SUB: HYDRAULICS, PNEUMATICS & MECHANICAL

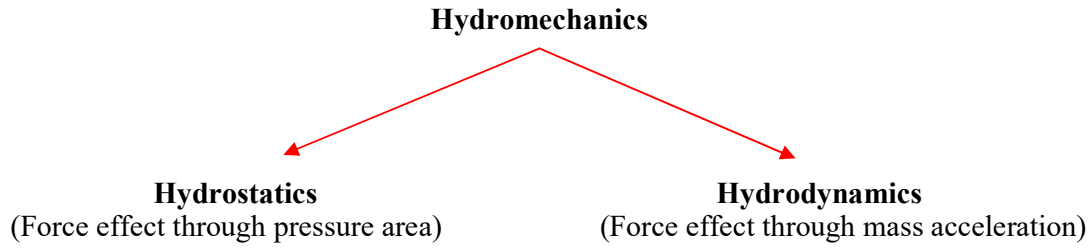
Duration: 22 Sessions = 44 Periods

Sub-discipline: Hydraulics (Lessons: 11 Sessions: 12)

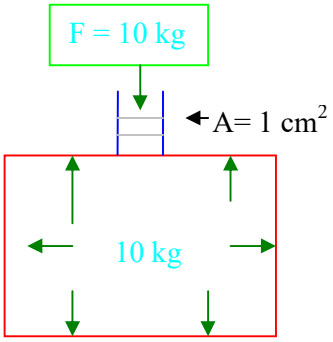
Lesson-I: Fundamentals, Symbols, Oil, Tank and Filter **Session–1:** Introduction, Hydraulic Symbols, Functions and Properties of Hydraulic oil, Functions and Parts of Hydraulic Tank, Functions and Types of filters, Importance of filtration.

INTRODUCION:

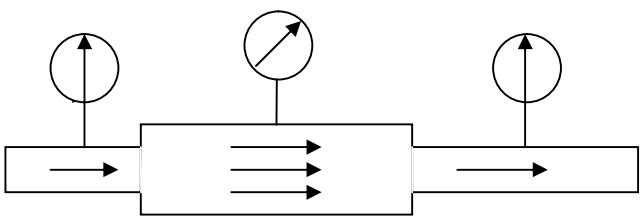
The word hydraulics originates from the Greek. This is made of two words-Hydor and aulos. Hydor means water and aulos means pipe i.e. flow of water through pipes. Today the term hydraulic commonly refers to "Power hydraulics" in which fluid is used under controlled pressure to do work. Hydraulic power is used in every branch of industry in a machine tool, missiles, man made satellite, boat, planes, cranes, lifts, track machines etc. So fluid is most versatile means of transmitting power & modifying motions. A fluid is infinitely flexible. It can easily change its shape, it can be divided into parts to do work in different locations, it can move rapidly in one place and slowly in another place. No other medium has the same accuracy, positiveness & power in minimum of volume & weight. It is the science of forces and movements transmitted by means of liquids i.e. generation of forces and motion using hydraulic fluid. It is a part of hydromechanics.



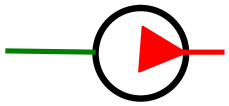
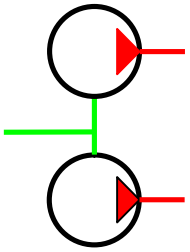
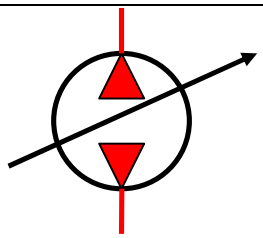
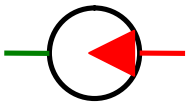
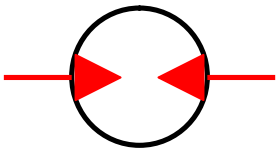
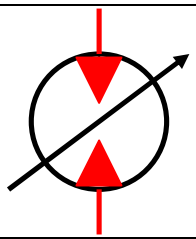
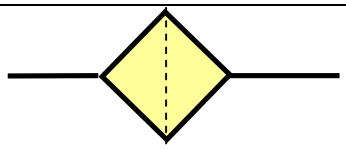
Hydraulic fluid contains two energy: (1) Kinetic energy (2) Potential energy.
Basically hydraulic fluid obeys:
PASCAL'S LAW: It states that when pressure is applied on a confined fluid, it is transmitted undiminished in all directions, and acts with equal force on equal areas, and at right angles to them.

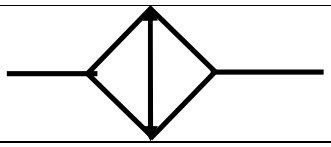
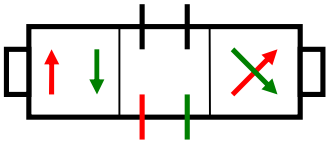
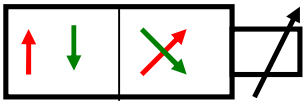
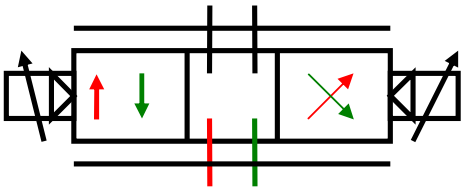
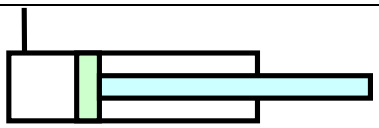
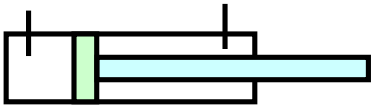
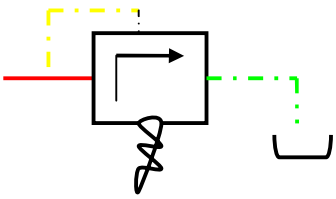
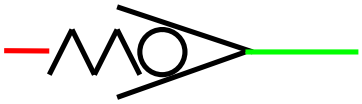


