University of Munich, allows mounting and testing of a complete synchronizer device (up to 180 mm in diameter) from a manual transmission of choice. Load conditions associated with normal transmission use are simulated during the test.

[0104] The test stand consists of an electric motor, two flywheels, actuating hydraulics, an oil heating and circulation system, and a test box. The large main flywheel is connected to the electric motor via a belt-and-pulley combination to ensure a constant and stable speed source. The small flywheel is the load that the synchronizers either bring to zero speed (shift to "A" position) or accelerate to a constant speed (shift to "B" position). This is accomplished by the two ring-and-cone synchronizers mounted in the test box. The rear unit accelerates the load flywheel to synchronous speed, while the forward unit decelerates the flywheel to zero speed. The actuating hydraulics move a shift fork that engages one unit and disengages the other. During shifting, heated lubricant is sprayed onto both synchronizer units. Subjecting these units to thousands of engagements serves to test synchronizer durability.

[0105] Use of a hardware set of known performance (such as the Audi B-80, New Venture Gear, or Daimler Benz synchronizers) allows determination of the effects of different lubricants on synchronizer endurance. As fluid formulations change to address new or greater performance requirements in other areas of the manual transmission, information provided by the test procedures run in this stand will allow lubricant formulators to determine if synchronizer performance will remain acceptable. The test is designated by the European CEC L-66-T-99.

Table 4. Brass Wear Performance

Test ID	**Test method**	**Hy-GARD®**	**Inventive UTTO Formulation**
B-80 Brass Wear Results	CEC L-66-T-99	1.13 mm	0.20 mm
Brass wear specimen	ASTM D-2714	9.3 mg wt. loss	3.5 mg wt. loss

[0106] Brass wear is reduced with the inventive UTTO using both brass synchronizers parts and brass material from hydraulic shoes.

Example 4 - Friction

[0107] The UTTO described in Table 1 was tested in an industry standard friction test, the Falex Block-on-Ring Friction and Wear Testing machine. Hy-GARD® was again tested as a comparative example. In the test, the UTTO according to the present disclosure showed a significant improvement in friction performance over the commercially available product. The test results are shown in Table 5 below. Further, FIG. 1 shows the static coefficient of friction for the inventive UTTO and the Hy-GARD® formulation. As shown in the figure, the results indicate that the static fiction stabilizes after an initial break-in phase compared to the commercial UTTO fluid that decreases over time. The commercial UTTO fluid has about 3 times the amount of wear with copper based alloy used in the hydraulic pump. FIG. 2 shows the friction change over time for the inventive UTTO and the Hy-GARD® formulation. As shown in the figure, the ratio of static to dynamic friction of the commercial UTTO fluid changes over time indicating a variable friction response with respect to the copper based alloy used in a hydraulic pump, while the inventive UTTO gives stable response and shows 1/3 the wear.

[0108] The Falex Block-on-Ring is described in ASTM D 2714 Falex Block-on-Ring Friction and Wear Testing Machine. The machine is operated using a steel test-ring rotating against a test block made from a copper-based hydraulic piston pump, the specimen assembly is partially immersed in the lubricant sample. The velocity of the test ring is variable between 0 and about 0.5 m/s. The specimens have a normal load applied by a 1 Ib dead weight on the 30:1 ratio lever system. Test cycles from stop to approximately 0.5 m/s to stop for a duration of 40 hours. Determinations are made for the coefficient of friction and the average weight loss for the stationary block at the end of the test.

Table 5. Friction Performance

Test ID	**Test Method**	**Hy-GARD®**	**Inventive UTTO**
B-80 Brass Coefficient of Friction	CEC L-6-T-99	0.092 CoF at 90K cycles	0.088 CoF at 100K cycles
Brass Friction	ASTM D-2714		
Static Friction		Figure 1	Figure 1
Static/Dynamic Ratio		Figure 2	Figure 2

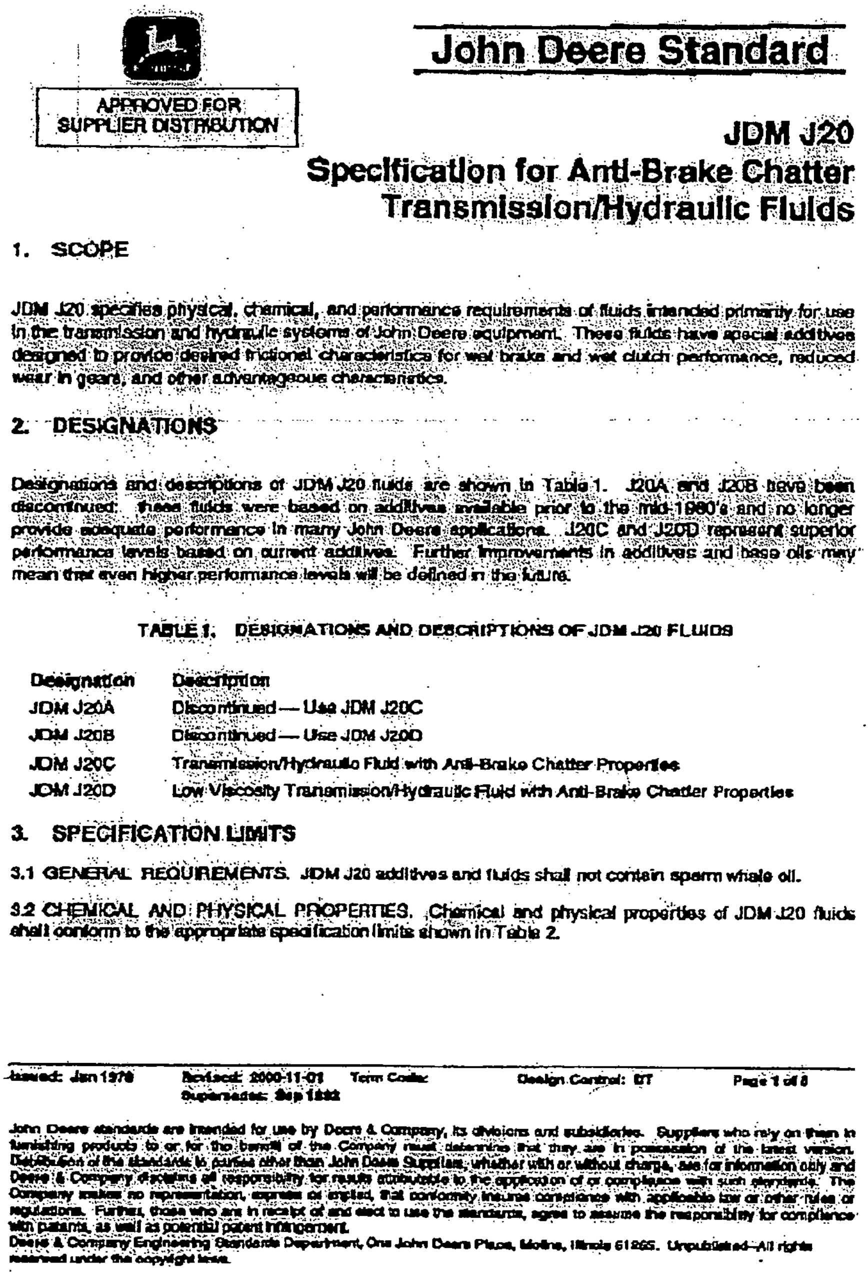
[0109] For the purposes of this specification and appended claims, unless otherwise indicated, all numbers expressing quantities, percentages or proportions, and other numerical values used in the specification and claims, are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

[0110] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contains certain errors necessarily resulting from the standard deviation found in their respective testing measurements. Moreover, all ranges disclosed herein are to be understood to encompass any and all subranges subsumed therein. For example, a range of "less than 10" includes any and all subranges between (and including) the minimum value of zero and the maximum value of 10, that is, any and all subranges having a minimum value of equal to or greater than zero and a maximum value of equal to or less than 10, e.g., 1 to 5.

[0111] It is noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the," include plural referents unless expressly and unequivocally limited to one referent. Thus, for example, reference to "a succinimide" includes two or more different succinimides. As used herein, the term "include" and its grammatical variants are intended to be non-limiting, such that recitation of items in a list is not to the exclusion of other like items that can be substituted or added to the listed items.

[0112] It will be apparent to those skilled in the art that various modifications and variations can be made to various embodiments described herein without departing from the spirit or scope of the present teachings. Thus, it is intended that the various embodiments described herein cover other modifications and variations within the scope of the appended claims and their equivalents.

