

Section 3.2



Machine Maintenance - Hydraulic Oil and Tank Information

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How Important Is Hydraulic Oil Level In The Tank?

The level of hydraulic oil in the tank is very important in any hydraulic system. If the oil level drops too low, the suction strainers for the pumps can be exposed to air. Exposing a suction strainer to air will allow the air to enter the pump where it will cause catastrophic damage. This is called “cavitation”.

When air mixes with oil in the suction line it forms bubbles. These bubbles are drawn into the pump and very tightly compressed by the pump’s piston rotary group. As the compressed air bubbles leave the rotary group, they expand very rapidly...like tiny explosions. These tiny explosions deteriorate the brass surface of the piston shoes very quickly and destroy the pump.

Catastrophic failures result in very large amounts of contamination being dumped into the hydraulic system. This will often result in the additional failure of other major components. In many cases the complete hydraulic system and its components must be thoroughly flushed to remove all contamination before the system returning to work.

To prevent cavitation, the hydraulic oil level in the tank must be kept at the level indicated on the tank’s sight gauge. See figure 1.

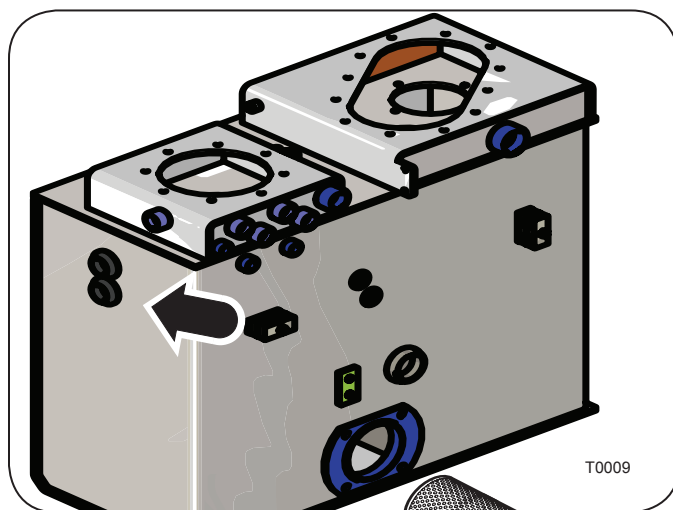


Figure 1: Hydraulic Oil Sight Gauge

NOTICE

Always place machine on level ground when checking hydraulic oil level. Failure to do so will cause an incorrect oil level reading.

Hydraulic Tank Sight Gauge

The hydraulic tank sight gauge can be viewed on the back of the hydraulic tank. See figure 1.

Always be sure that the hydraulic oil level remains in the upper sight gauge when the oil is at operating temperature. Keeping the hydraulic oil at this level will prevent the suction strainers from being exposed to air when positioned on a slope.

IMPORTANT: Always check oil level when it is at operating temperature. As oil warms it will expand. An over filled tank will purge oil out the safety relief and contaminate the environment.

It is a very good policy for the operator to visually check the sight gauge before and after the working shift. As added protection, TimberPro also installs a hydraulic oil level warning system on every machine.

Add Hydraulic Oil Level Warning and Low Hydraulic Oil Level Warning Lights

Two fluid level sensors are installed in the tank that warn the operator with an indicator light and buzzer if the hydraulic oil drops too low. see figure 2.

The first “Add Hydraulic Oil” yellow warning light is to tell the operator that the hydraulic oil has dropped to a lower than normal level and should be filled with oil.

The second “Low Hydraulic Oil” red warning light and buzzer is to warn the operator that the oil level has dropped to a dangerous level and that the hydraulic oil tank should be filled immediately to prevent damage to the hydraulic oil level.

This warning system should not replace a visual check of the sight glass by the operator. It is designed only to alert the operator if there was a rapid loss of oil like a ruptured hose, etc.

