Pearson BTEC Levels 4 Higher Nationals in Engineering (RQF)

Unit 29: Electro, Pneumatic and Hydraulic Systems

Unit Workbook 4

in a series of 4 for this unit

Learning Outcome 4

Maintenance of Pneumatic and Hydraulic Systems

Safety, fault-finding and maintenance

Safety

Electrical systems are generally recognised as being potentially lethal, and all organisations must, by law, have procedures for isolation of equipment, permits to work, safety notices and defined safe working practices. Hydraulic and pneumatic systems are no less dangerous; but tend to be approached in a far more carefree manner. High pressure air or oil released suddenly can reach an explosive velocity and can easily maim, blind or kill.

Unexpected movement of components such as cylinders can trap and crush limbs. Spilt hydraulic oil is very slippery, possibly leading to falls and injury. It follows that hydraulic and pneumatic systems should be treated with respect and maintained or repaired under well -defined procedures and safe working practices as rigorous as those applied to electrical equipment.

Some points of note are:

- Before doing anything, think of the implications of what you are about to do, and make sure anyone who could be affected knows of your intentions. Do not rush in, instead, think.
- Anything that can move with changes in pressure as a result of your actions should be mechanically secured or guarded. Particular care should be taken with suspended loads. Remember that fail open valves will turn on when the system is de-pressurised.
- Never disconnect pressurised lines or components. Isolate and lock-off relevant legs or de-pressurise the whole system (depending on the application). Apply safety notices to inhibit operation by other people. Ideally the pump or compressor should be isolated and locked off at its MCC. Ensure accumulators in a hydraulic system are fully blown down. Even then, make the first disconnection circumspectly.

- In hydraulic systems, make prior arrangements to catch oil spillage (from a pipe replacement, say). Have containers, rags and so on, ready and, as far as is possible, keep spillage off the floor. Clean up any spilt oil before leaving.
- Where there is any electrical interface to a pneumatic or hydraulic system (eg, solenoids, pressure switches, limit switches) the control circuits should be isolated, not only to remove the risk of electric shock, but also to reduce the possibility of fire or accidental initiation of some electrical control sequence. Again, think how things interact.
- After the work is completed, leave the area tidy and clean. Ensure people know that things are about to move again. Check there is no one in dangerous areas and sign-off all applied electrical, pneumatic or hydraulic isolation permits to work. Check for leaks and correct operation.
- Many components contain springs under pressure. If released in an uncontrolled manner these can fly out at high speed, causing severe injury. Springs should be released with care. In many cases manufacturers supply special tools to contain the spring and allow gradual and safe decompression.

Most hydraulic or pneumatic faults are caused by dirt. Very small particles nick seals, abrade surfaces, block orifices and cause valve spools to jam. In hydraulic and pneumatic systems cleanliness is next to

Godliness. Dismantling a valve in an area covered in swarf or wiping the spool on an old rag kept in an overall pocket does more harm than good.

Ideally components should not be dismantled in the usual dirty conditions found on site, but returned to a clean workshop equipped with metal-topped benches. Too often one bench is used also for general mechanical work: it needs little imagination to envisage the harm metal filings can do inside a pneumatic or hydraulic system.

Components and hoses come from manufacturers with all orifices sealed with plastic plugs to prevent dirt ingress during transit. These should be left in during storage and only removed at the last possible moment.

Filters exist to remove dirt particles, but only work until they are clogged. A dirty filter bypasses air or fluid, and can even make matters worse by holding dirt particles then releasing them as one large collection. Filters should be regularly checked and cleaned or changed (depending on the design) when required.

Oil condition in a hydraulic system is also crucial in maintaining reliability. Oil which is dirty, oxidised or contaminated with water forms a sticky gummy sludge, which blocks small orifices and causes pilot spools to jam. Oil condition should be regularly checked, and suspect oil changed before problems develop.

Fault-finding

Fault-finding is often performed in a random and haphazard manner, leading to items being changed for no systematic reason beyond 'Fred got it working this way last time'. Such an approach may work eventually (when every component has been changed!) but it is hardly the quickest, or cheapest, way of getting a faulty system back into production. In many cases more harm than good results, both with introduction of dirt into the system, and from ill advised 'here's a control adjustment; let's twiddle it and see if that makes any difference' approach. There must be a better way.

There are three maintenance levels. First line maintenance is concerned with getting faulty plant running again. When the cause of a fault is found, first line staff have the choice of effecting a first line, on site, repair (by replacing a failed seal, say) or changing the complete faulty unit for a spare. This decision is based on cost, time, availability of spares, technical ability of staff, the environment on site and company policy.