ANNEX 1



APPROVED FOR SUPPLIER DISTRIBUTION

John Deere Standard

JDM J20

Specification for Anti-Brake Chatter Transmission/Hydraulic Fluids

1. SCOPE

JDM J20 specifies physical, chemical, and performance requirements of fluids intended primarily for use in the transmission and hydraulic systems of John Deere equipment. These fluids have special additives designed to provide desired frictional characteristics for wet brake and wet clutch performance, reduced wear in gears, and other advantageous characteristics.

2. DESIGNATIONS

Designations and descriptions of JDM J20 fluids are shown in Table 1. J20A and J20B have been discontinued: these fluids were based on additives available prior to the mid-1980's and no longer provide adequate performance in many John Deere applications. J20C and J20D represent superior performance levels based on current additives. Further improvements in additives and base oils may mean that even higher performance levels will be defined in the future.

TABLE 1. DESIGNATIONS AND DESCRIPTIONS OF JDM J20 FLUIDS

Designation	Description
JDM J20A	Discontinued — Use JDM J20C
JDM J20B	Discontinued — Use JDM J20D
JDM J20C	Transmission/Hydraulic Fluid with Anti-Brake Chatter Properties
JDM J20D	Low Viscosity Transmission/Hydraulic Fluid with Anti-Brake Chatter Properties

3. SPECIFICATION LIMITS

3.1 GENERAL REQUIREMENTS. JDM J20 additives and fluids shall not contain sperm whale oil.

3.2 CHEMICAL AND PHYSICAL PROPERTIES. Chemical and physical properties of JDM J20 fluids shall conform to the appropriate specification limits shown in Table 2.

Issued: Jan 1978 Revised: 2000-11-01 Term Code: Design Control: DT Page 1 of 8
Supersedes: Sep 1992

John Deere standards are intended for use by Deere & Company, its divisions and subsidiaries. Suppliers who rely on them in furnishing products to or for the benefit of the Company must determine that they are in possession of the latest version. Distribution of the standards to parties other than John Deere Suppliers, whether with or without charge, are for information only and Deere & Company disclaims all responsibility for results attributable to the application of or compliance with such standards. The Company makes no representation, express or implied, that conformity insures compliance with applicable law or other rules or regulations. Further, those who are in receipt of and elect to use the standards, agree to assume the responsibility for compliance with patents, as well as potential patent infringement.
Deere & Company Engineering Standards Department, One John Deere Place, Moline, Illinois 61265. Unpublished—All rights reserved under the copyright laws.

JDM J20

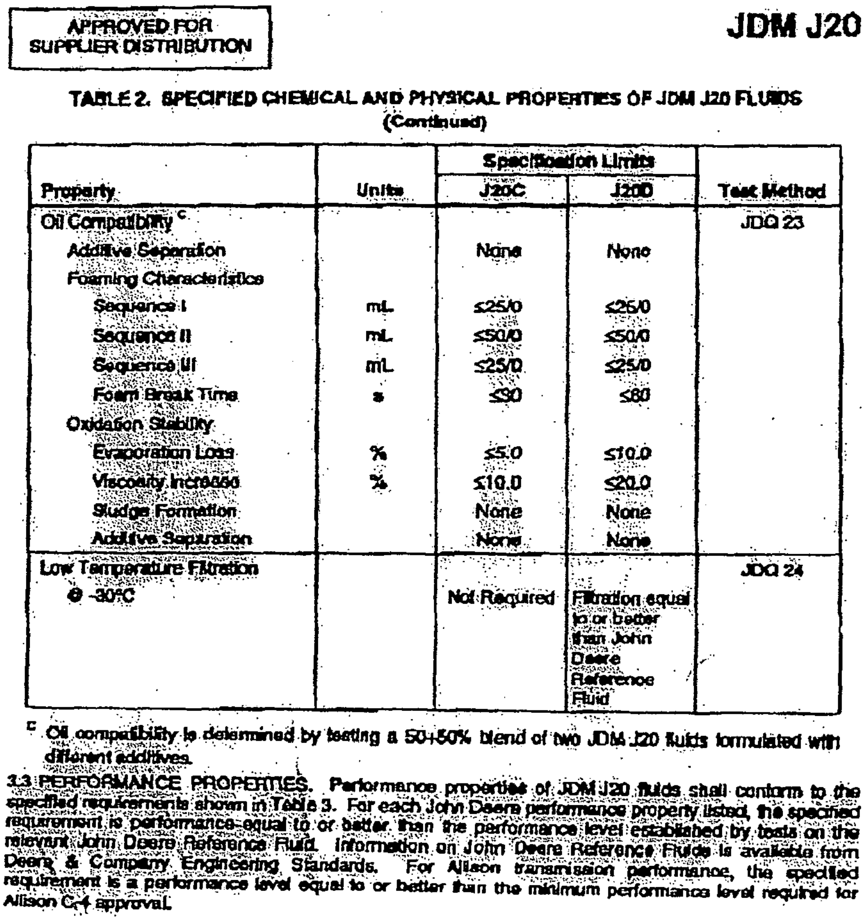
APPROVED FOR
SUPPLIER DISTRIBUTION

TABLE 2. SPECIFIED CHEMICAL AND PHYSICAL PROPERTIES OF JDM J20 FLUIDS

Property	Units	Specification Limits		Test Method
		J20C	J20D	
Kinematic Viscosity				ISO 3104
@ 100°C	mm²/s	≥9.1	≥7.0	
Shear Stability Viscosity				JDQ 102
@ 100°C	mm²/s	≥7.1	≥5.0	
Brookfield Viscosity [A]				ASTM D2983
@ -20°C	Pa-s	≤5.5	≤1.5	
@ -35°C	Pa-s	≤70.0		
@ -40°C	Pa-s		≤20.0	
Flash Point	°C	≥200	≥150	ISO 2592
Pour Point [B]	°C	≤-38	≤-45	ISO 3016
Stable Pour Point [B]	°C	≤-36	≤-45	SAE J300 Appendix B
Rust Protection	h	≥100	≥100	JDQ 22
Foaming Characteristics				JDQ 33
Sequence I	mL	≤25/0	≤25/0	
Sequence II	mL	≤50/0	≤50/0	
Sequence III	mL	≤25/0	≤25/0	
Foam Break Time	s	≤30	≤80	
Water Sensitivity				JDQ 19
Solids	% Volume	≤0.1	≤0.1	
Additive Loss	% Mass	≤15.0	≤15.0	

[A] For some market areas, specification limits shown in Table 2 for Brookfield viscosity may be revised. Brookfield viscosity of JDM J20C fluids marketed in these areas must be ≤20.0 Pa-s at a temperature 5°C below the tenth percentile minimum temperature for the coldest month of the year in the marketing area, or 5°C below the minimum temperature that the marketer recommends for their use, whichever applies. Tenth percentile minimum temperatures for approximately 2000 locations throughout the world are listed in HNBK-4.

[B] For some market areas, specification limits shown in Table 2 for pour point and stable pour point may be revised. Pour point and stable pour point of fluids marketed in these areas must be at least 5°C below the tenth percentile minimum temperature for the coldest month of the year in the marketing area, or 5°C below the minimum temperature that the marketer recommends for their use, whichever applies. Tenth percentile minimum temperatures for approximately 2000 locations throughout the world are listed in HNBK-4.



APPROVED FOR
SUPPLIER DISTRIBUTION

JDM J20

TABLE 2. SPECIFIED CHEMICAL AND PHYSICAL PROPERTIES OF JDM J20 FLUIDS
(Continued)

Property	Units	Specification Limits		Test Method
		J20C	J20D	
Oil Compatibility [c]				JDQ 23
Additive Separation		None	None	
Foaming Characteristics				
Sequence I	mL	≤25/0	≤25/0	
Sequence II	mL	≤50/0	≤50/0	
Sequence III	mL	≤25/0	≤25/0	
Foam Break Time	s	≤30	≤60	
Oxidation Stability				
Evaporation Loss	%	≤5.0	≤10.0	
Viscosity Increase	%	≤10.0	≤20.0	
Sludge Formation		None	None	
Additive Separation		None	None	
Low Temperature Filtration @ -30°C		Not Required	Filtration equal to or better than John Deere Reference Fluid	JDQ 24

[c] Oil compatibility is determined by testing a 50+50% blend of two JDM J20 fluids formulated with different additives.

3.3 PERFORMANCE PROPERTIES. Performance properties of JDM J20 fluids shall conform to the specified requirements shown in Table 3. For each John Deere performance property listed, the specified requirement is performance equal to or better than the performance level established by tests on the relevant John Deere Reference Fluid. Information on John Deere Reference Fluids is available from Deere & Company Engineering Standards. For Allison transmission performance, the specified requirement is a performance level equal to or better than the minimum performance level required for Allison C-4 approval.

