HYDRAULIC OIL SYSTEMS

Hydraulic systems are found in a broad cross-section of industry and are used to transmit power or motion to a variety of equipment parts or machinery. The systems perform vital functions in die casting machines, plastics moulding machines, presses, hydraulic couplings, forklift trucks and heavy earthmoving machinery.

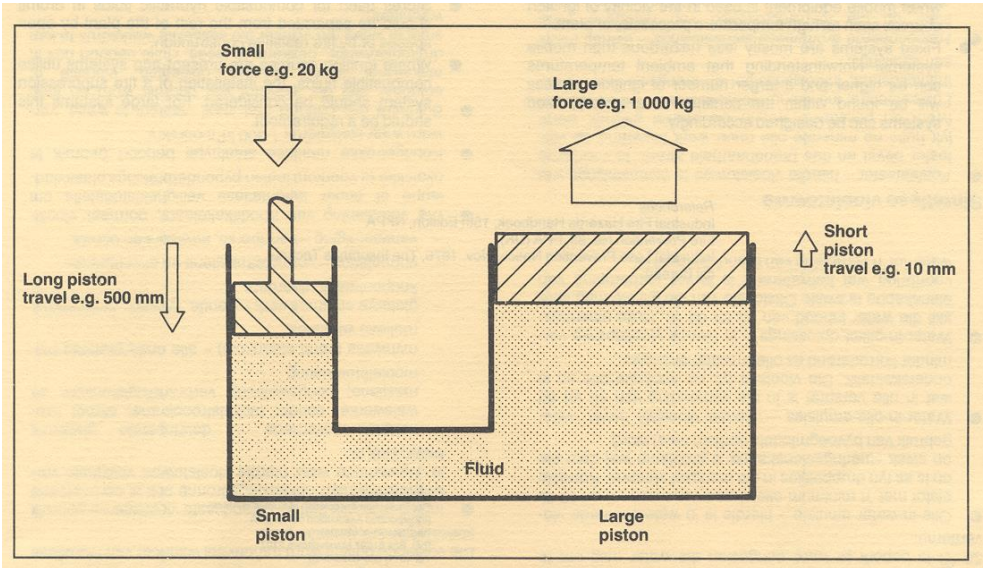
The hydraulic press

Pascal's principle states that when a fluid completely fills a vessel and pressure is applied to it at any part of the surface, that pressure is transmitted equally throughout the whole of the enclosed unit.

In the diagram, the small piston applies pressure to the fluid surface over a small area. This pressure rise is transferred to the large piston and acts over a large area. A large force results, since force is equal to pressure multiplied by area.

The hazards

Ignition of hydraulic fluid is the biggest potential danger. System temperatures are not normally high enough to cause concern but fluid released accidentally from the system may be ignited by ignition sources such as open flames, molten metal or a similar ignition source in the immediate area. Due to the fact that systems are under pressure, released fluid will tend to be in a mist or atomised form and can be propelled up to 15 m. In this state even contact with hot surfaces may result in ignition.



In 1956 at the Marchinelle Mine in Belgium the fracture of an hydraulic pressure hose resulted in a fine spray of oil being ignited by sparks caused by a simultaneous break in an adjacent electrical cable. The resulting blaze claimed the lives of 261 miners.

Hydraulic fluids

Hydraulic fluids may be either combustible or fire resistant.

Combustible type

Mineral oils – These are the most efficient hydraulic fluids from the mechanical point of view but they do burn. The fluids consist of a mixture of hydrocarbons.

Fire resistant type

When selecting fire resistant fluids consideration should be given to fluid cost, plant modification required, corrosion and toxicity of the fluid.

The fire resistance of these fluids is achieved by their high flashpoint and low flame spread characteristics. Water-based fluids and anhydrous synthetic fluids are the two main types. All contain combustible compounds which will burn if the fire conditions are severe enough, so the fluids cannot be termed non-combustible.

Water-based fluids

All water-based fluids can be corrosive because of the water content. In addition their usage should be confined to work areas of ambient temperature less that 50°C because the water tends to evaporate.