Second line maintenance is concerned with repair to complete units changed by first line maintenance staff. It should be performed in clean and well-equipped workshops. Work is usually well-defined and is often a case of following manufacturers' manuals.

The final level is simply the return of equipment for repair by manufacturer. The level at which this is needed is determined by the complexity of equipment, ability of one's staff, cost and the turnaround time offered by the manufacturer.

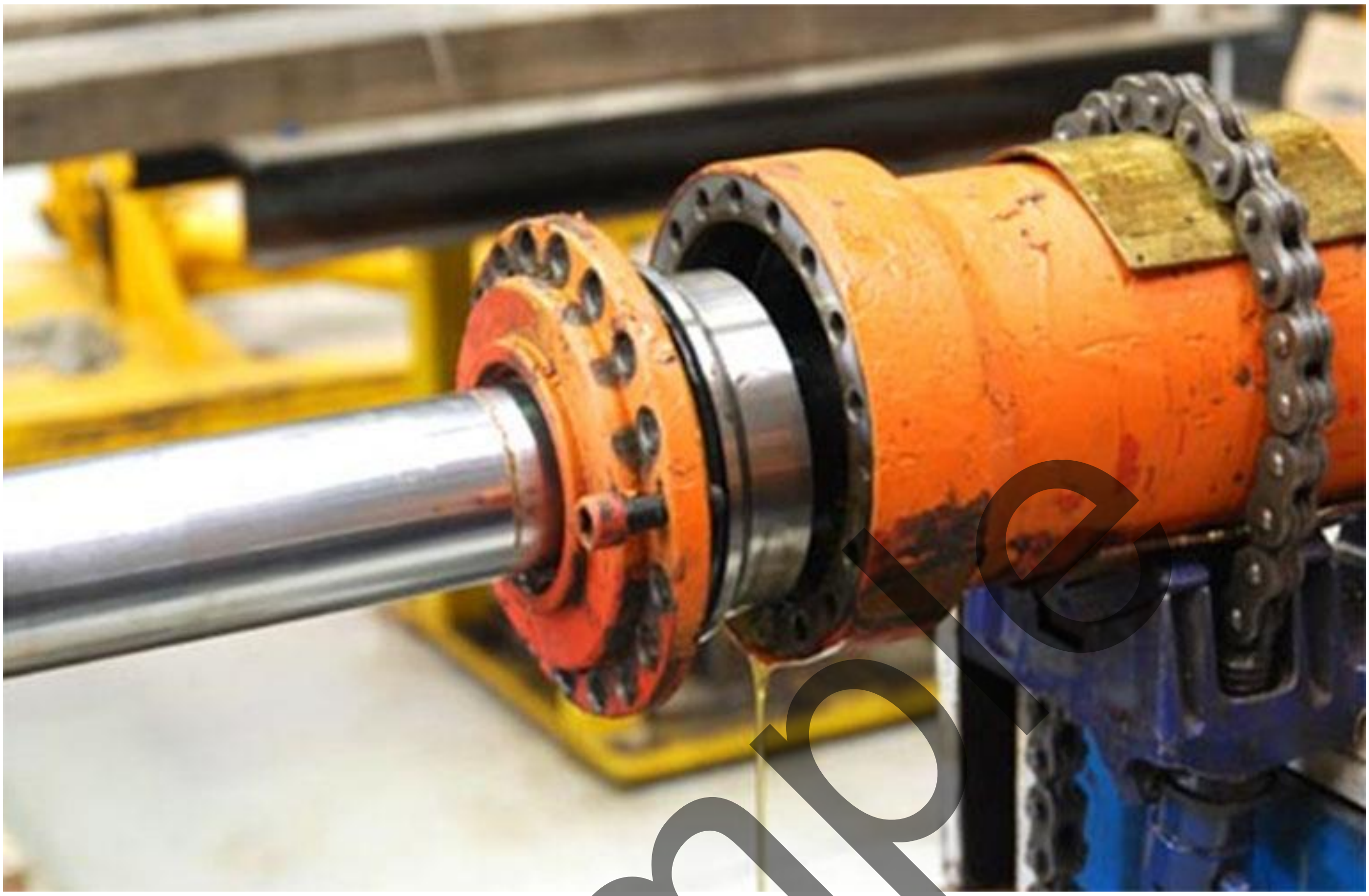
Of these three levels; first line maintenance is hardest, as work is ill-defined, pressures from production staff are great and the responsibility high. Unfortunately, it is too often seen as a necessary evil.