TABLE 3. SPECIFIED PERFORMANCE PROPERTIES OF JDM J20 FLUIDS

Performance Property	Satisfactory Test Results Required For		Test Method
	J20C Fluids	J20D Fluids	
JOHN DEERE BRAKE PERFORMANCE			JDQ 96
• Torque Variation (Chatter)	Yes	Yes	
• Capacity	Yes	Yes	
• Brake Pad Wear	Yes	Yes	
JOHN DEERE PST CLUTCH PERFORMANCE			JDQ 94
• Friction Coefficient	Yes	Yes	
• Stall Time	Yes	Yes	
JOHN DEERE HYDRAULIC PUMP PERFORMANCE			JDQ 84
• Flow Degradation	Yes	Yes	
• Pump Wear/Corrosion	Yes	Yes	
JOHN DEERE SPIRAL BEVEL & FINAL DRIVE PERFORMANCE			JDQ 95
• Spiral Bevel Rating	Yes	Yes	
• Sun Pinion Wear	Yes	Yes	
• Gear Surface Condition	Yes	Yes	
ALLISON TRANSMISSION PERFORMANCE			DOAC C-4
• Allison C-4 Approval Tests	Yes	Yes	

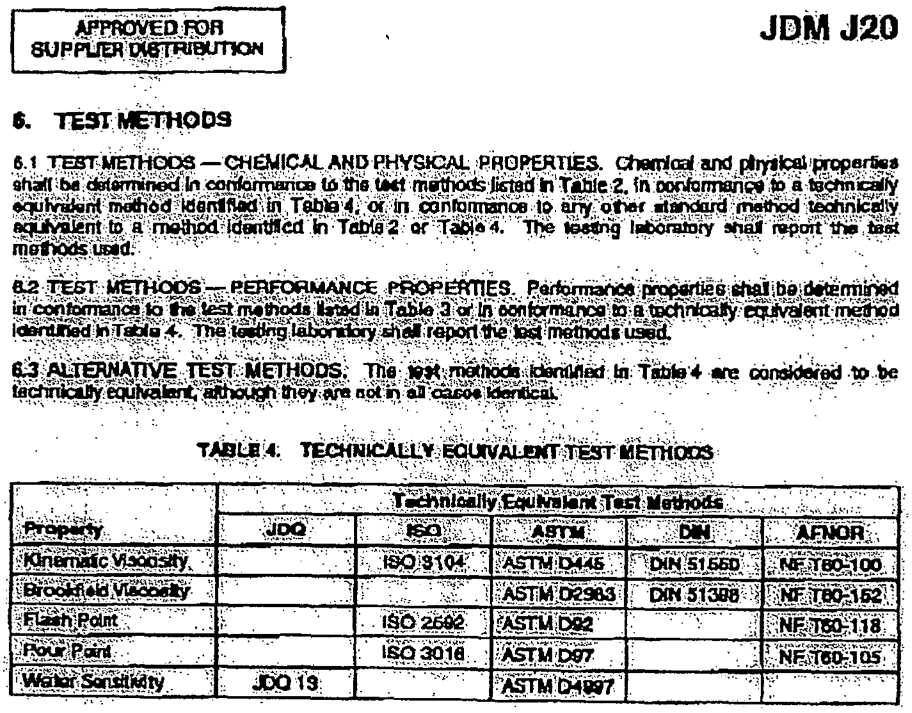
4. FACTORY FILL APPROVAL

Factory fill fluids shall meet the required chemical, physical, and performance properties for JDM J20C or J20D fluids. Individual Deere units may also establish additional or more restrictive requirements. Any such requirements shall be documented by adoption of an appropriate unit standard.

5. MARKETING OF TRANSMISSION/HYDRAULIC FLUIDS

5.1 Marketers of transmission/hydraulic fluids that use statements of conformance to this standard may be required to substantiate performance claims.

5.2 Marketers shall not use or imitate any trade dress or color scheme employed by Deere & Company, shall not use a depiction of a vehicle, machine, or other product manufactured or marketed by Deere & Company, and shall not use any trade name or trademark belonging to Deere & Company.'



APPROVED FOR
SUPPLIER DISTRIBUTION

JDM J20

6. TEST METHODS

6.1 TEST METHODS — CHEMICAL AND PHYSICAL PROPERTIES. Chemical and physical properties shall be determined in conformance to the test methods listed in Table 2, in conformance to a technically equivalent method identified in Table 4, or in conformance to any other standard method technically equivalent to a method identified in Table 2 or Table 4. The testing laboratory shall report the test methods used.

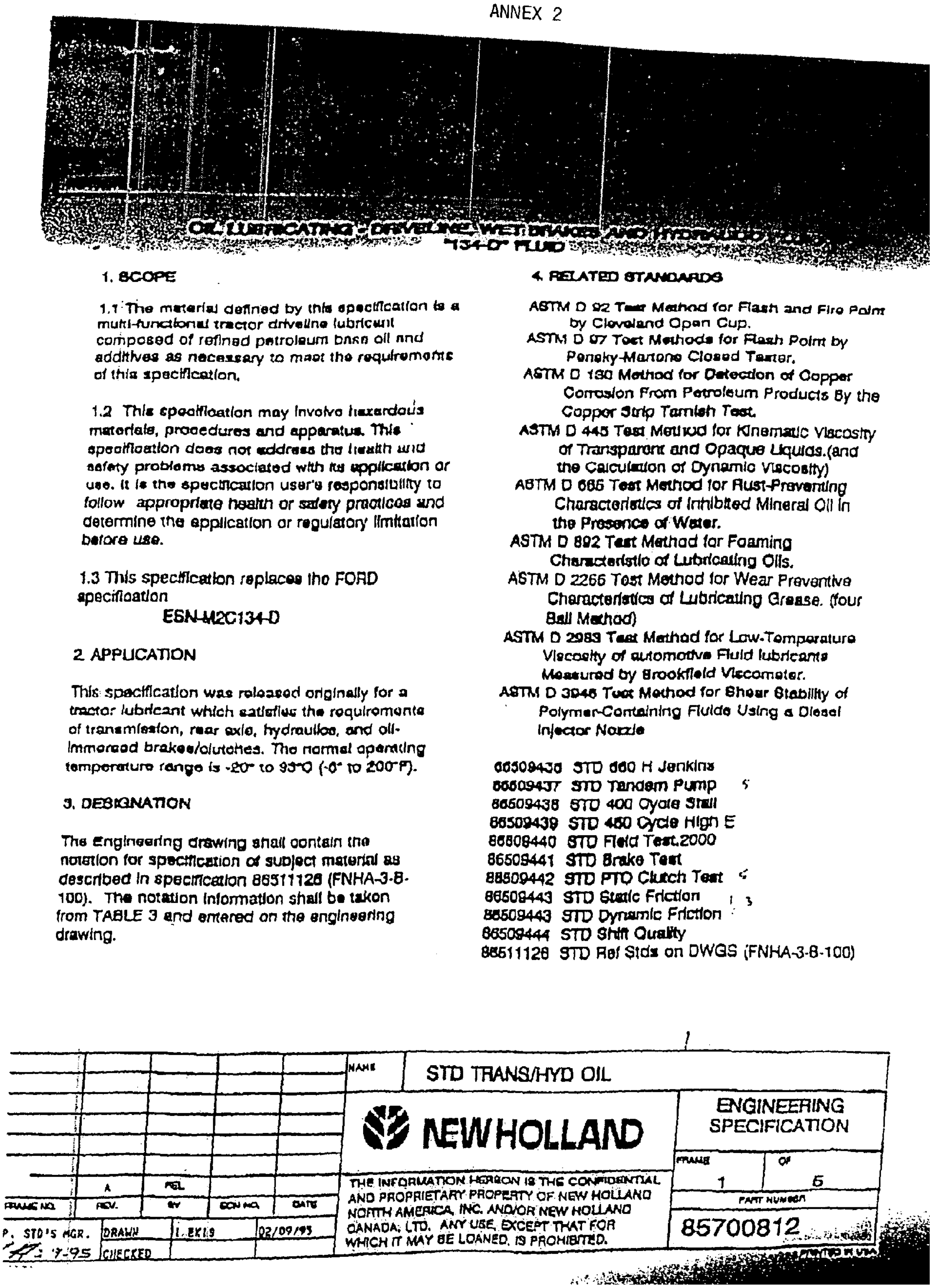
6.2 TEST METHODS — PERFORMANCE PROPERTIES. Performance properties shall be determined in conformance to the test methods listed in Table 3 or in conformance to a technically equivalent method identified in Table 4. The testing laboratory shall report the test methods used.

6.3 ALTERNATIVE TEST METHODS. The test methods identified in Table 4 are considered to be technically equivalent, although they are not in all cases identical.