BERNOULLI'S PRINCIPLE: "It states that in a system with constant flow rate, energy is transformed from one part to other each time the pipe cross-section changes"



HYDRAULIC SYMBOLS:

	**Single Pump**
	**Double Pump**
	**Variable Pump**
	Return Line **Pressure Line**
	Pilot Line
	**Uni-Directional Motor**
	**Bi-Directional Motor**
	**Variable Motor**
	Stop Cock
	**Filter**

	**Cooler**
	**4/3 Way Valve**
	**4/2 Way Valve**
	**Servo Valve or Proportional Valve**
	**Single Acting Cylinder**
	**Double Acting Cylinder**
	**Relief Valve**
	**Check Valve/ Non-Return Valve**

FUNCTIONS OF HYDRAULIC OIL:

1. To transmit power from one point to another
2. To lubricate moving parts
3. To cool or dissipate heat
4. To seal clearance between parts
5. Cushioning of oscillations caused by pressure jerks.
6. Corrosion protection.
7. Scuff removal.

PROPERTIES OF HYDRAULIC OIL:

1.1 Suitable viscosity:-viscosity is measure of fluid's resistance to flow. If a fluid flows easily, its viscosity is low. Fluid flows with difficulty have a high viscosity. Some methods of define viscosity are: absolute viscosity, kinematic viscosity, and relative viscosity and SAE numbers. kinematic viscosity is the most common way of measuring viscosity. It is measured by the amount of time needed for a fixed volume of oil to flow through a capillary tube. The unit for kinematic viscosity is mm^2/sec or centistokes.

1.2 Anti-rust and anti-corrosive:-rusting is the chemical union of steel with oxygen. Corrosion is chemical union between a metal and acid. Corrosion occurs as the acid acts on the metals. Rusting is caused by air bubble in the system. It is usually not possible to keep air and atmosphere born moisture out of hydraulic system. They contaminant the system and promote wear. There are several ways of preventing rust and corrosion. The best way is that hydraulic system may work at proper temperature and pressure. A fluid should filtered properly

1.3 Oxidation resistance :- Fluid oxidation is the chemical reaction of the fluid with air which forms new substances or compounds, when hydraulic oil oxidized, it form gum, sludge some of these soluble compounds are acids which rusts are bites the metallic components in the system. It is the most common factor that reduces the fluid life. These contaminants close the orifice, increases wear and tear and causes valves to stick. The best control is through the good maintenance.

1.4 Resistance to foaming:- A small air bubbles get entrapped during course of suction and delivery of released oil from circuit. Air also enters through vent hole and mixes with oil and affects the efficiency. Air also causes heating of the oil and hydraulic assemblies. Return pipe should be located well below in the hydraulic tank.

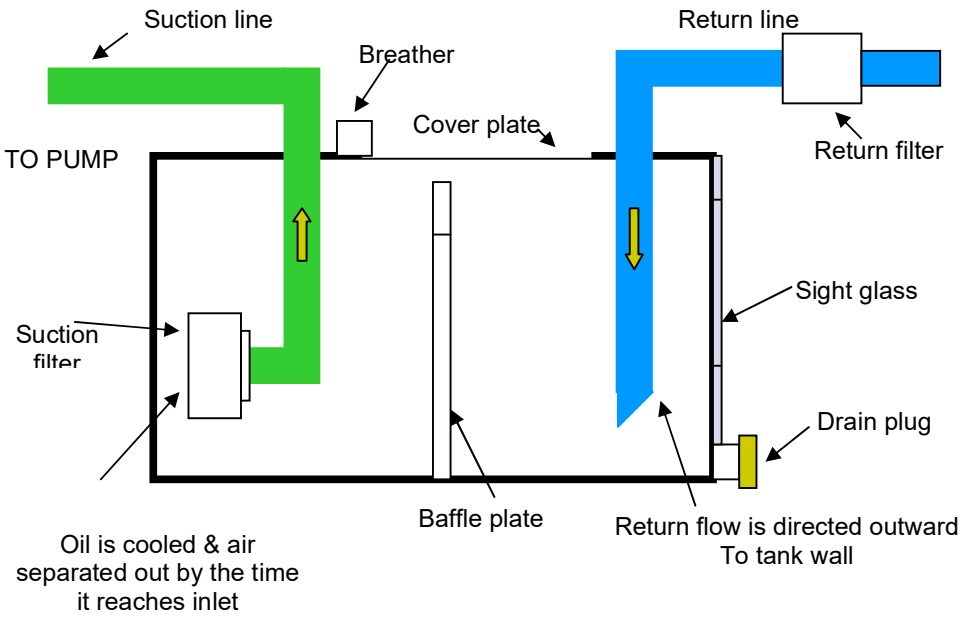
1.5 Low pour point: Pour point is the lowest temperature at which a fluid will flow. Beyond this it becomes so thick that it won't flow any more.