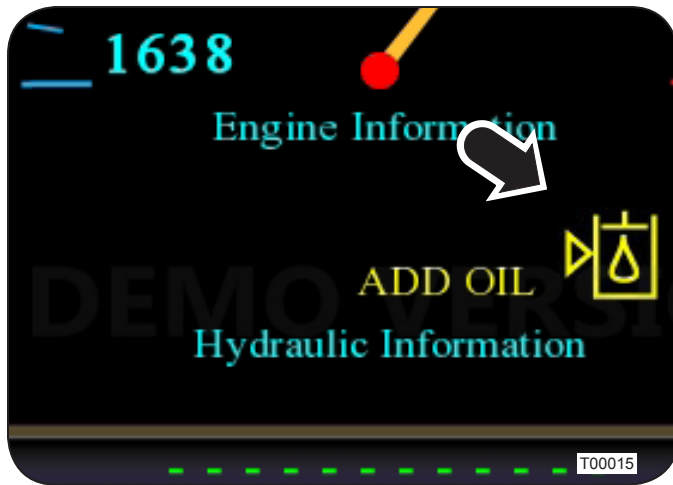


Figure 2: Hydraulic Oil Warning Indicator

Pressurized Hydraulic Tank

The hydraulic tank must be pressurized because most pumps, especially piston pumps, cannot “suck” oil. Oil must be forced into the pump’s inlet. Piston pumps can cavitate, and be damaged, if the suction inlet pressure drops below 1 psi (7 kPa).

How Is The Hydraulic Tank Pressurized?

The hydraulic tank is pressurized to 5 psig (35 kPa) using turbo boost from the engine. The engine is capable of producing up to 25 psi (172 kPa) boost pressure, therefore, a pressure regulator is required to maintain the required 5 psig (35 kPa) boost pressure.

A check valve is located between the turbo boost line and tank to prevent oil from getting into the turbo.

The tank is also equipped with a 13 psi (90 kPa) safety relief to protect the system in the event the pressure regulator would malfunction.

How Is Pressure Released From The Hydraulic Tank?

! WARNING

Hydraulic oil tank under pressure. Escaping oil can cause serious injury. Vent tank before removing cap or servicing the hydraulic system

Before adding oil or opening the tank for any reason, boost pressure must be released by venting

the hydraulic tank. This can be done by rotating and holding the Vent Switch in the clockwise position. The Vent Switch is located on the upper dash panel inside the cab. See Figure 3. Rotating and holding the Vent Switch in the clockwise position for about 60 seconds will make sure the tank is fully vented.

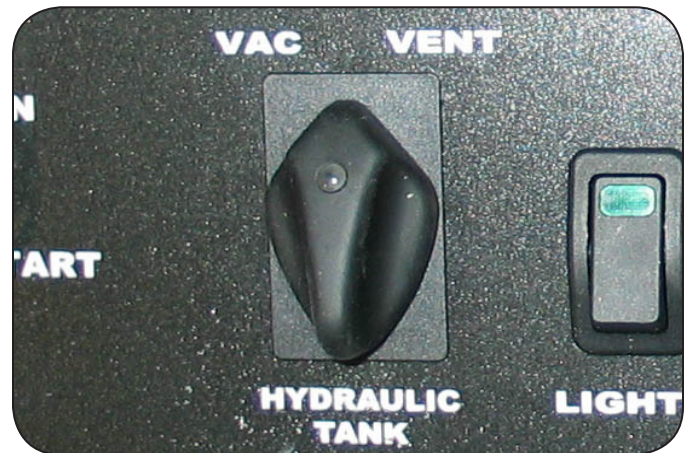


Figure 3: Hydraulic Tank Vent Switch

It is also good practice to vent the tank before performing any maintenance on the hydraulic system. many lines are common to the tank. Releasing the boost pressure will prevent oil from escaping under force when loosening fittings.

Hydraulic Tank Vacuum System

TimberPro also has a vacuum system on the hydraulic tank to help stop contamination to the environment when a leak or broken hose occurs.

To activate the Hydraulic Tank Vacuum you first need to **SHUTDOWN THE ENGINE**. Then the next step would be to fully vent all pressure from the hydraulic tank. After the tank has been vented you can now activate the Vacuum Switch located next to the key switch on the upper dash. See figure 3.

! WARNING

IMPORTANT: Always shut off the vacuum pump and completely vent the system and bleed any air from implement pump suction tube before starting the engine. Failure to do so will cause major damage to the hydraulic pumps.

The Vacuum pump monitors the vacuum in the hydraulic tank and will automatically turn off and back on again to maintain vacuum on the

tank. The vacuum system is only meant to be used “temporarily” until the hydraulic leak can be repaired. **You should never activate the vacuum system and leave the machine unattended.**

After you are finished using the vacuum system the hydraulic tank needs to be properly vented for at least 60 seconds. Once the tank is vented the oil level should be checked and refilled to a proper level (see image 1).