TABLE 4. TECHNICALLY EQUIVALENT TEST METHODS

Property	Technically Equivalent Test Methods				
	JDQ	ISO	ASTM	DIN	AFNOR
Kinematic Viscosity		ISO 3104	ASTM D445	DIN 51550	NF T60-100
Brookfield Viscosity			ASTM D2983	DIN 51398	NF T60-152
Flash Point		ISO 2592	ASTM D92		NF T60-118
Pour Point		ISO 3016	ASTM D97		NF T60-105
Water Sensitivity	JDQ 13		ASTM D4997		

ANNEX 2



OIL LUBRICATING - DRIVELINE, WET BRAKES AND HYDRAULIC "134-D" FLUID

1. SCOPE

1.1 The material defined by this specification is a multi-functional tractor driveline lubricant composed of refined petroleum base oil and additives as necessary to meet the requirements of this specification.

1.2 This specification may involve hazardous materials, procedures and apparatus. This specification does not address the health and safety problems associated with its application or use. It is the specification user's responsibility to follow appropriate health or safety practices and determine the application or regulatory limitation before use.

1.3 This specification replaces the FORD specification

ESN-M2C134-D

2. APPLICATION

This specification was released originally for a tractor lubricant which satisfies the requirements of transmission, rear axle, hydraulics, and oil-immersed brakes/clutches. The normal operating temperature range is -20° to 93°C (-0° to 200°F).

3. DESIGNATION

The Engineering drawing shall contain the notation for specification of subject material as described in specification 86511128 (FNHA-3-8-100). The notation information shall be taken from TABLE 3 and entered on the engineering drawing.

4. RELATED STANDARDS

ASTM D 92 Test Method for Flash and Fire Point by Cleveland Open Cup.

ASTM D 97 Test Methods for Flash Point by Pensky-Martens Closed Tester.

ASTM D 130 Method for Detection of Copper Corrosion From Petroleum Products By the Copper Strip Tarnish Test.

ASTM D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids.(and the Calculation of Dynamic Viscosity)

ASTM D 665 Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.

ASTM D 892 Test Method for Foaming Characteristic of Lubricating Oils.

ASTM D 2266 Test Method for Wear Preventive Characteristics of Lubricating Grease. (four Ball Method)

ASTM D 2983 Test Method for Low-Temperature Viscosity of automotive Fluid lubricants Measured by Brookfield Viscometer.

ASTM D 3945 Test Method for Shear Stability of Polymer-Containing Fluids Using a Diesel Injector Nozzle

86509436	STD 660 H Jenkins
86509437	STD Tandem Pump
86509438	STD 400 Cycle Stall
86509439	STD 460 Cycle High E
86509440	STD Field Test.2000
86509441	STD Brake Test
86509442	STD PTO Clutch Test
86509443	STD Static Friction
86509443	STD Dynamic Friction
86509444	STD Shift Quality
86511128	STD Ref Stds on DWGS (FNHA-3-8-100)

NAME STD TRANS/HYD OIL

NEW HOLLAND

ENGINEERING SPECIFICATION

FRAME 1 OF 5

A REL

FRAME NO. REV. BY ECN NO. DATE

THE INFORMATION HEREON IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF NEW HOLLAND NORTH AMERICA, INC. AND/OR NEW HOLLAND CANADA, LTD. ANY USE, EXCEPT THAT FOR WHICH IT MAY BE LOANED, IS PROHIBITED.

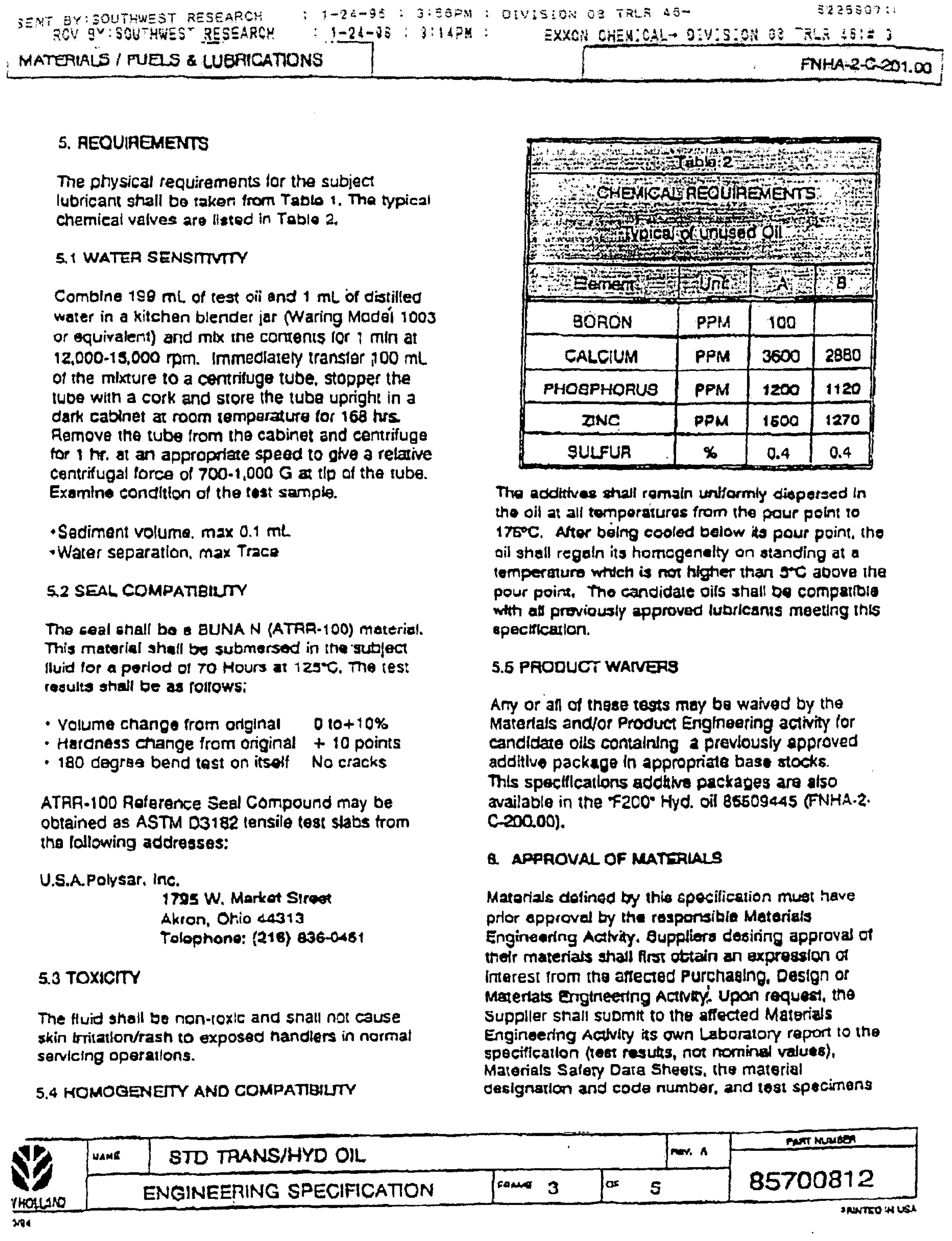
PART NUMBER 85700812

P. STD'S MGR. 7-95

DRAWN L. EKIS 02/09/95

CHECKED

PRINTED IN USA



5. REQUIREMENTS

The physical requirements for the subject lubricant shall be taken from Table 1. The typical chemical valves are listed in Table 2.

5.1 WATER SENSITIVITY

Combine 199 mL of test oil and 1 mL of distilled water in a kitchen blender jar (Waring Model 1003 or equivalent) and mix the contents for 1 min at 12,000-15,000 rpm. Immediately transfer 100 mL of the mixture to a centrifuge tube, stopper the tube with a cork and store the tube upright in a dark cabinet at room temperature for 168 hrs. Remove the tube from the cabinet and centrifuge for 1 hr. at an appropriate speed to give a relative centrifugal force of 700-1,000 G at tip of the tube. Examine condition of the test sample.

- Sediment volume, max 0.1 mL
- Water separation, max Trace

5.2 SEAL COMPATIBILITY

The seal shall be a BUNA N (ATRR-100) material. This material shall be submersed in the subject fluid for a period of 70 Hours at 125°C. The test results shall be as follows:

• Volume change from original	0 to+10%
• Hardness change from original	+ 10 points
• 180 degree bend test on itself	No cracks

ATRR-100 Reference Seal Compound may be obtained as ASTM D3182 tensile test slabs from the following addresses:

U.S.A.Polysar, Inc.
1795 W. Market Street
Akron, Ohio 44313
Telephone: (216) 836-0461

5.3 TOXICITY

The fluid shall be non-toxic and shall not cause skin irritation/rash to exposed handlers in normal servicing operations.