FUNCTIONS OF HYDRAULIC TANK:

The reservoir in the hydraulic system fulfils several task--

1. Acts as intake and storage reservoir for the hydraulic fluid required for the operation of the system.
2. Dissipates heat.
3. Separates air, water and solid materials.
4. Supports a built – in or built – on pump and drive motor and other hydraulic components such as valves, accumulator etc.

PARTS OF HYDRAULIC TANK:



i. Baffle plate: - it separates pump inlet line and return line. It is usually about 2/3 of the total height of the tank lower corner of the plate may be cut away to permits circulation. Thus the baffle plate
   a. Prevents local turbulence
   b. Allows foreign material to settle to the bottom.
   c. Give the fluid an opportunity to free of entrapped air.
   d. Helps heat dissipation.

ii. Inlet and Return line:-most line of the tank terminates below the oil level. The line connections are often sealed. This prevents dirt from entering through these openings. Pumps inlet and return line must be below the oil level otherwise oil may be aerated and foaming may start. Connections above the oil level must be tightly sealed to prevent the entry of air in the system.

iii. Air breather: - An air Breather is installed at the tank to vent to the atmosphere and also atmosphere air exerts pressure on the oil surface through air breather, so screening element of air breather should be cleaned regularly.

iv. Sight glass: - This is provided to see the oil level in the hydraulic tank and oil is filled accordingly.

v. Drain plug: - It is provided at the bottom of the tank to drain oil from tank at the time of cleaning the tank. Generally magnetic drain plug is provided to trap iron particles present in the oil.

vi. Return filter: - It is provided on the top of the tank. It traps contaminants present in oil which is returned form the hydraulic circuit to tank.

FUNCTION & IMPORTANCE OF FILTRATION:

About 75% of hydraulic maintenance is caused by dirty oil. Dirt can cause untold damage to the entire system. The use of a filter is an important stage in keeping dirt cut off the system and hence reducing hydraulic maintenance.

Filter is a device whose primary function is retention, by some porous medium, of insoluble contaminants from a fluid. Porous medium simply refers to a screen of filtering material that allows fluid to flow through it but stops other materials by porous medium. A simple screen or wire strainer is rated in microns for filtering fineness or a mesh number or its nearest seive number. The higher the mesh or sieve number, the finer the screen. When a filter is specified as so many microns, it usually refers to the filters nominal rating and its value is in microns

such that a 10 micron filter can trap particles having size more than 10 micron. So filters are of great significance in hydraulic systems for the reliable functioning and long service life of component.
It is the task of the filter to reduce the contamination to an acceptable level in order to protect the various components from excessive wear. it is necessary to use correct grade of filter and a contamination indicator is required in order to check the efficiency of the filter. Systems are often flushed using economical filters before commissioning.

TYPES OF FILTERS:

1. **Inlet strainer & filter:-** Strainer is installed on pump inlet lines inside the tank, it is relatively course as filter being constructed of fine mesh wire. A 100 mesh strainer is suitable for thin oil, protects the pump from particle, above about 150μ in size. There are also inlet line filters usually mounted out side the tank near pump inlet A fine filter (unless it is very large) creates more pressure drop that can be tolerated in on inlet line of a pump.
   The filter must pass the full pump volume within the permitted inlet vacuum for that pump. The filter must provide bypass flow which is still with in that limit where the filter element is blocked. Inlet filters should be used only to prevent large particles from entering the pump & causing catastrophic failure.

2. **Pressure line filter:-** This filter can trap much smaller particle than inlet line filter. Such a filter is used where system components such as valves are less dirt tolerant than the pump. The filter traps fine contaminants from the fluid as it leaves the pump & also protects the system in the event of a catastrophic failure of the pump. Pressure line filters must be able to withstand the operating pressure of the system as well as any pump pulsation.

3. **Return line filter:-** These filters can also trap very small particles before the fluid returns to the tank. Return line filter is necessary in a system with a high performance pump which has very close tolerance & usually cannot be sufficiently protected by an inlet line filter. Full flow return filter should have enough capacity to handle max return flow without opening the bypass valve (non return valve) the performance of any return line filter depends on magnitude of flow and pressure changes.
   The term “full flow” applied to a filter means that all the flow into the filter inlet port pass through the filtering element. In most full flow filters there is a bypass valve preset to open at a given pressure drop to divert flow past the filter element. This prevents the element from being subjected to excessive pressure which could cause collapse. The bypass opens when total flow can no longer pass through the contaminated element without raising the pressure.