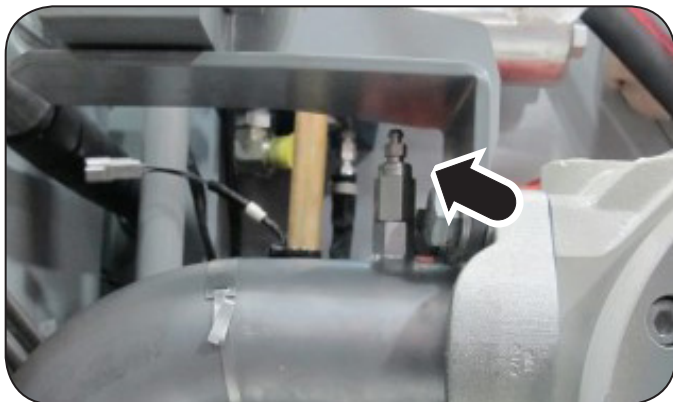


Figure 4: Implement Pump Suction Tube Bleeder

Before restarting the engine the Implement Pump Suction Tube will need any air bled from it. (see image 4) Open the bleeder until a steady stream of hydraulic oil comes out all air is removed. Failure to do so can result in damage to the Implement Pump.

TimberPro’s Hydraulic Oil Filtration System

Hydraulic oil filtration is also extremely important for the good operation and long service life of your hydraulic system. Filters and strainers catch and retain harmful contaminants that can damage the system.

Suction Strainers

TimberPro installs individual suction strainers made of 100-mesh screen in all pump suction lines. See Figure 5.

The primary purpose of a suction strainer is to prevent “vortexing” or “swirling” of the oil as it enters the pump suction line. Water draining from a sink is a good visual example of a “vortex” condition. It is important to prevent vortexing because it can cause cavitation and damage the pump.

The other purpose of a suction strainer is to stop large particles from entering the suction line. The suction strainers will not protect the hydraulic system