All the evidence on a fault gathered so far is evaluated, and possible causes considered. The simplest test to reduce the number of possibilities is then performed and the cycle repeated until the fault is found.

The final steps are concerned with fault recording and fault analysis. Any shift crew (which performs almost all the first line repairs) only sees one quarter of all faults. The fault recording and analysis process shows if there is any recurring pattern in faults, indicating a design or application problem. Used diplomatically, the records may also indicate shortcomings in a crews' knowledge and a need for training.

Modern plants tend to be both complex and reliable. This means that a maintenance crew often sees a plant in detail for the first time when the first fault occurs. (Ideally, of course, crews should be involved at installation and commissioning stages - but that is another story!). It is impossible to retain the layout of all bar the simplest of systems in the mind, so it is essential to have schematic diagrams readily available.

Equally important, readings at each test point should be documented when the system is working correctly. It is not much use to know pressure at TP3 is 15 bar, the motor draws 75 A or flow to rotary actuator C is 1500 litres per minute under fault conditions, without knowing what the normal readings are.



Preventive maintenance

Many production people think a maintenance department exists purely to repair faults as they occur (the common image being a team sitting in the workshop waiting for the 'phone to ring). The most important part of a maintenance department's responsibility, however, is performing routine planned maintenance.

This provides regular servicing of equipment, checks for correct operation and identifies potential faults, which can be corrected before they interrupt production. A personal analogy is the 6,000-mile service for motor cars. As an often-overlooked side benefit, planned maintenance trains the maintenance craftsmen in the operation and layout of the plant for which they are responsible.

A planned maintenance schedule can be based on a calendar basis (work done daily, weekly, monthly and so on) or on an operation-based schedule (work done after so many hours operation, or so many cycles) with time run or number of cycles recorded by control equipment. Different parts of the system may have differing maintenance schedules. Identifying what work needs to be done, and the basis of the schedule for each item is the art of planned maintenance. It depends heavily on the nature of the plant; air filters in a dust filled steel works say, require checking more often than in a clean food factory.

With the advent of the desk-top personal computer many excellent computer-based maintenance planning programs are available. These produce fully detailed work schedules on a shift-by-shift basis, and flag urgent work. The user still, however, has to specify the work to be done and the basis of schedules.

In hydraulic systems it is generally thought that oil problems (level in the tank, contamination by dirt, air or water) are responsible for around three-quarters of faults. Regular checks on oil condition and level are therefore of utmost importance. Any sudden change in level should be investigated.

Oil temperature should also be checked regularly. High temperatures arise from heat produced by flow discharging with a high pressure drop. Apart from the obvious possible fault with a heat exchanger (no water flow for example) other possible causes are incorrect operation of relief or unloading valves (ie, the pump on load continuously) internal leakage or too high a fluid viscosity.

System pressure should be recorded and checked against design values. Deviations can indicate maladjustment or potential faults. Too high a pressure setting wastes energy and shortens operational life. Too low a pressure setting may cause relief valves to operate at pressures below that needed by actuators, leading to no movement. Pressure deviation can also indicate developing faults outside the system. The fouling of a component moved by an actuator, for example, may cause a rise of pressure which can be observed before a failure occurs.

Motor currents drawn by pumps and compressors should also be checked both in working and unloading states (ideally, indication of motor currents should be available on a panel local to the motor). Changes in current can indicate a motor is working harder (or less) than normal.

Filters are of prime importance in both hydraulic and pneumatic systems. The state of most hydraulic filters is shown by a differential pressure indicator connected across the filter element. Obviously, filters should be changed before they become blocked. Inlet air filters on pneumatic systems also need regular cleaning (but not with flammable fluids such as petrol or paraffin). A record should be kept of filter changes.

Many checks are simple and require no special tools or instruments. Visual checks should be made for leaks in hydraulic systems (air leaks in pneumatic systems generally can be detected from the noise they make!). Pipe runs and hosing should be visually checked for impact damage and to ensure all supports are intact and secure. Connections subject to vibration should be examined for tightness and strain. It is not unknown for devices such as pumps and compressors to 'walk' across the floor dragging their piping with them.

Where the device examined follows a sequence, the operation should be checked to ensure all ancillary devices, such as limit switches, are operating. The time to perform sequences may be worth recording as a lengthening of sequence times may indicate a possible developing fault due to, say, leakage in a cylinder.

Actuators have their own maintenance requirements given in manufacturers' manuals. Seals and bushing in cylinders, for example, require regular checking and replacement if damaged. Cylinder rods should be examined for score marks which can indicate dust ingress. Actuators which move infrequently under normal duty can be operated to check they still work (and also to help lubricate the seals).