SUB-DISCIPLINE: HYDRAULICS (LESSONS: 11 SESSIONS: 12)

Lesson-II: Accumulator, Hydraulic Seal, 'O'-Ring, Hose and Fitting **.**

Session–2: Functions, Types, Working of Bladder Accumulator, Charging of Accumulator, Precautions during providing Hydraulic Seals, Causes of Failure, Hose specification: DIN, SAE and EN standards, Hydraulic Fittings, Precautions during mounting Hydraulic Hoses and Fittings

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ACCUMULATOR:

FUNCTIONS:

1. It acts as an emergency unit. In case of sudden power loss e.g. pipe or joint failure, pump breakdown etc. the accumulator can provide sufficient energy to complete an operational cycle.
2. As a leakage compensator. Oil reserve for maintaining pressure to compensate leakage losses and to maintain pressure for longer period.
3. As an anti vibration device. It prevents pressure knocks and unpleasant operating noise resulting from system. Rapid valve closer can produce shock waves resulting in over pressurization of pipes, joints, valves, etc. The accumulator can neutralize or reduce the shock.

TYPES:

1. Weight type
2. Spring type
3. Piston type
4. Bladder type
5. Diaphragm type

WORKING OF BLADDER OR DIAPHRAGM TYPE ACCUMULATOR:

Operation of an accumulator is automatic. A combination of oil (which is non-compressible) and nitrogen gas (which can both expand and compress) make the accumulator work. When the oil pressures rises, incoming oil compresses the gas. When oil pressure drops, the gas expands forcing out oil. The gas is separated from the oil by bladder. This prevents mixing of the gas and oil and keeps gas out of the hydraulic system. Oil forces the bladder to compress until the resistance of gas is equal to oil pressure. When the hydraulic system needs oil, the compressed gas inside the bladder forces oil to maintain the system flow. The bladder is precharged through the valve core with nitrogen gas. The other end of accumulator contains the oil valve which connects the hydraulic circuit. A rubber sealing ring is provided near at the oil valve to protect the bladder during operation.

CHECKING AND FILLING WITH CHARGING UNIT:

Make sure that Hydraulic pressure is released from the system before attempting to fill or check the Accumulator for Nitrogen.

PROCEDURE:

1. Remove the protecting cap from top of accumulator.
2. Remove the closing nipple from the Accumulator gas valve.
3. Close the venting screw on the charging unit. Turn the handle fully clockwise.
4. Turn the spindle on filler head fully anticlockwise.
5. Connect the filler head to the gas valve and by turning knur clockwise.

6. Connect the charging unit to nitrogen bottle and tighten nut.
7. For checking only nitrogen bottle is not necessary. On new types of charging units a check valve prevents a gas return flow from the accumulator.
8. Turn the spindle on filler head gently clock wise.
9. Read the existing nitrogen pressure in the accumulator on pressure gauge.
10. If a recharging is necessary, open the bottle valve gently until a filling pressure of 90 atm is reading. Shut the bottle valve properly again.
11. Open gently the venting screw on the charging until the required pressure 80 atm is reading on the pressure gauge. Shut the venting screw properly again.
12. Remove the charging unit from the nitrogen bottle.
13. Turn the spindle on filler head fully anticlockwise.
14. Release nitrogen pressure left in the charging unit by opening the venting screw.
15. Disconnect the charging unit from the gas valve on the accumulator.
16. Check the sealing of the gas valve.
17. Fit the closing nipple on to the gas valve and also the protecting cap.

HYDRAULIC SEALS AND 'O'-RINGS:

FUNCTION:

Seals are required to maintain pressure, to prevent fluid loss and to keep out contamination. Excessive leakage any where in a hydraulic circuit reduces efficiency and result in power loss. Mostly hydraulic components are built with operating clearances which allow a certain amount of internal leakage for lubrication purpose. Additional internal leakage occurs when component begins to wear. Internal leakages may cause temperature rise of hydraulic oil.

PRECAUTIONS DURING PROVIDING HYDRAULIC SEALS:

1. A special driver should be used for inserting lip-type shaft seals.
2. Cup seals must be clamped tightly in place.
3. Several piston rings are placed side by side for more positive sealing.
4. The packing is compressed by tightening a flanged follower ring against them.
5. There should be no dent mark on groove where seal is to be provided.
6. Seal of proper size should be used.
7. The operating temperature should always be kept well within the temperature range of the seals being used. At very low temperatures, a seal may become too brittle and at too high temperature, a seal may harden, soften or swell.
8. Seal must be lubricated prior to installation, otherwise the seal will wear quickly and leak.

CAUSES FOR SEAL AND 'O' RING FAILURES

1	Freedom to roll	Unsatisfactory groove shape and not following the groove completely causes early wear and leakage.
2	Reduced contact area	Due to unsatisfactory design causes single point contact causing early wear and leakage.
3	High temperature	Attacking the rubber material causing early damage.
4	Poor rubbing surface	Unclean surface, scratches on cylinder surfaces cause seals& O-rings to wear very fast.
5	Eccentricity	Cause loading one side only, due to which the seals wear on one side and get damaged.
6	Side loads	Cause loading one side only, due to which the seals wear on one side and get damaged.
7	Excessive stretching	Less in size as such O-ring have to be stretched too much causing early wear and sometimes even breaking.
8	Poor quality of rubber.	Seals wear due to poor quality of rubber and improper hardness.