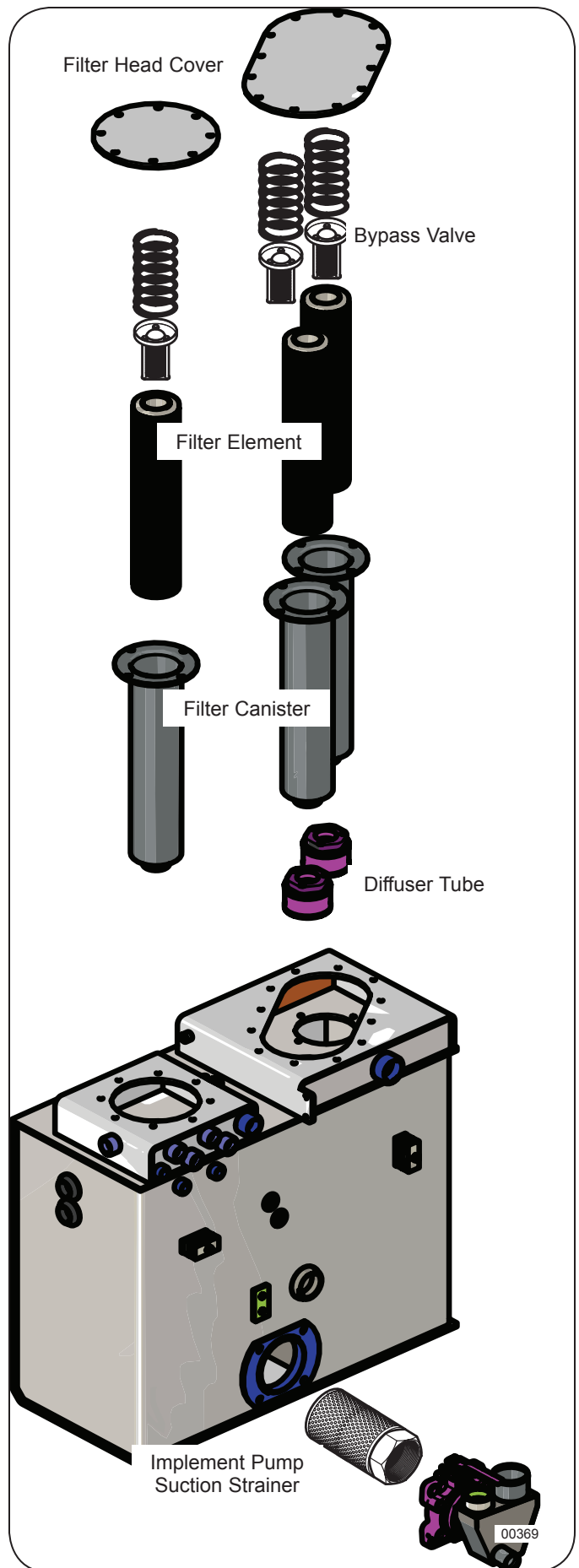


Figure 5: Exploded View - Hydraulic Tank Filters & Strainers

if the return filters go into bypass and contaminate the tank.

IMPORTANT: A suction strainer is not a filter. A 100-mesh screen will pass a 149-micron size particle, a little larger than a grain of salt, that will damage a pump.

Suction strainers should be removed and cleaned at least every 2000 hours, or once a year.

Return Oil Filters

There are two different filters installed through the top of the hydraulic tank that filter return oil. See Figure 5. All return oil must pass through one of these filter assemblies before entering the main tank.

NOTE: The filter assembly furthest from the boom is for case drain oil.

How Oil Is Filtered

Each filter assembly has a removable 15-micron element that filters the oil to ISO Code 16/13. Hydraulic oil is filtered in the following manner:

- 1) Oil enters the filter assembly at the filter head. See Figure 5.
- 2) From the filter head, the oil goes down into the canister between the canister wall and filter element.
- 3) Oil is then filtered by passing from OUTSIDE the filter element to INSIDE the filter element.
- 4) Filtered oil can now enter the main tank through a diffuser at the bottom of the canister. The diffuser reduces turbulence in the oil.

Return Filter Bypass: Why It Should Be Avoided.

NOTICE

Return filter bypass allows unfiltered oil into the main tank where it begins contaminating the rest of the hydraulic system. Prevent return filter bypass.

TimberPro's return oil filter assemblies are equipped with a bypass valve that prevents the filter element from rupturing or collapsing if the filter canister back-pressure gets too high. This bypass valve is located where the filter head cover seals the top of the filter element. See Figure 5.

The filter bypass valve is set to open when the filter canister back pressure reaches 29 psig (200 kPa). Bypass can occur for several reasons:

- 1) The filter element is plugged.
- 2) The hydraulic oil viscosity is too heavy for ambient conditions.
- 3) The hydraulic oil is too cold to flow easily through the filter element.

Avoiding filter bypass is very important because it allows unfiltered oil to return directly into the main tank. If a pump or motor has a catastrophic failure and the debris plug a return filter causing it to bypass, severe damage to the rest of the hydraulic system could result.

The Return Filter Back Pressure Warning Light

WARNING

Dirty Filters lead to return filter bypass and possible hydraulic system contamination. Change filters according to preventative maintenance guidelines, or sooner if required.

NOTICE

Incorrect cold weather starting can force return filter bypass and possible hydraulic system contamination. Always allow hydraulic oil to reach proper operating temperature before running engine at full throttle.

TimberPro machines are equipped with a pressure switches on the tank which monitor back pressure in the return filter canisters. The operator will be alerted with a warning light and buzzer if return filter back pressure reaches 29 psig (200 kPa); indicating that a return filter is nearing the bypass setting [normal operating back pressure is 10 - 15 psig (70 - 105 kPa) depending upon oil temperature]

Excessive back pressure is usually the result of dirty filters in need of changing, or in the case of a cold start, cold oil being forced through the filters.

During a cold start always allow the oil to warm to operating temperature before running the machine at full throttle. Idle the engine, then activate hydraulic functions to the end of the boom which, because of the length of oil flow, will warm the oil quicker. Keep increasing throttle as the oil warms making sure the return filters do not go into bypass as indicated by the Charge or Return Filter Lights. See Figure 6.