- Oil-in-water emulsion - This fluid is water-based with a mineral oil content of between 5 and 15 % dispersed in the mixture as fine droplets. Corrosion and poor lubrication properties are problems that have to be overcome by the use of additives.

- Water-in-oil emulsions - This fluid has water dispersed in oil at a ratio of 40 to 60 respectively. The fluid resembles mineral oil and is less corrosive than oil-in-water emulsions.

- Water-glycol solutions - In these fluids water content varies from 35 to 60 %. They have poor lubricating properties. Also oxidation of the glycols may produce acids which are corrosive while evaporation of water leads to an increase in combustibility.

Synthetic fluids

- *Phosphate esters* - These fluids are compounds containing phosphorous which inhibits combustibility. They resemble mineral oils in appearance but are corrosive to paints and gaskets used in the system. Phosphate esters include tributyl phosphate, trioctyl phosphate, triphenyl phosphate, tricresyl phosphate and mixtures of these compounds

- *Halogenated aromatic compounds* - These rely on the presence of halogens, particularly chlorinated diphenyls and naphthalenes to reduce their combustibility. In the event of contamination of water, hydrolysis may occur producing highly corrosive halogen acids. This can be overcome by the use of additives.

  Aromatic fluorine compounds such as hexafluorbenzene have good fire properties and are stable at high temperatures.

- *Silicone fluids* - Silicate esters include a very wide range of fluids which are stable at high temperatures and have good fire resistant properties.

Type of system

Hydraulic systems may be found as fixed systems integrated with processes or plant or may form part of mobile equipment.

- Mobile equipment usually utilises mineral oils. The main hazard being a leak from seals or hoses resulting in pressurised oil being sprayed onto and being ignited by hot exhaust or engine surfaces. The hazard escalates when mobile equipment is used in the vicinity of ignition sources such as high temperature processes or plant.

- Fixed systems are mostly less hazardous than mobile systems. Notwithstanding that ambient temperatures can be higher and a larger number of ignition sources will be found within the confines of a factory, fixed systems can be designed accordingly.

Recommendations

The following guidelines are advocated when hydraulic systems are utilised.

- If possible, fire resistant fluids should be used whenever ignition sources are prevalent. Industries where these fluids improve safety include:

  - Metal industry - continuous casters, rolling mills, furnaces, stripper cranes, scrap charges, arc welder, combustion controls and mobile equipment.

  - Mining (particularly coal) - all underground hydraulic requirements.

  - Foundries and forging – furnaces, moulding lines, forge presses, extrusion presses and billet manipulators.

  - Die casting - die casting machines and trip presses.

  - Fabrication - forming presses, welders and furnaces.

- The provision of emergency switches, excess flow valves or other automatic safety devices to prevent oil leakage should piping failures occur.

- Cold-drawn seamless steel tubing should be used where system pressures exceed 1 300 kPa.

- Flexible hose should be steel reinforced, be compatible with the fluid being used and protected against abrasion due to machine movement, vibration or pressure surges. They should also be capable of withstanding five times the system working pressure.

- To minimise failure due to vibration, piping and tubing should be secured.

- Machines should be placed as far away from ignition sources as practicable.

- Excess oil or spillages should be dealt with immediately. No effort should be made to salvage or reclaim spilled fluids since they will be contaminated.

- High pressure leaks occur due to the failure of hose, gaskets, seals, couplings etc. Regular inspections of the system on a shift or daily basis and pre-planned maintenance should be carried out.

- Suitable precautions should be taken if maintenance of the system involves hot work. In this case, clean the surroundings of combustibles, clear up spilt or leaking oils and then depressurise the system before hot work commences.

- Stores used for combustible hydraulic fluids in drums should be separated from the rest of the plant by open spaces or by fire resistive construction.

- Where ignition sources are present and systems utilise combustible fluids, the installation of a fire suppression system should be considered. For large systems this should be a requirement.

References:

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Fire Prevention No. 85 FPA(UK)
Industrial Loss Prevention Notice, Nov. 1976, The Insurance Technical Bureau

Published by
Fire Protection Association of Southern Africa
(Incorporated Association not for Gain)
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