HYDRAULIC HOSES AND FITTINGS:

FUNCTIONS:

Piping is a general term which embraces the various kinds of conducting lines that carry hyd. oil between components plus the fittings or connectors used between the conductors. Flexible hoses are mostly used in track machines to carry hyd. oil from one point to another. These offer more convenience in making connections and servicing. These are used when the hyd. lines are subjected to movement. Hoses are fabricated in layers of synthetic rubber and braided fabric or wire braids. Wire braided hoses permit high pressure. The inner layer of hose must be compatible with hyd. oil used. The outer layer is usually of rubber to protect braid layer.

TYPES:

1. **Suction Hose:** This hose is provided between tank and pump. This is low pressure hose and has single wire braid. Dash no. of hoses used in suction line are 32, 48 & 64.
2. **Pressure Hose:** This hose is provided between pump and actuator. This is medium and high pressure hose and has double wire braid or multiple wire braid. Dash no. of hoses used in pressure line are 4, 6, 8, 10, 12, 16 & 20.
3. **Return Hose:** This hose is provided between actuator and tank. This is low pressure hose and has single wire braid. Dash no. of hoses used in return line are 6, 12, 16, 20, 24 & 32.

HOSE SPECIFICATION

i. EN (European Norm)- EN 853- 1 SN-Single wire braid, 2 SN-Double wire braid
ii. DIN (Deutsch Industry Norm) –DIN 20022-2 Wire braid, DIN 20023- spiral wire
iii. SAE (Society pf automotive Engineers) -100R1 – single wire braid, 100R2 – two wire braid, 100R5 – single wire braid, 100R9 – 4 spiral wire reinforced.

PRECAUTIONS WHILE MOUNTING HOSES:

1. The hose should be provided in the end filling properly.
2. It should be made long enough without tension.
3. It should be avoided to exceed the min bend radius.
4. Twisted hose should not be installed.
5. At vibrated place the hoses should be secured with proper packing.

FITTINGS:

Hose fittings may be either reusable (screw-together, bolt-together, etc.) or non reusable (crimp or swage). It is recommended that hose fittings have a swivel nut or an SAE split flange on each end so that hose assembly does not have to be turned or twisted for proper installation.

Two types of fittings are manufactured for hoses,

1. Swaged type or crimped type- which is non reusable.
2. Detachable type which has as socket and threaded nipple. This fitting can be used again and again until hose wear out or damages. The socket grips the hose & a nipple is inserted into this hose & screwed into the socket. This gives a firm strong attachment of the hose to the fittings. The high pressure fittings are stamped as H.P and medium pressure fitting as M.P.

PRECAUTIONS WHILE PROVIDING FITTING ON HOSE:

1. The place of work should be cleaned first.
2. Rubber and wire cuttings should not be left in pipes.
3. Before providing fitting compressed air should be passed through pipes.
4. The other end of the pipe should not be left loose on the ground.
5. After preparing the pipe compressed air should be passed through pipes to remove any foreign material remaining inside.

SUB-DISCIPLINE: HYDRAULICS (LESSONS: 11 SESSIONS: 12)

Lesson-III: Hydraulic Pump **Session–3:** Definition, Functions, Classification, Working and Construction of Vane pump, gear pump, Axial piston pump, Precautions during mounting, Troubleshooting, Aeration and Cavitation.

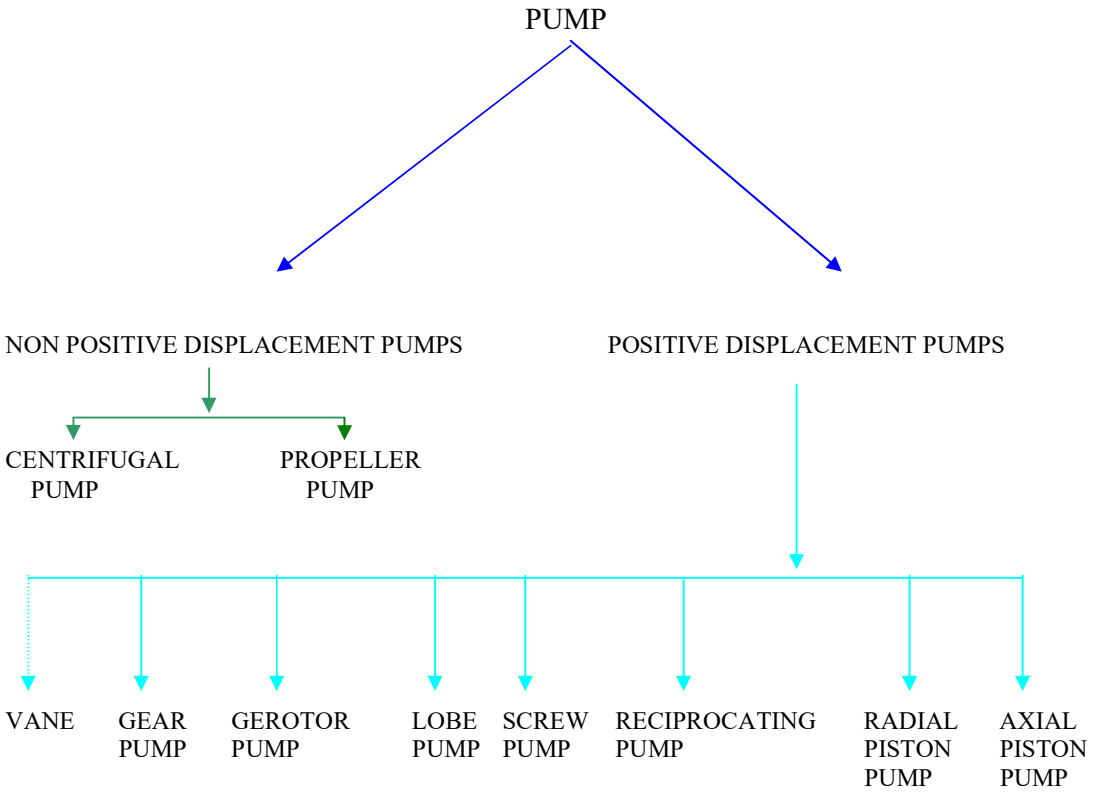
DEFINITION:

