UNIT 47: Engineering Plant Technology

Unit code: F/601/1433       QCF level: 5       Credit value: 15

OUTCOME 1

TUTORIAL 2 – GENERAL PLANT PIPEWORK

1. Understand procedures for safe and effective operation and testing of plant

   Safe operating procedures: pre start-up Checks; start-up; running and shutdown procedures; permit to work; emergency procedures

   Testing procedures: performance monitoring eg collation of data and results, flow variables such as temperature, pressure, volume flow, abnormal conditions, quality control, corrective action; performance testing eg comparison of measured results with accepted norms for criteria such as power, efficiency, heat loss, power factor, slip

This tutorial complements tutorial 1 with knowledge of plant pipework.
STORAGE OF FLUIDS AND PIPES

The correct storage of materials is important because

1. It enables a check to be kept of usage.
2. It enables safety procedures to be followed.
3. It prevents damage and deterioration of the materials.
4. It enables proper identification of the types.

FLUIDS

Hydraulic fluids as with other fluids must be stored in a safe way that makes it accessible and prevents it deteriorating with age. For these reasons the oil should be stored in drums and the method for removing oil from the drum should prevent spillage (e.g. the use of drip trays). Spilled oil is a fire hazard and a safety hazard to those walking on it.

The drums should be stored in a safe place, in particular, somewhere with no fire hazard. For example do not store it near a furnace or in an electrical switch gear room. The drums should have closed tops, not left open and the oil should be removed from a tap with a drip can.

The life of a hydraulic fluid is governed largely by oxidation. For this reason the oil should not be left exposed to the air and should not be stored in a warm place.

The drums should be clearly labelled with the type of fluid to reduce the risk of someone putting the wrong fluid in a machine.

Proper store keeping accounts should be used to keep track of who uses which fluid for which machine, how much was used and the date.

PIPES

The main hazard with the storage of pipes is the danger to anyone passing near them getting caught on a jagged end or having them fall on him. Proper storage racks should be used with the walkways parallel to the lengths.

The pipes should be racked in order of size. Since pipes are made of various materials and grades of materials, correct identification procedures should be made and proper store keeping procedures adhered to regarding who used what and when.

The location of the racks should be such that the pipes do not deteriorate. For example a dry area should be used to prevent rusting. Flexible hoses and plastic tubing should be stored away from chemicals and heat.

Plant pipework is generally larger in size and capacity than hydraulic and pneumatic pipework. The kind of fluids which may be flowing in these pipes are for example

- Water
- Steam
- Oil
- Chemicals
- Foodstuffs
- Pharmaceuticals
There are standards regarding the construction, materials and safety of such systems. The main standard for you to learn is BS1553 which covers the symbols for pipes and plant items connected with the pipe work. The main symbols are shown on the attached sheets and should be learned.

IDENTIFICATION OF CONTENTS

It is vital that a pipe fitter be able to identify the contents of a system so that he may take appropriate safety measures when breaking into the system. This is done through a colour code system and by symbols. Pipes are painted in a basic colour to identify the basic content. The main ones are:

- Water: Green
- Steam: Silver Grey
- Air: Blue
- Oil: Brown
- Gas: Yellow Ochre
- Electric Conduit: Orange

A second colour is added as a band to identify the content in more detail. Here are some examples.

Water pipes may have the following bands

- Red: Fire fighting water
- Green: Fresh water

Oil pipes may have the following bands

- Black: Waste oil
- Salmon: Power applications (Hydraulics)

A third band may be added in the middle of the second band to indicate further information. For example

- Black/Yellow stripes: Danger.

Extra symbols may be added such as the ionising radiation symbol to indicate radiation hazard.

In the case of large ducts which cannot be painted with bands, coloured triangles are used on the side of the duct. The colour identification should be placed at obvious points such as at the stop valves.
BASIC SYMBOLS FOR PIPE DRAWINGS

- Main Pipe Line
- Minor Pipe Line
- Underground Pipe Line
- Pipes crossing
- Pipes joining

JOINING

Most plant pipes are joined to each other or to hardware items as follows.

1. Welded joints.
2. Flanged joints.

Some of the symbols are shown below.

PIPE LINE VALVES

There are many types of valves on pipe lines. The main functions are as follows.

ISOLATING VALVES are for completely closing the pipe and to isolate a section of the plant. These are vital for safety reasons.

FLOW CONTROL VALVES are for controlling the flow in the pipe by adjusting the opening accordingly.

PRESSURE REGULATING VALVES are for controlling the pressure in the system.

PRESSURE REDUCING VALVES reduce the pressure to a lower value and regulates that pressure.

PRESSURE RELIEF VALVES are a safety item for limiting the pressure in the system.

VENTING VALVES are a form of stop valve for releasing the contents of the plant.
A valve symbol consists of 4 parts.

1. The basic symbol for a valve.
2. The type of valve.
3. The way it is joined to the pipe.
4. The way it is operated.

The example below shows a manually operated needle valve with flanged connectors.