5.4 HOMOGENEITY AND COMPATIBILITY

Table 2

CHEMICAL REQUIREMENTS

Typical of unused Oil

Element	Unit	A	B
BORON	PPM	100	
CALCIUM	PPM	3600	2880
PHOSPHORUS	PPM	1200	1120
ZINC	PPM	1500	1270
SULFUR	%	0.4	0.4

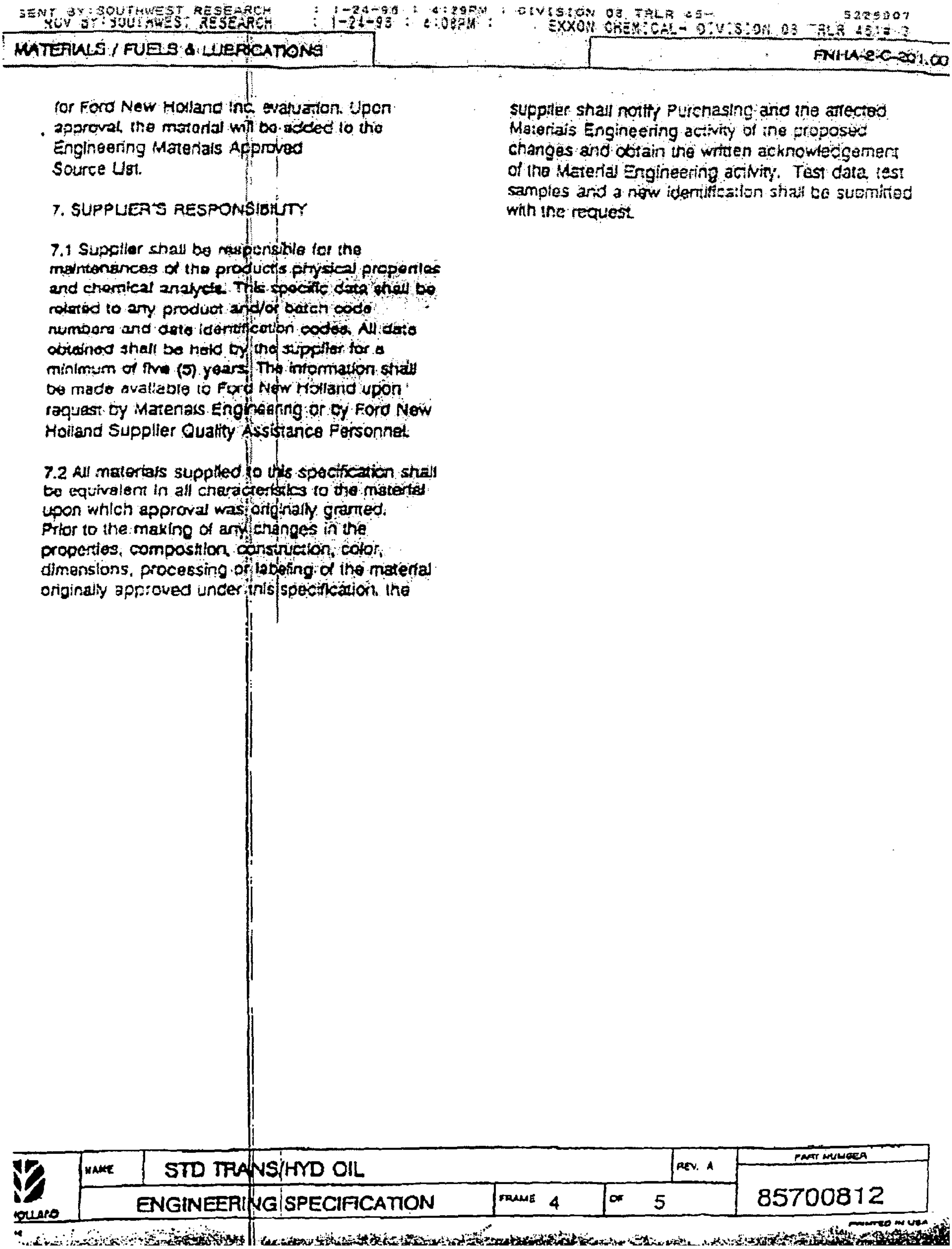
The additives shall remain uniformly dispersed in the oil at all temperatures from the pour point to 176°C. After being cooled below its pour point, the oil shall regain its homogeneity on standing at a temperature which is not higher than 5°C above the pour point. The candidate oils shall be compatible with all previously approved lubricants meeting this specification.

5.5 PRODUCT WAIVERS

Any or all of these tests may be waived by the Materials and/or Product Engineering activity for candidate oils containing a previously approved additive package in appropriate base stocks. This specifications additive packages are also available in the "F200" Hyd. oil 86509445 (FNHA-2-C-200.00).

6. APPROVAL OF MATERIALS

Materials defined by this specification must have prior approval by the responsible Materials Engineering Activity. Suppliers desiring approval of their materials shall first obtain an expression of interest from the affected Purchasing, Design or Materials Engineering Activity. Upon request, the Supplier shall submit to the affected Materials Engineering Activity its own Laboratory report to the specification (test results, not nominal values), Materials Safety Data Sheets, the material designation and code number, and test specimens



SENT BY:SOUTHWEST RESEARCH : 1-24-98 : 4:29PM : DIVISION 03 TRLR 45- 5225907
RCV BY:SOUTHWEST RESEARCH : 1-24-98 : 4:08PM : EXXON CHEMICAL- DIVISION 03 TRLR 45;# 3

MATERIALS / FUELS & LUBRICATIONS FNHA-2-C-201.00

for Ford New Holland Inc. evaluation. Upon approval, the material will be added to the Engineering Materials Approved Source List.