Pump is a device which converts mechanical energy into hydraulic energy. Basically pump creates flow from hydraulic tank to system.

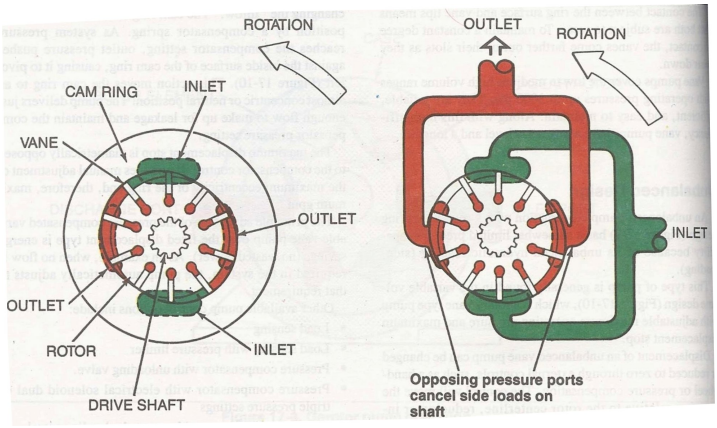
FUNCTION:

The hydraulic pump in a hydraulic system converts mechanical energy in a drive unit into hydraulic energy (pressure energy).The pump draws-in hydraulic fluid due to partial vacuum and drives it out into a system of lines. The resistances encountered by the flowing hydraulic fluid cause a pressure to build up in the hydraulic system. Thus the fluid pressure in a hyd. system is not predetermined by the pump. It builds up in accordance with the resistances in extreme cases until a component is damaged. In practice it is prevented by installing a pressure relief valve directly after the pump or in the pump housing at which the max operating pressure recommended for the pump is set.

CLASSIFICATION:

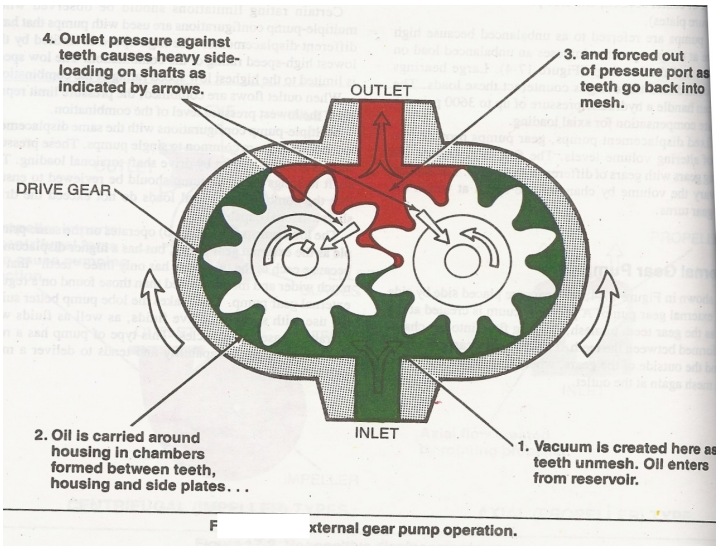


WORKING AND CONSTRUCTION OF VANE PUMP:



Basically this pump consists of a cam ring and a splined drive shaft carrying a slotted rotor. In each slot of rotor vane is fitted which is free to slide. Thus following the ring profile as the rotor rotates. The vanes are held against the ring contour by a combination of centrifugal force and system pressure. Since system pressure is not usually present until the pump develops flow, centrifugal force is necessary to eject the vanes when the unit is started. Once the pump is in operation fluid at system pressure is directed to each rotor slot to hold the vanes against the ring contour. The vanes divide the area between the rotor and cam ring into a series of varying size of chambers. The pump inlet is situated in that part of pump where the chambers are expanding in size and the vanes are moving outward from rotor. Fluid is drawn into the pump by the partial vacuum, caused by this expansion. At the pump outlet the chambers are reducing in size, the vanes moving inwards and the trapped fluid being forced through the outlet port..

WORKING AND CONSTRUCTION OF EXTERNAL GEAR PUMP:-



F xternal gear pump operation.

