A Guide to Converting Hydraulic Systems from Mineral Oil to Synthetic Hydraulic Fluid

Lyle Ruble

Introduction

After careful thought and consideration you have decided to convert your hydraulic system over to a synthetic hydraulic fluid. It is not a simple matter of draining the old oil out and replacing it with the new fluid. The change out process requires considerable preparation including some basic research. Your system was probably designed to run on standard mineral oil based hydraulic fluid. The Original Equipment Manufacturer's (OEM) Manual of Operating and Maintenance Procedures were, most likely written, based on the use of mineral oil. Therefore, with the use of a synthetic fluid some of the recommended maintenance procedures will most likely have to modified or expanded. This guide is as of a result of nearly three decades in the fluid power and process control industry. I will be recommending what I have come to consider as the best practice and procedures, but it is always prudent to refer to your Operating and Maintenance Procedures Manual provided by the OEM.

Step Number One

Research:

Before changing out the system to the synthetic fluid it is wise to contact the OEM and ask for their recommendations regarding synthetic fluids. Based on the construction materials of the system there may be fluids that cannot be used in the equipment. The use of fluids that are either unknown fluids or not recommended by the OEM may void any limited warranties that are in force. Always seek approval from the OEM and get an affirmation, if possible, in writing. If the OEM cannot guide you in the fluid selection then it is best to contact the various hydraulic component OEMs and fluid suppliers prior to changing the fluids. Most reputable fluid suppliers will be able to advise you as to whether or not the fluid is compatible with your system construction. For example: some fluids react with non-anodized aluminum or galvanized components. Still again, there are some fluids that cannot be used with certain seal materials. If your system contains questionable materials, then you should proceed with caution and do further research by contacting fluid power and hydraulic fluid professionals. From the fluid supplier always ask for a reference list of other similar applications that you can contact to confirm the claims made by the fluid supplier, and make sure that you contact them. Do not purchase any fluid prior to completing your research.

Get to know the characteristics and properties of the fluid that you are converting to. There are a number of important things that must be understood. Your fluid supplier should be able to provide you with the information and also should be able to explain the information in terms that you can understand. If they can't, then find another supplier.

1. **What is the basic chemistry of the fluid?**
2. **What third party approvals does the fluid carry?**
3. **Is the fluid water soluble or is it anhydrous.**
4. **Ask if the fluid is biodegradable in your operating area?**
5. **How will the fluid operate at your system pressure?**
6. **What is the normal ph level?**
7. **What is the normal viscosity and VI (Viscosity Index)?**
8. **What is the fluids bulk modulus?**
9. **What is the pour point?**
10. **What are the temperature limitations?**
11. **What is the expected life time of the fluid?**
12. **How often should the filters be changed?**
13. **How often should the fluid be sampled?**
14. **How often should the fluid be changed?**
15. **What type of filter media is recommended?**
16. **What type of fire resistance does the fluid offer?**
17. **What are the proper disposal procedures of the fluid?**
18. **What affect does the fluid have on worker contact?**
19. **Does the fluid require special handling characteristics?**
20. **What is the recommended shelf life of the fluid?**
21. **Does the fluid supplier have a fluid power professional on staff to provide assistance?**

Step Number Two

Draining the System:

Equipment needed:

- Fluid transfer pump electric or manual
- Waste containers to put used oil in, 55 USG drums or 275 USG totes
- Splash pans to contain any spillage
- Absorbent media for spillage
- Lint free shop towels
- Fluid dams in case of large uncontrolled spills (optional)

1. Select a time when the hydraulic system can be shut down for at least an 8 hour period.

This will give you plenty of cushion time in case problems develop.

2. Prior to shutting the hydraulic system down, record the pressure and temperature readings of the system. Make sure the system has run long enough that the fluid in the system is warm. Also make a mental note of what the system sounds like before shutting down. Once the conversion has taken place you will want to compare the sound of what the system sounded like before the fluid conversion to what it sounds like after the conversion.
3. Turn off all power to the hydraulic system. If the prime mover is an electric motor, lockout with paddle locks the main power or disconnect switch. Place a placard on the disconnect alerting of the maintenance status and **Do Not Turn On**.
4. Place the appropriate size splash pan on a level floor surface in close proximity of the reservoir to be drained. Make sure the discharge hose of the transfer pump will reach. If it will require more than one waste container to completely drain the system then have another waste container already set up on another transfer pallet for easy transfer.
5. Place a transfer pallet on the drip pan and place the waste oil container on the pallet.
6. Remove the oil filler cap on the reservoir and place the fluid transfer pump pick up tube within ½ inch of the bottom of the reservoir.
7. Place the transfer pump discharge hose into the waste container.
8. Prior to pumping insure that all sources of ignition are extinguished, especially smoking materials.
9. Begin pumping and monitor the discharge flow and insure that the pump does not start to cavitate.
10. To remove all fluid, when the fluid level in the reservoir gets to within 1 inch from the bottom, move the transfer pump inlet tube to within a 1/8 of inch from the bottom.
11. When the waste container is full shut the discharge pump off and carefully remove the transfer pump discharge hose. Replace the container if necessary.
12. Once the fluid has been fully pumped out of the reservoir and into the waste container/s; seal off the waste container and mark it clearly as used oil and do not use. Remove the waste container to a safe storage area and clean up any spillage.