The complete range of valve symbols are attached and should be used when drawing a plant pipe work system. Diagrams of the main types of valves along with information on their use is attached. The main things to consider when selecting a valve is:

- The pressure loss over the valve when fully open.
- The smoothness of the flow passage when open.
- The speed of opening and closing.
- The material used in the construction.
- The pressure rating.
- The reliability and life span.
- The quality of the seals.

For example a ball valve offers a completely smooth passage when open. A needle valve gives gradual opening and closing. A globe valve gives quick opening and closing. A diaphragm valve completely seals the contents of the valve from the outside.

OTHER PLANT SYMBOLS

There are many symbols for plant such as evaporators, coolers, reaction vessels, pumps, heat exchanges and so on. You are not expected to learn these but it is useful to recognise the main items as they will be part of a plant pipe work diagram.

DRAIN TRAPS

Drain traps are to allow the draining of one fluid from a system while retaining another fluid. For example a trap may release water while retaining air or steam. It may release air while retaining liquid. The symbols for drain traps are shown below.
PIPE LINE PROTECTION

Large pipe lines carrying chemicals, gas, oils and so on, must have protection built into the system. The dangers are:
1. bursting from over-pressure.
2. explosions, some of which might travel along the pipe.
3. freezing or caking causing a blockage.
4. fires due to leakage.
5. electrical faults developing.
6. fractures due to thermal expansion or lack of support.

The prevention measures which can be taken are as follows.

1. BURSTING

PRESSURE RELIEF VALVES.

Bursting can be prevented by the use of pressure relief valves. These must be capable of passing the flow quickly and safely to prevent over-pressure. If the pipe contains dangerous fluids, they must be vented into a safe container.

BURSTING DISCS

If a large volume must be vented quickly then bursting discs are sometimes used. These are discs over an opening in the system which burst at a known pressure and allows the fluid to escape.

2. EXPLOSIONS AND FIRES

An explosion in a pipe line sometimes travels quickly along the inside of a pipe. To prevent this flame arresters are used (fire traps). A typical flame arrester is a short length of pipe containing a honeycomb filter-like metal mesh through which the fluid normally passes. When a flame shoots through the pipe, the mesh cools the gas very quickly and prevents re-ignition on the other side. Miners’ safety lamps are similar in principle.

Bursting discs attached to a vent allows an explosion to vent itself. Fires and explosions may be contained by allowing a gas such as carbon dioxide to purge the system.

3. CAKING

Oils and certain chemicals are prone to caking and waxing when the temperature falls below the operating point. (not necessarily cold). In order to prevent this the pipe should be lagged and electrical heating elements may be placed under the lagging to keep the pipe warm. Typically a tape with a built in electrical heating wire is wrapped around the pipe along its length. Steam and hot water may be used also with a suitable jacket around the pipe. Pipe line lagging should be fire proof.

4. ELECTRICAL HAZARDS.

Most pipe lines should be thoroughly earthed to prevent arcing and risk of explosions due to electricity being conducted along the pipe.
5. THERMAL EXPANSION AND SUPPORTS

Sudden changes in temperature in a large pipe line can cause such sudden changes in lengths that stresses are set up rapidly causing THERMAL SHOCK which results in fractures.

Pipe lines should be warmed up and cooled down slowly. Even so, due account must be taken of the changes in lengths due to expansion or contraction. If the pipe is rigidly attached at two points, the change in length will compress or stretch it and cause it to bend. This may cause it to fracture. Prevention of thermal stresses should be incorporated into the design. Features such as expansion joints, flexible bends, expansion loops, sliding pipe supports and so should be used.

Pipe lines should also be supported to prevent them bending under their own weight and breaking. A variety of pipe supports are available including resilient ones to help absorb vibration and sliding ones to allow expansion movement. Symbols for pipe supports are shown below.

MAINTENANCE

Strict safety procedures must be adopted when doing maintenance work on a pipe line. The regulations depend upon the fluid in the pipe. In general you must do the following.

1. Obtain a permit to work.
2. If the fluid is flammable or chemical you must obtain a certificate of clearance for work on hazardous systems.
3. Arrange for standby plant to be brought into operation if required.
4. Shut down the pipe safely.
   a. Display notices to prevent anyone tampering while you are working.
   b. Close isolating valves.
   c. Release pressure from the pipe safely with bleed valves.
   d. Allow gradual cooling if necessary.
   e. Blank off any outlets as required.
   f. Purge system if required.
   g. Electrical isolation of instruments, thermal heating and so on.
5. Restart safely.
   a. Correct alignment of pipe.
   b. Reconnect electrical equipment and monitoring equipment (e.g. heat tracing).
   c. Check safety devices and interlocks (e.g. fire arresters and alarms).
   d. Test pipes.

Hydrostatic pressure test.
Purging.
Blow through.

e. Warm up gradually to avoid thermal shock.
f. Bring on line and check all readings are normal.
g. Complete job sheet.