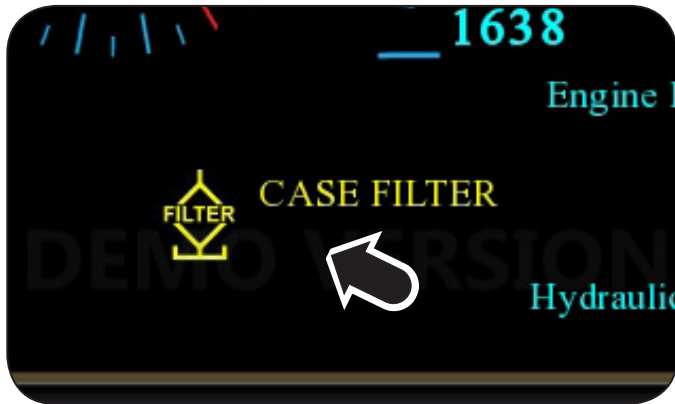


Figure 6. Return Filter Bypass Light

Changing Return Oil Filters

IMPORTANT: When changing a filter element, inspect the oil around the element for metallic flakes before removing it. If metallic flakes can be seen, or if there has been a pump or motor failure recently, you should not remove the filter element. Doing so will allow the contaminated oil around the element to drain directly into the main tank. In this case, the entire filter assembly must be removed before the element can be changed.

Return oil filters should be changed after the first 100 hours of operation and, thereafter, every 500 hours of operation.

1. Place booms on the ground and shut down the engine.
2. Release boost pressure on the hydraulic oil Tank.
3. Remove the bolts securing the cover over the return filters on top of the hydraulic tank. See Figure 7.

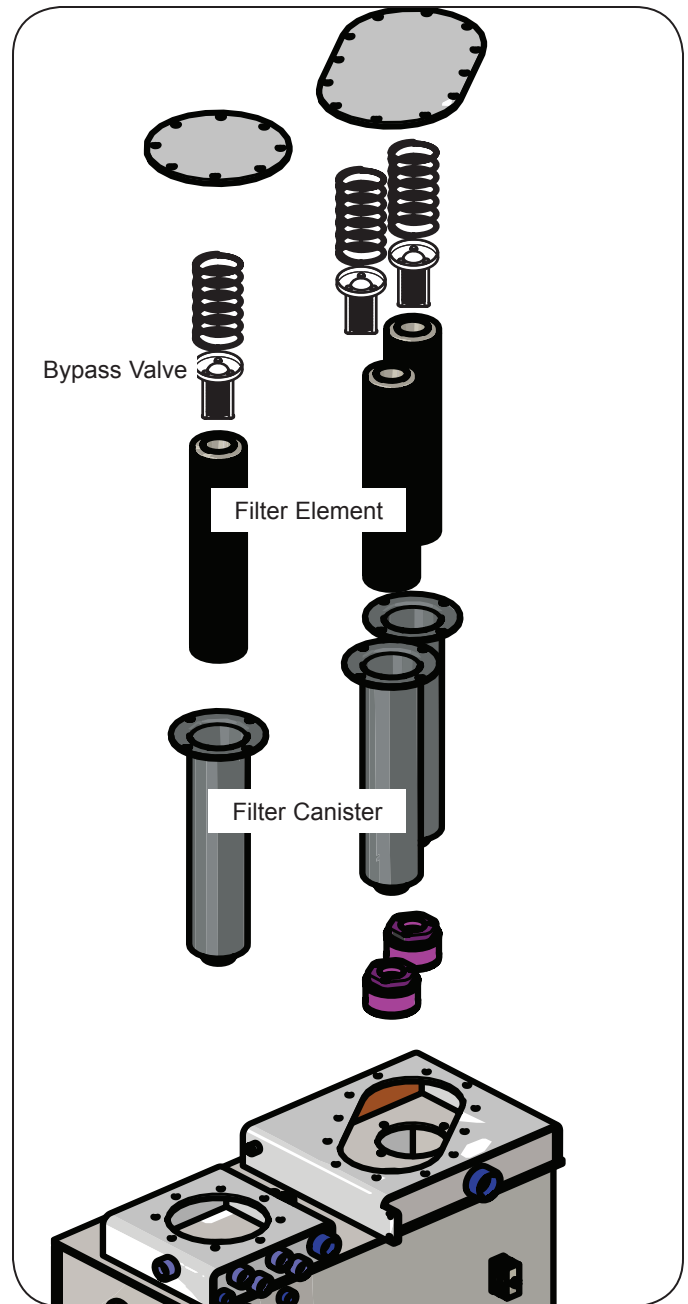


Figure 7: Exploded View - Hydraulic Tank Filters & Strainers

4. Remove the spring and bypass valve to expose the filter element. See Figure 7.

! WARNING

When changing return filters, care must be taken to insure that no contaminated oil is allowed to drain into the main tank.