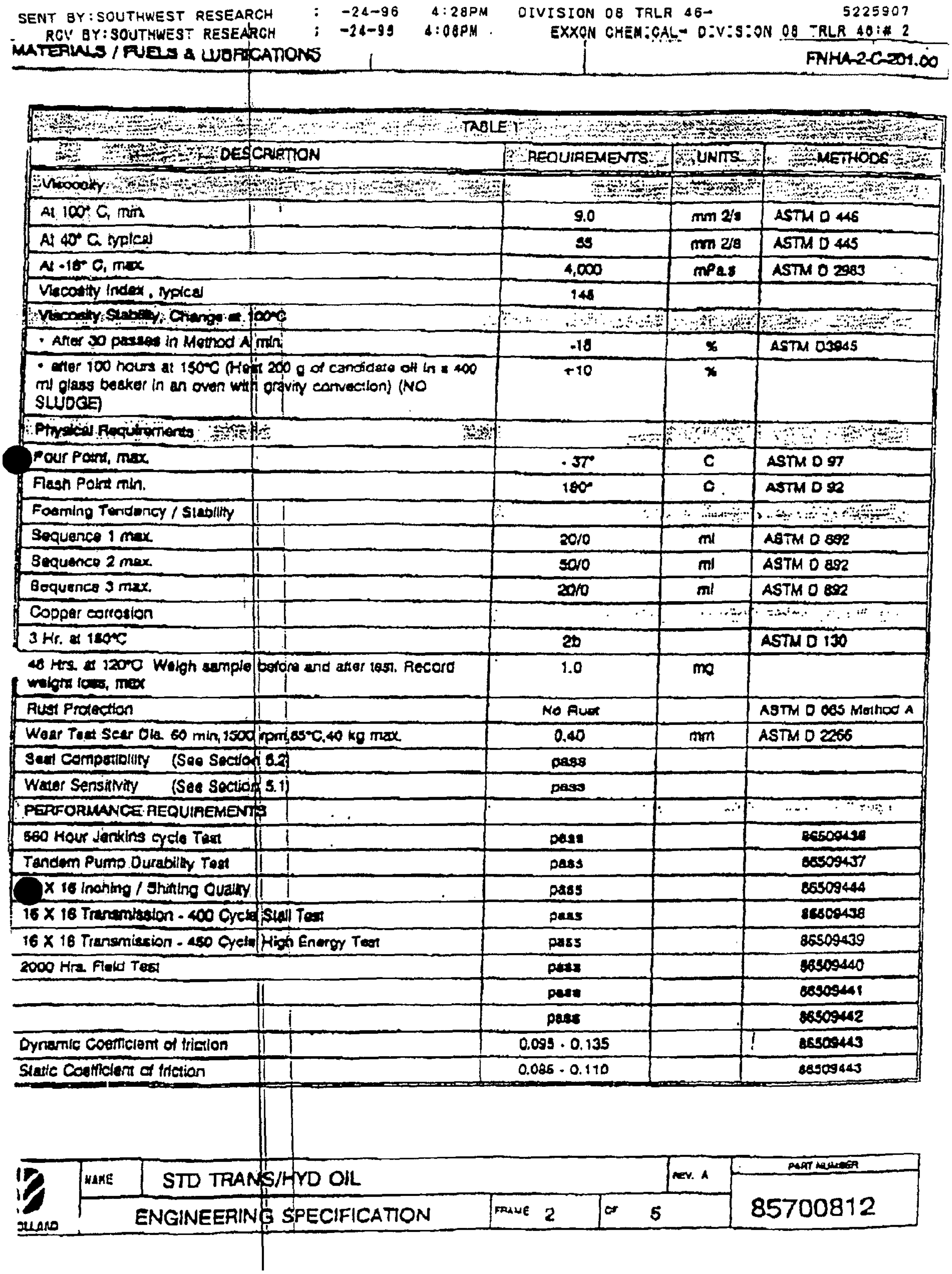
7. SUPPLIER'S RESPONSIBILITY

7.1 Supplier shall be responsible for the maintenances of the products physical properties and chemical analysis. This specific data shall be related to any product and/or batch code numbers and data identification codes. All data obtained shall be held by the supplier for a minimum of five (5) years. The information shall be made available to Ford New Holland upon request by Materials Engineering or by Ford New Holland Supplier Quality Assistance Personnel.

7.2 All materials supplied to this specification shall be equivalent in all characteristics to the material upon which approval was originally granted. Prior to the making of any changes in the properties, composition, construction, color, dimensions, processing or labeling of the material originally approved under this specification, the supplier shall notify Purchasing and the affected Materials Engineering activity of the proposed changes and obtain the written acknowledgement of the Material Engineering activity. Test data, test samples and a new identification shall be submitted with the request.

NAME	STD TRANS/HYD OIL		REV. A		PART NUMBER
ENGINEERING SPECIFICATION		FRAME 4	OF 5		85700812

PRINTED IN USA



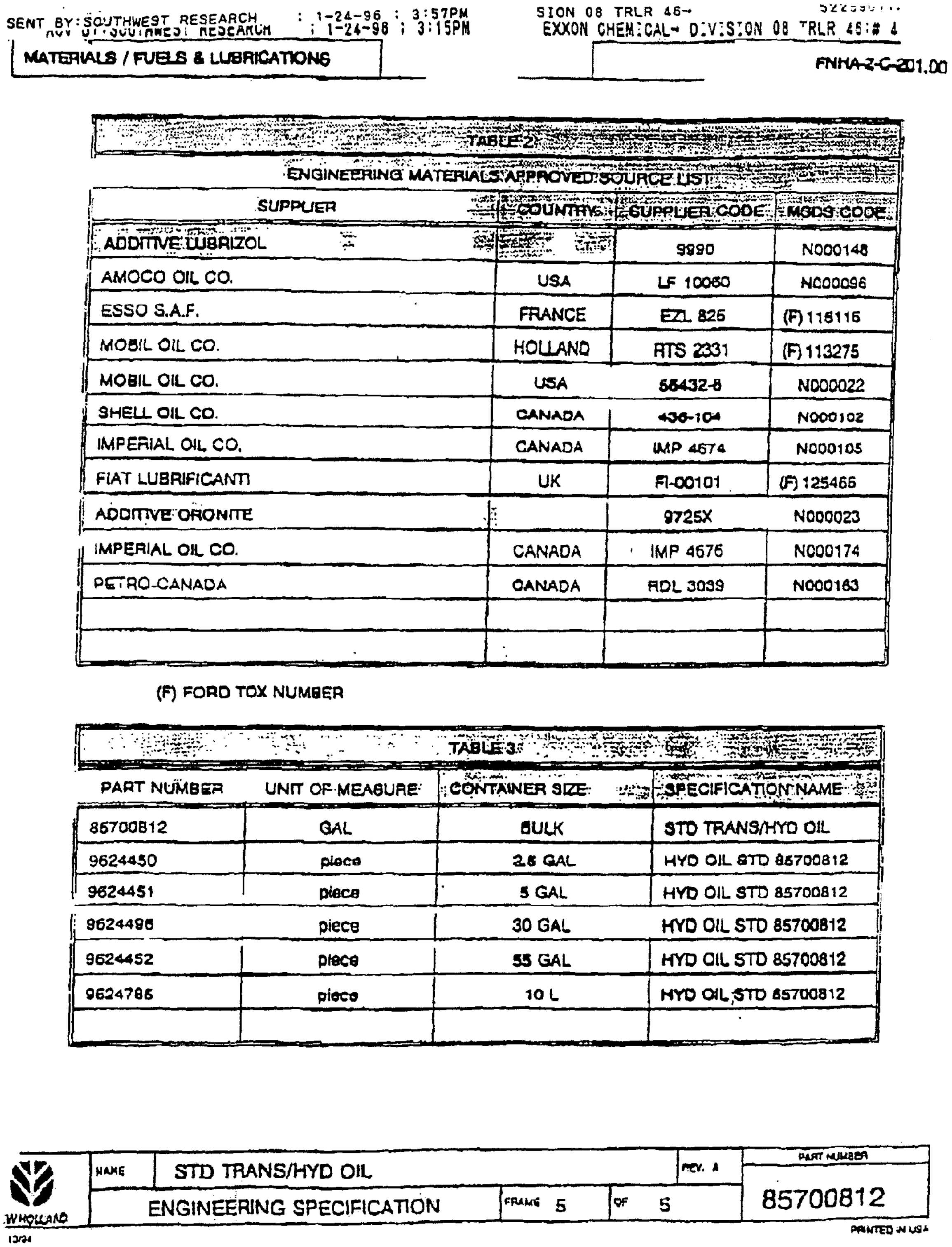
SENT BY:SOUTHWEST RESEARCH : -24-96 4:28PM DIVISION 08 TRLR 46- 5225907
RCV BY:SOUTHWEST RESEARCH ; -24-95 4:08PM EXXON CHEMICAL- DIVISION 08 TRLR 46:# 2

MATERIALS / FUELS & LUBRICATIONS FNHA-2-C-201.00

TABLE 1

DESCRIPTION	REQUIREMENTS	UNITS	METHODS
Viscosity			
At 100° C, min.	9.0	mm 2/s	ASTM D 445
At 40° C, typical	55	mm 2/s	ASTM D 445
At -18° C, max.	4,000	mPa.s	ASTM D 2983
Viscosity Index, typical	148		
Viscosity Stability, Change at 100°C			
• After 30 passes in Method A min.	-15	%	ASTM D3945
• after 100 hours at 150°C (Heat 200 g of candidate oil in a 400 ml glass beaker in an oven with gravity convection) (NO SLUDGE)	+10	%	
Physical Requirements			
Pour Point, max.	- 37°	C	ASTM D 97
Flash Point min.	180°	C	ASTM D 92
Foaming Tendency / Stability			
Sequence 1 max.	20/0	ml	ASTM D 892
Sequence 2 max.	50/0	ml	ASTM D 892
Sequence 3 max.	20/0	ml	ASTM D 892
Copper corrosion			
3 Hr. at 150°C	2b		ASTM D 130
48 Hrs. at 120°C Weigh sample before and after test. Record weight loss, max	1.0	mg	
Rust Protection	No Rust		ASTM D 665 Method A
Wear Test Scar Dia. 60 min, 1500 rpm, 65°C, 40 kg max.	0.40	mm	ASTM D 2266
Seal Compatibility (See Section 5.2)	pass		
Water Sensitivity (See Section 5.1)	pass		
PERFORMANCE REQUIREMENTS			
560 Hour Jenkins cycle Test	pass		86509436
Tandem Pump Durability Test	pass		86509437
X 16 Inching / Shifting Quality	pass		86509444
16 X 16 Transmission - 400 Cycle Stall Test	pass		86509438
16 X 16 Transmission - 450 Cycle High Energy Test	pass		86509439
2000 Hrs. Field Test	pass		86509440
	pass		86509441
	pass		86509442
Dynamic Coefficient of friction	0.095 - 0.135		86509443
Static Coefficient of friction	0.085 - 0.110		86509443