Step Number Three

Cleaning the System:

- Equipment needed:
- Steam cleaner (optional)
- Wet/dry shop vacuum
- Splash pans to contain any spillage
- Absorbent media for spillage
- Lint free shop towels
- New filters

1. Carefully remove the reservoir clean out access cover.
2. Vacuum out any fluid left in the bottom of the reservoir.
3. Inspect the interior of the reservoir for any obvious signs of damage, excessive wear and corrosion. Also look for evidence of foreign particles that are metallic. This may be an indication that some of the components in the system are about to fail. This can be easily done by running a small hand held permanent magnet around the surface of the bottom of the reservoir. If metallic particles are found it can also be an indication that the rating on your return filters is not correct and the return filters are not catching enough of the contaminants.
4. If the system has a suction strainer, remove it and clean it and if it cannot be cleaned then replace it. Most new systems usually no longer use suction strainers especially if the system utilizes cavitation sensitive pumps. If your system has such a pump and also has a suction strainer then you may want to ask your OEM if the strainer can be removed.
5. Wipe out the interior of the reservoir with lint free shop towels until all traces of old fluid and dirt is removed.
6. At this point you may want to steam clean the interior of the reservoir. This is especially wise in old systems that have been operating for long periods of time with mineral based oil hydraulic fluid. The steam will soften and remove the build up of oil oxidation varnishes.
7. It is possible to use certain approved solvents to clean with instead of steam cleaning, but make sure to check with the fluid supplier before using any solvents for compatibility with the synthetic fluid.
8. Thoroughly wipe out the interior of the reservoir with clean lint free shop towels.
9. Inspect the seal on the clean out access panel for obvious signs of aging or damage. Thoroughly clean the clean out access panel and reinstall on the reservoir.
10. Close off the oil filler access and thoroughly clean the exterior of the reservoir.

11. Inspect the rest of the hydraulic system for leaks or damage. Steam clean the rest of the hydraulic system if possible.
12. Remove all filters in the system and replace with fluid supplier recommended filters.

Step Number Four

Repair or replace damaged components:

1. This is the perfect time to repair or replace worn components in the system. If pumps or motors are beginning to lose efficiency or if cylinders are not operating correctly; then go ahead and repair or replace them. Make sure to repair all leaks. Also replace all damaged and worn tubes and hoses at this time. When replacing hoses the new hose or tube should be thoroughly cleaned with solvent and then "pigged out". (Pigging out of a hose is a small absorbent plug that is pushed through the hose with air pressure. It will remove the solvent and any particle contamination that accumulated during the hose construction.) Make sure that whatever components are replaced that they are replaced with like components.
2. If there are upgrades that you want to make to the system, this is the time to do so. Whatever upgrades are made; make sure that the upgrade components will be compatible with the new synthetic fluid. If the upgrades are particularly complicated it may be wise to have a fluid power professional do the upgrades.

Step Number Five

Filling the System:

- Equipment needed:
- Viscometer
- Fluid filler cart
- Wet/dry shop vacuum
- Splash pans to contain any spillage
- Absorbent media for spillage
- Lint free shop towels
- Fluid dams in case of large uncontrolled spills (optional)

