BFPA

HOW TO...???

Why so many oil types and grades

The functions of oil in a hydraulic system

Hydraulic oil plays 6 distinct and important roles within a hydraulic system and is arguably the most important element (the 'lifeblood') of the system. These roles are to:

- Transmit power
- Provide lubrication and wear protection
- Provide corrosion protection
- Transport contamination
- Provide cooling
- Act as a sealing medium

Each of these roles are considered below:

The transmission of power

The function of the oil is to allow power to be smoothly and efficiently transferred from the pump (the prime mover) to where it is required in the system. In order to do this the oil must be virtually incompressible and have suitably acceptable flow characteristics.

Lubrication and wear protection

The oil must be capable of providing a suitable film strength to separate moving parts under load, thereby reducing friction and allowing the hydraulic system to perform in a smooth and efficient manner.

Corrosion protection

Hydraulic systems are predominantly manufactured from carbon steel components and must be protected against corrosion caused by water within the oil and in the atmosphere above the oil level. In certain, more aggressive environments (e.g. offshore and chemical processing facilities) the oil will also be required to protect against this too. During the life of the fluid oxidation occurs, copper, brass and bronze materials in the system need protection from sulphur containing compounds and organic acids formed by this oxidation process. Bearing life is reduced by approximately half when water in the system oil reaches 300 part per million.

The transportation of contamination

The oil is required to transport any contaminant within the hydraulic system to a filter where it can be removed. Water must also be carried back to the reservoir where it can be separated and drawn off. It must therefore be possible to filter the oil to the target cleanliness level without changing the oil's properties – this also includes its additive content.

Cooling

Within a hydraulic system heat is generated as a result of friction and changes in pressure (the pressure in a locked cylinder will increase by 11.8 bar for every 1°C increase in oil temperature e.g. a temperature increase of 5°C will increase its pressure by 59 bar).

There are 3 main problems associated with hydraulic systems at elevated temperatures, these are:

- Oil life
- Oil viscosity
- Life of hose and seals

Hydraulic oil as a sealing medium

Although seals and o rings provide the sealing mechanism for the larger clearances between components, the hydraulic oil within the system provides sealing of the tighter clearances.

Once such example is where a spool valve has a seal at each end to prevent oil from escaping to atmosphere whereas inside the valve, each notch and undercut on the spool is sealed from the next only by the tight tolerance of the spool and valve bore, together with the oil's surface tension and resistance to shearing.

The oil viscosity is critical to this sealing function. A fluid with a high viscosity index (VI) is able to resist changes in viscosity as the fluid heats up, allowing the fluid to maintain a consistent seal.

Viscosity is the most important factor when considering which hydraulic oil to use

Hydraulic oil has a low viscosity when it is thin and a high viscosity when it is thick. The viscosity changes with the temperature - this is exactly the reason why butter can be very difficult to spread when it is taken straight out of the fridge but becomes easier to spread as it warms to room temperature (this warming can be increased by providing additional means of heat).

- As temperature increases, viscosity reduces (warm butter spreads easily)
- As temperature decreases, viscosity increases (cold butter is difficult to spread)

Low viscosity (thin) oil provides a relatively thin film of lubrication between mating parts, this can result in 'metal to metal' contact and damage to components. Lack of lubrication can results in premature excessive wear, it also increases internal leakage in hydraulic pumps and motors resulting in these having a lower volumetric efficiency.

High viscosity (thick) oil has a higher resistance to flow and can result in a reduction in mechanical efficiency and slow operation. High viscosity oil can results in energy loses resulting in elevated operating temperatures. High viscosity oil can cause a reduction in lubrication due to the fact that the 'thicker' oil may not be able to reach areas which have tight tolerances (but where thinner oil would reach). High viscosity oils can cause cavitation and lower air release properties.

Common viscosities for hydraulic oil are; 22, 32, 46 and 68 with others also being available. The viscosity is often prefixed ISO VG (e.g. ISO VG 46), the higher the number the more viscous (thicker) the oil.

Where the recommended viscosity cannot be achieved with standard fluids, or where the operating temperature window of the system is too large, fluids with a high viscosity index may be required.

Choosing the correct oil

If the hydraulic system has been constructed for a specific application, the manufacturer may have already provided an oil recommendation.

It is usually wise to follow this advice, particularly during the warranty period, unless major changes in the duty cycle or the system environment are made.

If no recommendation has been made on the appropriate oil to use, then some basic questions about the system, its operation and the working environment need to be answered to select the correct hydraulic oil with the following being important properties:

- Viscosity
- Pour point
- Shear stability
- Density or specific gravity
- Lubrication and wear protection
- Air release
- Foaming
- Compressibility
- Thermal properties
- Oxidation stability
- Thermal stability
- Hydrolytic stability
- Corrosion stability
- Material compatibility
- Filterability
- Water separation
- Fire resistance

Selection of the correct fluid can therefore be based on the following:

The needs of the system

What types of pump (and actuators) are used?

- Do they need antiwear oils?
  - HM – without viscosity index (VI) improver
  - HV – VI improved
  - HG – and HM type with anti stick-slip properties
- If no antiwear additives are required then rust inhibitors and antioxidants are used
  - HL – without VI
  - HR – VI improved
- Are the performance characteristics available?

What are the viscosity requirements of the system?

- Which ISO viscosity grade needs to be met?
- The requirements at the operating temperature(s)?

Are there any other unusual requirements arising from the system design?

From what material is the system constructed, e.g., metals, seals, hoses, gaskets and paints?

- Do any of the system parts preclude use of a certain type of fluid?

Matching the operating conditions

What is the duty cycle of the system?

- Is the fluid subjected to high temperature and pressures for long periods?

Does the operating temperature vary greatly?

- Is a high viscosity index (HV) fluid needed?

Quick Thought

Less than 0.5% of a plant's maintenance budget is spent purchasing lubricants, but the downstream effects of poor lubrication can impact as much as 30% of a plant's total maintenance costs each year.

ExxonMobil Case Study

How easy is it to maintain the system?

- Is it to be used in remote locations?

The working environment

Does the fluid pose any risk to the equipment operators?

- How can this be minimised?

Is the environment cold/hot/wet/dusty? Is fire a significant risk?

- What are the likely sources of ignition?
- Is a fire-resistant (HF) fluid needed?
  - HFB – water-in-oil emulsions
  - HFC – water polymer solutions
  - HFD – non-aqueous fluids
  - HFDR – phosphate esters
  - HFDU – other compositions (natural and synthetic esters and polyalkyleneglycols)

Is leakage into the environment a possibility?

- Is an environmentally acceptable (HE) fluid needed?
  - HETG – based on vegetable oil
  - HEES – based on synthetic esters
  - HEPG – based on polyglycols
  - HEPR – based on polyalphaolefins (PAOs)

Is the system involved in food processing?

- Is a food-grade (H1) fluid needed?

Economic factors

What is the cost effectiveness of the fluid? (i.e. does it permit a higher energy efficiency or a longer service life).

- Based on the above, would a high-performance fluid prove more economical?

What will the supplier contribute in terms of ongoing fluid monitoring?

What are the associated costs in terms of maintenance and reliability?

Disposal

How should this fluid be treated after use?

What options are there for fluid disposal?

- Can it be used elsewhere after reconditioning?

Does the supplier offer any recovery/replacement or disposal service?

What will it cost to dispose of the fluid correctly?

BFPA

British Fluid Power Association
Cheriton House, Cromwell Park,
Chipping Norton, Oxfordshire OX7 5SR

Tel: +44 (0)1608 647900
Fax: +44 (0)1608 647919
Email: enquiries@bfpa.co.uk