5. Visually inspect the condition of the element before removing it. If contamination is present or if a cylinder or know pump failure has occurred. Do not remove the filter from the filter canister. Continue to step 6.

If there are no bronze or brass specks visible,

remove the filter element, dispose of the old one properly, install a new filter. Skip to step 8.

WARNING

If there has been a pump or cylinder failure, or there are bronze or brass specks visible, the whole filter and canister assembly must be removed so that contaminated oil cannot drain into the main tank.

6. If contamination is present or if a cylinder or know pump failure has occurred. Do not remove the filter from the filter canister. Remove the four bolts for the filter canister and remove the canister with the filter still inside.

7. After removing the filter canister the filter can now be removed from the canister and the canister can be cleaned before re-installing the canister and new filter.

8. Replace bypass valve, spring and cover.

Importance of Clean Hydraulic Oil

TimberPro hydraulic systems use piston pumps and motors that operate at pressures as high as 6500 PSI. These state-of-the-art components must be manufactured with very tight tolerances to provide high performance and efficiency. The tighter the tolerances, the more damage contamination will cause.

Types Of Contaminates:

There are many types of contaminants. The most common are:

- 1) Particulate (dust, dirt, sand, fibre, rust, rubber, paint chips, metal flakes, etc.)
Particulates are referred to by their size in "Microns".

For example:

Grain of table salt	100 microns
Human hair diameter	70 microns
Limit of visibility	40 microns
White blood cell	25 microns
Talcum powder	10 microns
Red blood cell	8 microns
Bacteria	2 microns

2) Water

3) Sealants (teflon, etc.)

4) Sludge (result of hydraulic oil breakdown)

Sources Of Contaminates:

Contaminates can get into a hydraulic system in several ways:

- 1) Un-clean "new" hydraulic oil.

Hydraulic oil, as it is packaged by the manufacturer, is not clean enough to use in a hydraulic system without filtering.

- 2) Built-in (component storage, manufacturing process, assembly, etc.).

- 3) Ingested from the environment (dust, dirt, moisture, chemicals, etc.).

- 4) Produced internally (component wear, hydraulic oil or hose breakdown as a result of overhear, rust, oxidation, etc.).

WARNING

Whenever a hydraulic system component is removed, especially hoses, contaminants can enter the system. Even changing filter elements can allow contaminants to enter the system.

Concerns When Replacing Hydraulic System Components

Replacing hydraulic system components, especially hoses, is a big potential source of contamination. When replacing a component, be sure to do the following:

- 1) Thoroughly clean the area around the component before removal.

- 2) Always cap or plug disconnected hoses immediately. Do not leave hoses or ports open to atmosphere unless specifically required by a test procedure.

- 3) Use only replacement hose assemblies that have been flushed and capped. An unflushed hose is full of contaminants from when the hose was cut.

- 4) Always bleed the hydraulic circuit, especially hydrostatic drive circuits, of air after replacing a component or hose. Air in the system can damage pumps and motors. See (Wheel Drive Circuit) information later in this manual.

Importance of Choosing Hydraulic Oil

Using the correct hydraulic oil in your hydraulic system is extremely important. Consider this when selecting a hydraulic oil:

- 1) Use a hydraulic oil with properties that meet the equipment manufacturer's performance specifications.

TimberPro's hydraulic oil performance specifications can be found at the end of this section.

- 2) Use a hydraulic oil with the correct ISO viscosity rating for your local climate.

Using a hydraulic oil that meets these requirements will help eliminate costly machine downtime and reduce the overall operating cost of your equipment. Failure to use the correct hydraulic oil will create problems and cost you time and money.

Hydraulic Oil Viscosity

The viscosity of an oil is identified by its "ISO Viscosity Rating" The ISO viscosity rating can be found on the oil container's label.

Timberpro uses three ISO viscosity oils when filling machines at the factory.

ISO 32 - A light weight oil for cold weather conditions with local temperatures from -20° to +50°F (-29° to +10°C).

ISO 46 - A medium weight oil for mid-range conditions with local temperatures from +25° to +70°F (-4° to +21°C).