NAME	STD TRANS/HYD OIL	REV. A	PART NUMBER
ENGINEERING SPECIFICATION	FRAME 2	OF 5	85700812



SENT BY:SOUTHWEST RESEARCH : 1-24-96 : 3:57PM
SION 08 TRLR 46→
EXXON CHEMICAL→ DIVISION 08 TRLR 46:# 4

MATERIALS / FUELS & LUBRICATIONS

FNHA-2-C-201.00

TABLE 2

ENGINEERING MATERIALS APPROVED SOURCE LIST

SUPPLIER	COUNTRY	SUPPLIER CODE	MSDS CODE
ADDITIVE LUBRIZOL		9990	N000148
AMOCO OIL CO.	USA	LF 10060	N000096
ESSO S.A.F.	FRANCE	EZL 825	(F) 116116
MOBIL OIL CO.	HOLLAND	RTS 2331	(F) 113275
MOBIL OIL CO.	USA	56432-8	N000022
SHELL OIL CO.	CANADA	436-104	N000102
IMPERIAL OIL CO.	CANADA	IMP 4674	N000105
FIAT LUBRIFICANTI	UK	FI-00101	(F) 125466
ADDITIVE ORONITE		9725X	N000023
IMPERIAL OIL CO.	CANADA	IMP 4676	N000174
PETRO-CANADA	CANADA	RDL 3039	N000163

(F) FORD TOX NUMBER

TABLE 3

PART NUMBER	UNIT OF MEASURE	CONTAINER SIZE	SPECIFICATION NAME
85700812	GAL	BULK	STD TRANS/HYD OIL
9624450	piece	2.5 GAL	HYD OIL STD 85700812
9624451	piece	5 GAL	HYD OIL STD 85700812
9624496	piece	30 GAL	HYD OIL STD 85700812
9624452	piece	55 GAL	HYD OIL STD 85700812
9624786	piece	10 L	HYD OIL STD 85700812

NAME	STD TRANS/HYD OIL		REV. A		PART NUMBER
ENGINEERING SPECIFICATION		FRAME 5	OF 5		85700812

WHOLLAND
13/94

PRINTED IN USA

Claims

1. A method for making a Universal Tractor Transmission Oil (UTTO) from a Super Tractor Universal Oil (STUO) comprising:

reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification (annex1) and the Ford M2C134D performance specification (Annex 2).

2. The method of claim 1, wherein the one or more additive components comprises one or more additives selected from the group consisting of an ashless dispersant, a detergent, a corrosion inhibitor, a friction modifier, an antioxidant, an extreme pressure agent, an antiwear agent, an antifoamant, and a defoamant.

3. The method of claim 1, wherein reducing the amount of the one or more additive components comprises reducing the amount of an ashless dispersant by about 5% to about 100%.

4. The method of claim 1, wherein reducing the amount of the one or more additive components comprises reducing the amount of a detergent sufficient to improve the water tolerance of the UTTO.

5. The method of claim 1, wherein reducing the amount of the one or more additive components comprises reducing the amount of a detergent by about 50% to about 100%.

6. The method of claim 1, wherein reducing the amount of the one or more additive components comprises a reducing the amount of a corrosion inhibitor by about 25% to about 100%.

7. The method of claim 6, wherein the corrosion inhibitor is a crankcase corrosion inhibitor.

8. The method of claim 1, wherein reducing the amount of the one or more additive components comprises reducing the amount of friction modifier sufficient to improve wet brake noise.

9. The method of claim 1, wherein reducing the amount of the one or more additive components comprises a reducing the amount of a friction modifier by about 25% to about 100%.

10. The method of claim 1, wherein reducing the amount of the one or more additive components comprises a reducing the amount of an antioxidant by about 25% to about 100%.

11. The method of claim 10, wherein the antioxidant is a high temperature antioxidant.

12. The method of claim 1, wherein reducing the amount of one or more additive components comprises reducing the amount of an ashless dispersant by about 5% to about 100 %, the amount of a detergent by about 50% to 100%, the amount of a corrosion inhibitor by about 25% to about 100%, the amount of a friction modifier by about 25% to about 100%, and the amount of an antioxidant by about 25% to about 100%.

13. The method of claim 1, wherein reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO comprises omitting the one or more additive components.

14. The method of claim 1, wherein reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO comprises omitting an ashless dispersant, a detergent, and an antioxidant.

15. A UTTO made from the method of claim 1.

16. The UTTO of claim 15, wherein the STUO comprises a major amount of a base oil and a minor amount of an additive concentrate and wherein the UTTO comprises a major amount of a base oil and a minor amount of an additive concentrate, wherein the treat rate of the UTTO additive concentrate is about 40% to about 70% less than the STUO additive concentrate.

17. Use of a UTTO made from the method of claim 1 to lubricate moving parts of a tractor.

18. Use of a UTTO made from the method of claim 1 to lubricate one or more of or all of a transmission, a hydrostatic transmission, a gear-box, a final drive, a hydraulic system, and a wet brake of off-highway mobile equipment.

19. Use of a UTTO made from the method of claim 1 to lubricate one or more of or all of a transmission, a hydrostatic transmission, a gear-box, a final drive, a hydraulic system, and a wet brake of construction equipment.

20. Use of a UTTO made from the method of claim 1 to lubricate one or more of or all of a transmission, a hydrostatic transmission, a gear-box, a final drive, a hydraulic system, and a wet brake of a tractor.

21. A method for making a Super Tractor Universal Oil comprising:

top treating a Universal Tractor Transmission Oil with an aftermarket additive package comprising one or more additives selected from the group consisting of an ashless dispersant, a detergent, a corrosion inhibitor, a friction modifier, and an antioxidant.

22. A Universal Tractor Transmission Oil (UTTO) having improved extreme pressure properties, wherein the UTTO is made from a Super Tractor Universal Oil (STUO) comprising:

reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification and the Ford M2C134D performance specification.

23. A Universal Tractor Transmission Oil (UTTO) having improved brass wear properties, wherein the UTTO is made from a Super Tractor Universal Oil (STUO) comprising:

reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification and the Ford M2C134D performance specification.

24. The UTTO of claim 23, wherein the UTTO is suitable for use in a hydrostatic transmission.

25. A Universal Tractor Transmission Oil having (UTTO) improved friction properties, wherein the UTTO is made from a Super Tractor Universal Oil (STUO) comprising:

reducing the amount of one or more additive components in the preparation of a STUO to provide a UTTO, wherein the STUO meets the John Deere J20-C performance specification and the Ford M2C134D performance specification.

FIGURE 1. Falex D-2714 Ring on Block Test

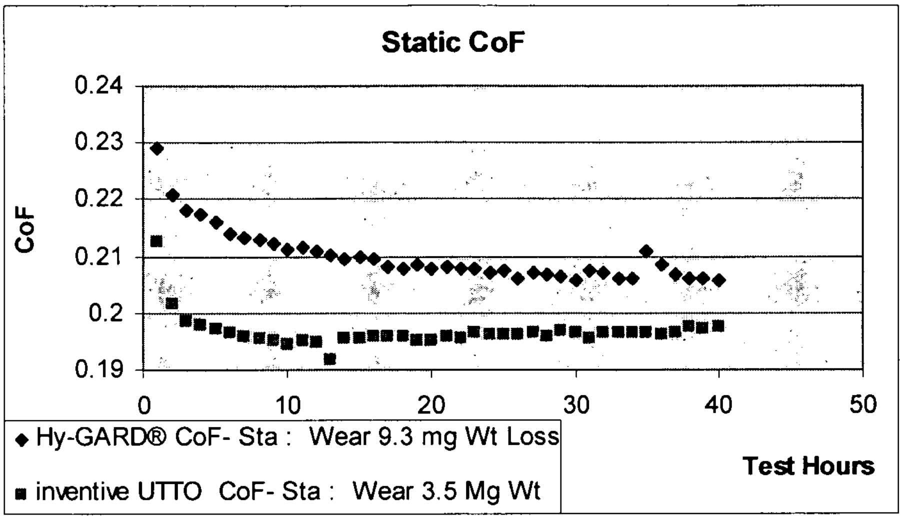
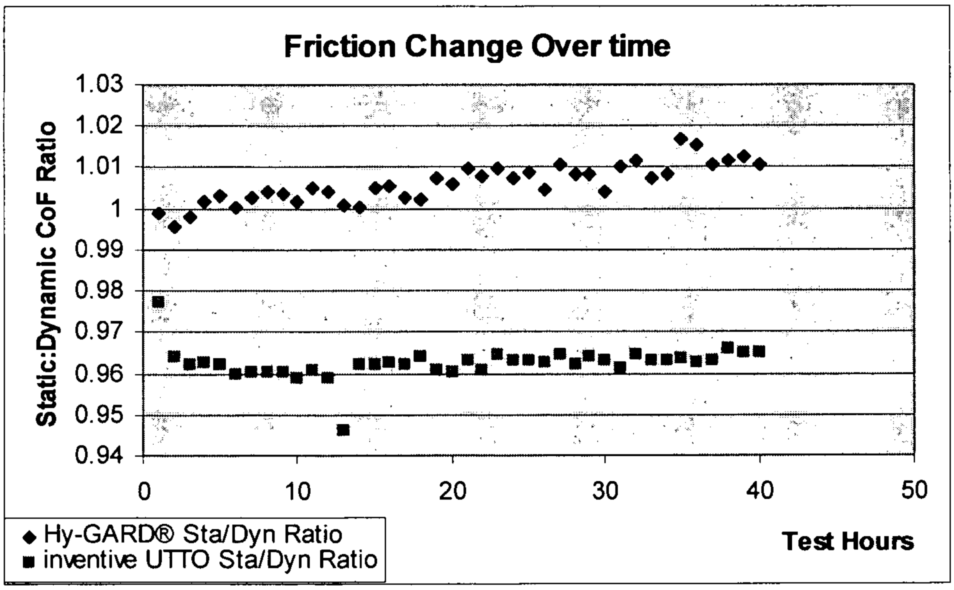