The pump consists of drive gear and a driven gear and closed in closely fitted housing. The gears rotate in opposite direction and mesh at a point in housing between inlet and outlet ports as the teeth of gear separate, fluid is drawn into the inlet chamber, due to partial vacuum the fluid is trapped between the gear teeth and housing and carried through two separate paths around the outlet chamber. As the teeth re-mesh, fluid is forced through the outlet port. Close fit of the gear teeth within the housing is required to provide a seal between inlet and outlet ports, minimizing internal leakage. High pressure at pump outlet imposes an unbalanced load on the gears and bearing supporting them. Most gear pump are fixed displacement pump. Internal leakage increases with wear. However the units are fairly durable and more dirt tolerant than other type.

WORKING AND CONSTRUCTION OF AXIAL PISTON PUMP:-

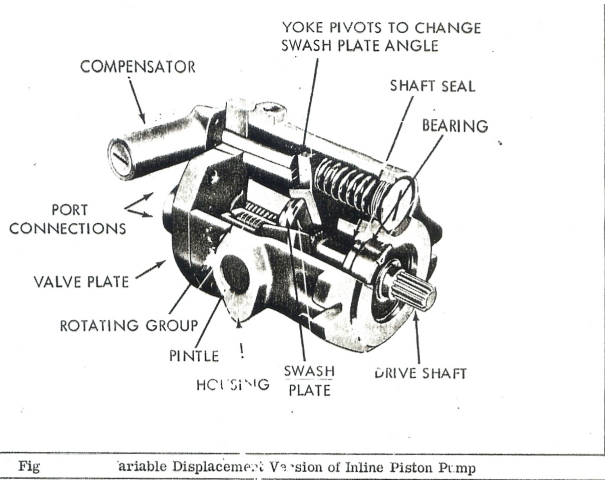


Fig ariable Displacement Version of Inline Piston Pump

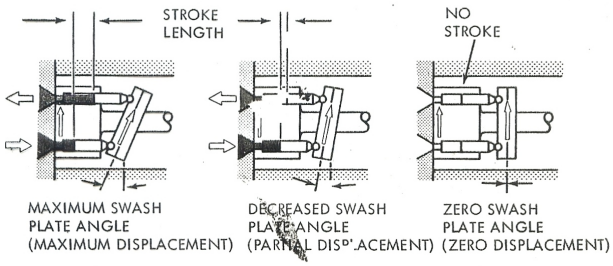


Fig riation in Pump Displacement

The circular arrangement of a piston is located parallel to the drive shaft in a fixed housing. The pistons run in a cylinder barrel which is firmly attached to the drive shaft by means of a key. The piston ends are of ball and socket design and run on slipper pads. These are held on a swiveling swash plate by means of holding discs. On the fixed displacement model the swash plate form a part of the housing and therefore has a fixed swash angle. On the variable displacement model the swash plate is built into the housing and can be swashed to angle of $\pm 15^0$ from centre. The piston travels a stroke relative to the swash angle which determines the pump displacement. When the swash plate is in centre position i.e. vertical to the drive shaft, the piston stroke and thus the pump displacement are zero. Swashing the pump over center changes the direction of flow without changing the direction of rotation. Control of the axial piston pump via inlets in a port plate. At in any one time four of these moving pistons are connected via these inlet ports with the tank side. Further four pistons are connected with the pressure side and displace fluid. A charge pump is mounted on the same shaft of the axial piston pump. This pump draws oil in from the hyd. tank and supplies it to the hydrostatic loop to keep it charged. The charge pump relief valve is set at 30 bar. The either ports of the axial piston pumps are known as low pressure port and high pressure port and denoted by a letter 'A' & 'B'. In either sides pressure relief valve is provided which is set at certain pressure to suit that hydraulic circuit. Such relief valves are called cross relief valves.

PRECAUTIONS FOR INSTALLING HYDRAULIC PUMPS:

1) Clean entire oil from tank, remove scaling paint, dirt etc. flush it with fresh oil.
2) Clean the filter (choked filter may cause cavitation.)
3) Check suction and return lines for air Leakages, loose connection and loose connection in delivery will cause fluid leakage.

4) Sealant tape and shellac with pump should be used while providing fittings on the pump.
5) While assembling direction of rotation should be checked carefully.
6) Suction and delivery ports to be kept in desired directions.
7) All the bolts, O-rings should be properly fitted at proper torque.
8) All blades should be properly fitted. Keeping attention on their direction.
9) All bolts should be properly tightened at a uniform pressure.
10) Oil seal and bearing should be properly fitted.
11) Driving shaft should not be eccentric to the pump shaft.
12) All joints and pipe connection should be preferably applied with hard grease.
13) There should be no seepage form the pipes and pump premises should remain dry.
14) Start the pump at low r.p.m. preferably not more than 1000 r.p.m.
15) Run the pump at this rpm for about 20 min.. and then apply pressure to it.
16) observe the sound if it is taking air the sound is unpleasant and abnormal, at this stage stop the pump and check for air leakage.
17) If suction pipe is getting squeezed it means suction is choked, stop the pump and check filter and suction pipe.
18) After applying pressure if there is no sound, see heating effect on the pump this should be normal.
19) Now the pump is ready for working.
20) Do not start pump immediately after filling the tank a period of at least 12 hrs. so that entrapped air may escape from the oil. Normal recoupment of oil should also be done after working hours.
21) During severe winter the pump must run idle before putting load, for 15-30 min., so that cavitation effect due to high viscosity at lower temperatures is avoided.
22) Max. running temperature of hydraulic fluid for day of working must not cross 80^0 C.