ISO 68 - A heavier oil for warm weather conditions with local temperatures from +40° to +90°F (+4° to +32°C).

Although not supplied by the factory, the following ISO viscosity is commonly used in extreme cold

weather.

ISO 22 - A light weight oil for arctic cold weather conditions with local temperatures from -40° to +40°F (-39° to +4°C)

The viscosity of the hydraulic oil used at the factory is determined by the time of year the machine is manufactured and where the machine will be shipped.

Please contact TimberPro if you have questions as to which viscosity oil was shipped in your machine.

Using the correct hydraulic oil viscosity for your local climate is extremely important. If the oil viscosity is too light for the local temperature, the hydraulic system will overheat easily and cause damage to components. If the oil viscosity is too heavy for the local temperature, the oil will be too thick to flow easily and cause damage to components from cavitation.

NOTICE

Extreme weather conditions may require seasonal oil viscosity changes.

IMPORTANT: Check with your supplier before mixing hydraulic oils of different type, brand, or viscosity. Many oils are not compatible and damage to your hydraulic system could result. When changing oil viscosity, flush and clean the hydraulic system before adding new oil.

ISO Code Rating

Cleanliness of hydraulic oil is rated on an ISO Code scale. An ISO Code rating is made up of two numbers that reference the approximate number of particulate contaminants, by size, that can be found in a fixed volume (1 ml) of hydraulic oil.

For example: ISO Code 17/14 - This is the cleanliness required by the manufacturer of the pumps and motors used in Timberpro's hydraulic system.

The lower the ISO Code numbers, the cleaner the oil is. Generally, the only time you will see an ISO Code rating is on an oil performance specification

sheet or an oil sample test results sheet. Because an ISO Code rating is based on particles you cannot see with the naked eye, it is difficult to use the ISO Code rating unless it references test results.

A better example, or reference, may be this:

ISO Code 14/10 - Cleanliness required by most hydraulic servo-type systems.

ISO Code 17/14 - Cleanliness required in the Timberpro's hydraulic systems.

ISO Code 21/19 - Generally, the cleanliness of "new" hydraulic oil shipped in the drum.

On the ISO Code rating scale, a 14/10 rating is 10X cleaner than a 17/14 rating, and... a 21/19 rating is 10X dirtier than a 17/14 rating. This is why it is so important to only add pre-filtered oil to your hydraulic system.

Hydraulic System Overheating

When hydraulic systems overheat several things can occur that can damage the system. These include;

- (1) breakdown of the hydraulic oil producing "sludge",
- (2) deterioration of hose lining releasing rubber particles into the system,
- (3) o-rings and seals become less pliable and begin to leak.
- (4) increased formation of acids that can begin to corrode components.

If you are experiencing hydraulic system overheating, be sure the hydraulic oil viscosity is correct for the ambient conditions. Correct any overheat problems as soon as possible.

Adding Hydraulic Oil

An electric fill pump is used to add hydraulic oil to the system. Oil must be added using the hydraulic fill pump so oil is properly filtered through the return filters before entering the hydraulic tank.

! WARNING

Never add oil directly to the hydraulic tank without the oil being pumped through the filters. This could contaminate the hydraulic oil tank.

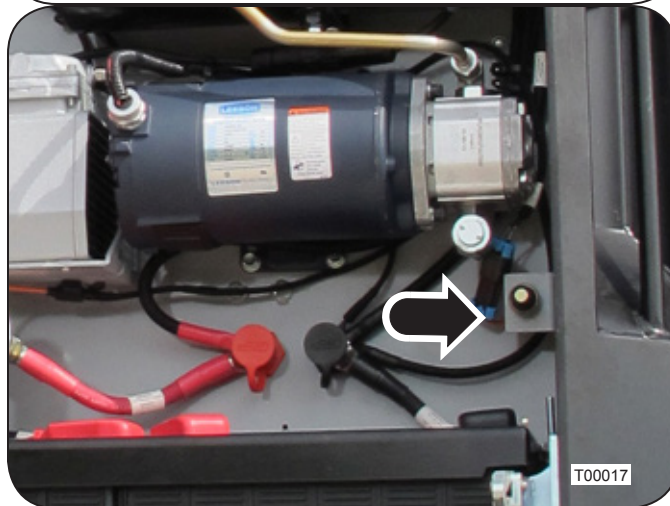


Figure 8: Fill Pump Switch

The hydraulic fill pump is located next to the batteries inside the electrical compartment behind the cab. The fill pump switch is located in this compartment (see figure 8) The keyswitch needs to be in the on position for the fill pump to work.