1. Before filling the reservoir it is recommended to take a synthetic fluid sample and check the viscosity using the viscometer. This is to assure that you didn't receive the wrong fluid from the supplier. If there is a certain color that the fluid should be this should also be checked. Once these observations have been made and satisfied then proceed with filling the reservoir.
2. Again place the appropriate size splash pan on the level floor surface. Place the drum or tote and pallet on the drip pan.
3. Place the fluid filler cart discharge hose into the reservoir and the inlet hose into the drum or tote. Begin pumping until the reservoir is ¾ full by the fluid site gauge. It is not necessary to fully fill the reservoir yet. Stop the fluid transfer and remove the discharge hose from the reservoir and replace the reservoir filler cap.
4. If the pump has a bled screw on the case, remove it and pour some synthetic fluid into the case until full. Many pumps don't have this option and if they don't go onto the next step.
5. Energize the system assuring that it is safe to do so. If there is a system unloading (dump) valve make sure that it is in the open mode. You want to make sure that you don't initially run the pump in a loaded condition. Start the electric motor and pump and run for 15 seconds. After 15 seconds shut the system off for 45 seconds. This procedure should fill the pump case and avoid excess cavitation of the pump (running a dry pump for prolonged periods can cause severe pump damage). You will know when the pump case is full and the pump fully primed by the sound. After 45 seconds at rest again start the electric motor and pump and run for a maximum of one minute. Shut the motor and pump off and let it set for 1 minute. After 1 minute start the electric motor and pump still in the unloaded condition. Close the dump valve and load the pump. Run for five minutes charging the system and forcing fluid over the safety relief valve. Do not begin to cycle the actuators. After several minutes shut the system down. After 5 minutes again start the unit and this time begin actuating each of the actuators one by one, thus forcing fluid through the actuators and back to the tank. After actuating the final actuator, shut the system down and check the fluid level in the reservoir. Caution: If at any time the reservoir drops to below ¼ full, shut the system down and fill to ½ full to resume the system charging.
6. Fill the reservoir up to the ¾ level again.
7. Start the unit again and run for an additional 5 minutes and then shut it down and bleed the air out of the system until fully bled. Start again and listen for noises of air and cavitation in the system. A properly bled system should sound very much like it did when it was running on mineral oil based fluid.
8. Shut the system down and inspect for fluid leaks and tighten any leaks.
9. Once leaks are corrected then start the system and run for 30 minutes monitoring system pressure and temperature.
10. After 30 minutes shut the system down and replace the return filters.
11. Allow the unit to set for 30 minutes and then open the reservoir and check the level of mineral oil that should have accumulated on the top of the synthetic fluid. If there is ¼ inch to one inch, carefully remove the surface layer of fluid with a

wet/dry vacuum. If there is more than 1 inch then the reservoir must be pumped off and refilled.

12. The procedure for pumping off the reservoir to remove excess accumulated mineral oil is to empty the reservoir into a clean open waste container. Once the reservoir is empty allow the fluid pumped out to set for approximately 30 to 60 minutes until the synthetic fluid and the waste mineral oil have separated. Once separated, careful not to agitate the fluids, skim off the waste oil with the wet/dry vacuum. Once the drum shows no further traces of the mineral oil it is safe to transfer the fluid back into the reservoir again using the filler cart.
13. Finish filling the reservoir to the OEM recommended level.
14. The transfer of fluids is now complete.
15. After running the system 6 hours, during normal operations, shut down the system and replace the system return filters and take a fluid sample.
16. Carefully monitor the system for the next 5 to 10 days and check the accumulation of old mineral oil on the top of the fluid in the reservoir. If it becomes excessive, a ¼ inch or more, then skim off the oil using the wet/dry vacuum.

Step Number Six

Maintaining the System:

No matter what the fluid is it must be properly maintained to enjoy its full benefits. The fluid will not correct past bad maintenance practices nor will it operate to its full potential unless properly maintained. The best source for proper maintenance practices and procedures is the OEM and the fluid supplier.

Even though the fluid will probably help to extend the life of the hydraulic system components, don't expect components not to fail, especially the components that were in place prior to the time of fluid conversion. Where the real benefits come in is when new components are installed. The properly maintained system will then most assuredly provide the extended life times that come with your synthetic fluid selection.

A Planned Maintenance Program is the best practice and procedure for operating your system. Listed are some more of the important practices to perform:

1. Carefully monitor the system and fluid. Take regular fluid samples and have them analyzed. This alone will help extend the life of the system. It will also tell you when the fluid is "worn out". Even the best and most robust fluids have a useful lifetime and should be changed when they are no longer able to properly provide the benefits and characteristics expected of the hydraulic fluid. Additionally, fluid samples tell you the overall health of the hydraulic system. It is like in medicine, a blood sample tells a great deal about the health of the individual. Fluid samples can indicate whether or not components are wearing excessively and if filtration is adequate.
2. Fix leaks. It is estimated that 10% to 20% of all hydraulic fluid is lost through leakage. This provides a hazard to the work space and the environment.
3. Change the system filters regularly before they become clogged and the system must be shut down. Dirty and worn fluid accelerates the wear process on system components.
4. Keep good maintenance records of the system. Maintenance records will show over time the overall system health and indicate when components are beginning to be excessively worn. Good maintenance records also provide documentation to equipment and component OEMs when warranty questions come up.

The final comment is to stay in close contact with fluid power professionals and hydraulic fluid professionals. Together they can assist in helping you get the most out of your hydraulic system. A good attitude toward maintenance will also keep the system operating at the desired level. A few pennies spent will reap dollars in return.

Lyle Ruble is currently the Director of Sales Engineering and Marketing for MRL Hydraulics. He brings over 25 years of experience in fluid power and process control.