FIGURE 2. Falex D-2714 Ring on Block Test



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 00 6607

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2004/211386 A1 (LUTHER ROLF ET AL) 28 October 2004 (2004-10-28) * paragraphs [0001] - [0003], [0017] * -----	15-25 1-14	INV. C10M177/00 C10M171/00
			TECHNICAL FIELDS SEARCHED (IPC)
			C10M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 July 2006	Kazemi, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

2

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 06 00 6607

11-07-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004211386 A1	28-10-2004	WO 03033957 A1	24-04-2003
		EP 1434964 A1	07-07-2004

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 4863623 A **[0040]**
- US 5075383 A **[0040]**
- US 5634951 A **[0041]**
- US 5725612 A **[0041]**
- US 5789353 A **[0044]**
- US 5137980 A **[0044] [0049]**
- US 3329658 A **[0048]**
- US 3449250 A **[0048]**
- US 3493520 A **[0048] [0049]**
- US 3519565 A **[0048]**
- US 3666730 A **[0048]**
- US 3687849 A **[0048]**
- US 3702300 A **[0048]**
- US 2459112 A **[0049]**
- US 2962442 A **[0049]**
- US 2984550 A **[0049]**
- US 3036003 A **[0049]**
- US 3163603 A **[0049]**
- US 3166516 A **[0049]**
- US 3172892 A **[0049]**
- US 3184474 A **[0049]**
- US 3202678 A **[0049]**
- US 3215707 A **[0049]**
- US 3216936 A **[0049]**
- US 3219666 A **[0049]**
- US 3236770 A **[0049]**
- US 3254025 A **[0049] [0051]**
- US 3271310 A **[0049]**
- US 3272746 A **[0049]**
- US 3275554 A **[0049]**
- US 3281357 A **[0049]**
- US 3306908 A **[0049]**
- US 3311558 A **[0049]**
- US 3316177 A **[0049]**
- US 3331776 A **[0049]**
- US 3340281 A **[0049]**
- US 3341542 A **[0049]**
- US 3346493 A **[0049]**
- US 3351552 A **[0049]**
- US 3355270 A **[0049]**
- US 3368972 A **[0049]**
- US 3381022 A **[0049]**
- US 3399141 A **[0049]**
- US 3413347 A **[0049]**
- US 3415750 A **[0049]**
- US 3433744 A **[0049]**
- US 3438757 A **[0049]**
- US 3442808 A **[0049]**
- US 3444170 A **[0049]**
- US 3448047 A **[0049]**
- US 3448048 A **[0049]**
- US 3448049 A **[0049]**
- US 3451933 A **[0049]**
- US 3454497 A **[0049]**
- US 3454555 A **[0049]**
- US 3454607 A **[0049]**
- US 3459661 A **[0049]**
- US 3461172 A **[0049]**
- US 3467668 A **[0049]**
- US 3501405 A **[0049]**
- US 3522179 A **[0049]**
- US 3539633 A **[0049]**
- US 3541012 A **[0049]**
- US 3542680 A **[0049]**
- US 3543678 A **[0049]**
- US 3558743 A **[0049]**
- US 3565804 A **[0049]**
- US 3567637 A **[0049]**
- US 3574101 A **[0049]**
- US 3576743 A **[0049]**
- US 3586629 A **[0049]**
- US 3591598 A **[0049]**
- US 3600372 A **[0049]**
- US 3630904 A **[0049]**
- US 3632510 A **[0049]**
- US 3632511 A **[0049]**
- US 3634515 A **[0049]**
- US 3649229 A **[0049]**
- US 3697428 A **[0049]**
- US 3697574 A **[0049]**
- US 3703536 A **[0049] [0051]**
- US 3704308 A **[0049]**
- US 3725277 A **[0049]**
- US 3725441 A **[0049]**
- US 3725480 A **[0049]**
- US 3726882 A **[0049]**
- US 3736357 A **[0049]**
- US 3751365 A **[0049]**
- US 3756953 A **[0049]**
- US 3793202 A **[0049]**
- US 3798165 A **[0049]**
- US 3798247 A **[0049]**
- US 3803039 A **[0049]**
- US 3804763 A **[0049]**
- US 3836471 A **[0049]**
- US 3862981 A **[0049]**
- US 3872019 A **[0049]**
- US 3904595 A **[0049]**

- US 3936480 A **[0049]**
- US 3948800 A **[0049]**
- US 3950341 A **[0049]**
- US 3957746 A **[0049]**
- US 3957854 A **[0049]**
- US 3957855 A **[0049]**
- US 3980569 A **[0049]**
- US 3985802 A **[0049]**
- US 3991098 A **[0049]**
- US 4006089 A **[0049]**
- US 4011380 A **[0049]**
- US 4025451 A **[0049]**
- US 4058468 A **[0049]**
- US 4071548 A **[0049]**
- US 4083699 A **[0049]**
- US 4090854 A **[0049]**
- US 4173540 A **[0049]**
- US 4234435 A **[0049]**
- US 4354950 A **[0049]**
- US 4485023 A **[0049]**
- US RE26433 A **[0049]**
- US 3087936 A **[0051]**
- US 3281428 A **[0051]**
- US 3282955 A **[0051]**
- US 2284409 A **[0051]**
- US 2284410 A **[0051]**
- US 3338832 A **[0051]**
- US 3344069 A **[0051]**
- US 3533945 A **[0051]**
- US 3658836 A **[0051]**
- US 3718663 A **[0051]**
- US 4455243 A **[0051]**
- US 4652387 A **[0051]**
- US 6482778 B **[0057]**
- US 2001108 A **[0062]**
- US 2081075 A **[0062]**
- US 2095538 A **[0062]**
- US 2144078 A **[0062]**
- US 2163622 A **[0062]**
- US 2270183 A **[0062]**
- US 2292205 A **[0062]**
- US 2335017 A **[0062]**
- US 2399877 A **[0062]**
- US 2416281 A **[0062]**
- US 2451345 A **[0062]**
- US 2451346 A **[0062]**
- US 2485861 A **[0062]**
- US 2501731 A **[0062]**
- US 2501732 A **[0062]**
- US 2585520 A **[0062]**
- US 2671758 A **[0062]**
- US 2616904 A **[0062]**
- US 2616905 A **[0062]**
- US 2616906 A **[0062]**
- US 2616911 A **[0062]**
- US 2616924 A **[0062]**
- US 2616925 A **[0062]**
- US 2617049 A **[0062]**
- US 2695910 A **[0062]**
- US 3178368 A **[0062]**
- US 3367867 A **[0062]**
- US 3496105 A **[0062]**
- US 3629109 A **[0062]**
- US 3865737 A **[0062]**
- US 3907691 A **[0062]**
- US 4100085 A **[0062]**
- US 4129589 A **[0062]**
- US 4137184 A **[0062]**
- US 4184740 A **[0062]**
- US 4212752 A **[0062]**
- US 4617135 A **[0062]**
- US 4647387 A **[0062]**
- US 4880550 A **[0062]**
- US 3480548 A **[0063]**
- US 3679584 A **[0063]**
- US 3829381 A **[0063]**
- US 3909691 A **[0063]**
- US 4965003 A **[0063]**
- US 4965004 A **[0063]**
- US 2765289 A **[0064]**
- US 2749311 A **[0064]**
- US 2760933 A **[0064]**
- US 2850453 A **[0064]**
- US 2910439 A **[0064]**
- US 3663561 A **[0064]**
- US 3862798 A **[0064]**
- US 3840549 A **[0064]**
- EP 0020037 A **[0069]**
- US 6103099 A **[0087]**
- US 6180575 B **[0087]**
- US 4943672 A **[0087]**
- US 6096940 A **[0087]**
- US 5882505 A **[0087]**
- US 6013171 A **[0087]**
- US 6080301 A **[0087]**
- US 6165949 A **[0087]**