To Add Hydraulic Oil:

- 1) Release boost pressure by pressing the vent switch on the dash or opening the manual tank vent.
- 2) Place the fill pump's suction hose into a container filled with clean hydraulic oil.

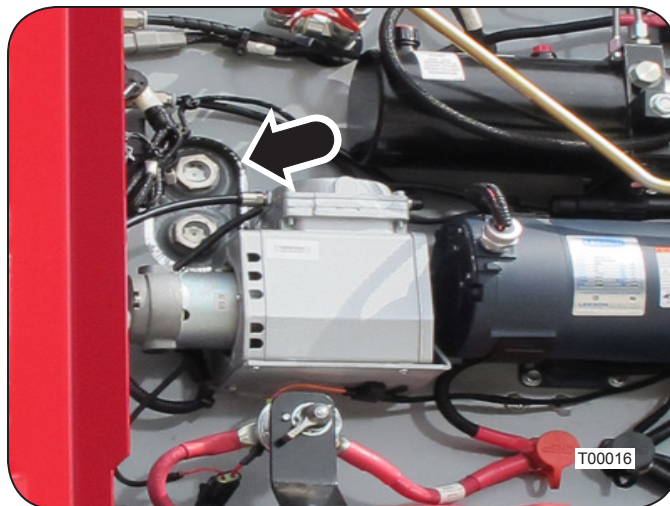


Figure 9: Oil Level Sight Gauge

3) Turn the keyswitch to the on position then press and hold the fill pump actuation button located near the fill pump on the left side of the engine. See Figure 8.

4) Add oil until level in the tank is visible in the site glass. See Figure 9. Do not over fill the tank.

 **WARNING**

Do not over-fill the hydraulic tank. This can cause hydraulic oil to drain out the overflow tube once the oil has been warmed up and expands.

TimberPro Hydraulic Oil Specifications

General Hydraulic Oil Specification

For optimum efficiency and hydraulics component life, Timberpro recommends that a high quality, wide temperature range, shear stable hydraulic oil be utilized which incorporates the following additive agents and viscosity limits.

IMPORTANT: The hydraulic oil is the life blood of the hydraulic system and should never be compromised.

- 1) Operating hydraulic oil viscosity (at normal operating temperature) be selected in the range of 81 to 167 SUS (17 to 35 cSt).
- 2) Anti-wear Agents - Zinc dithiophosphate at a minimum level of 800 ppm to provide lubricity (or equivalent).
- 3) Defoamers & Air Release Agents - Prevents the formation of air bubbles within the hydraulic oil.
- 4) Anti-Oxidant Agents - Prevents the formation of corrosive acids and sludge.
- 5) Rust & Corrosion Inhibitors - Protects metallic components from water and acids.
- 6) Detergents & Dispersants - Keeps system components free of deposits.

Reference the oil manufacturer's specification data sheet for the above hydraulic oil technical requirements.

Minimum Technical Hydraulic Oil Requirements

Any hydraulic oil utilized in TimberPro produced equipment should meet the following minimum technical requirements:

<u>Specification</u>	<u>Minimum Requirement</u>
FZG Rating, Din 51534	10+
Vickers 35VQ Vane Pump Test Vickers M-2950-S	<90 mg
Foam Test, ASTM D892	20/0 I, II, III/ml
Emulsion Test, ASTM 1401	10 max (minutes to 37ml. Water @ 130°F)
Cincinnati Milacron Thermal	Pass Stability (275°F, 168 hours)
Rust Test, ASTM D-665	Pass Procedures A & B
Sonic Shear Stability,	5 max ASTM D5621 (100C / 40 minutes) (% viscosity loss)
Water In Suspension	< .1% (% by Volume)
Oil Cleanliness ISO Standard.	17/14 min (16/12 prefer)
Viscosity Index, Min:	
ISO 32 Rating	169
ISO 46 Rating	145
ISO 68 Rating	135
Pour Point, Max:	
ISO 32 Rating	-45°F
ISO 46 Rating	-35°F
ISO 68 Rating	-30°F