AERATION:

Aeration occurs on account of presence of air in dissolved and free form in the hydraulic oil and renders the oil spongy. Air is always present in small quantity in the oil say up to 10% but this increased inclusion of air in oil reduces its lubricating properties and ultimately reduces the life of the pump.

CAUSES:

The following are the reasons of air inclusion in the oil.

1. Low oil level in the reservoir causes whirl pool at the intake and air is sucked by the pump along with the oil.
2. Restrictions in inlet pipe cause pressure to drop, which helps suction of air into pump.
3. If the return pipe opens above the hydraulic oil level in the reservoir it accompanies foaming in the tank and air inclusion.
4. Turbulent flow (intake and return) also causes air inclusion.
5. If the filter cartridge joint is not perfectly sealed or there is any void in the suction line, the pump sucks air through the same.
6. Leaking pump shaft seal, cylinder rod seals or other leaking unnumbered connections in the intake line cause aeration.

CAVITATION:

It is a sort of vacuum created in the hydraulic oil which breaks the fluid into layers or cavities and the fluid does not fill the line perfectly. It can occur equally in pump, motor or cylinder etc.

CAUSES:

The following are the probable causes of cavitations in the pump and other hydraulic equipments:-

1. Filter is clogged.
2. Sharp bend in the suction line.
3. Obstruction in suction line.
4. High viscosity hydraulic oil used in machine.
5. Pump inlet is too high above the oil level in the tank.
6. Tank, if not ventilated properly-oil shrinks in volume as it cools.
7. The load is more than the delivery of the pump.

TROUBLE SHOOTING :

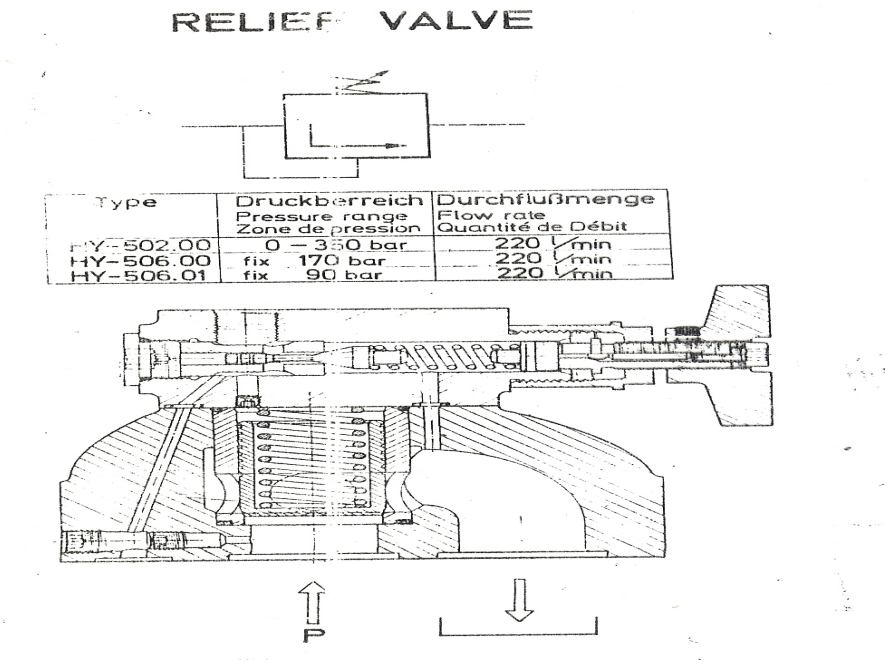
PROBLE M	CAUSES	REMEDIES
1. Pump not delivering oil.	1. Pump driven in wrong wrong direction.	1. We can check the pump rotation by hand priming, pour the oil in intake port and rotate the shaft and see if the oil is coming from outlet
ring	or not. If not change the direction	by repositioning the cam turned by 90^0.
choked.	2. Intake filter or pipe	2. Clean or replace the faulty one.
low in	3. Fill the tank with hydraulic	3. Oil level too
Pump shaft or rotor	the tank.	oil. 4.
suction line and replace	4. Replace the pump shaft or rotor line.	broken. broken.
		5. Air traps in suction 5. Check the
2). Pump making noi-se.	1). Oil level too low.	1). Fill the tank with hydraulic level that more air influence is prevented.
	2). Restricted or partially clogged intake filter or line.	2). Clean or replace the intake filter or line. Suction filter should be changed in time.
	3).Tank is not vented properly.	3).Air breather screening element should be cleaned regularly, so that atmospheric pressure exert effectiv-ely on the oil surface in tank and good suction may take place
	4).Viscosity of oil too high.	4).Use proper grade oil. In winter Season oil becomes thick so no free flow takes place, warm up the oil by starting pump for few minutes.
	5).Air leak at pump	5).Check for any loose connection or
3). Bearing failure.	1). Chips or other cont-aminants.	1). Replace bearing and check source of contaminants.
	2). In adequate lubri-cation.	2). Excessive heating of oil should be avoided.
	3).Pump running too fast.	3). Adjust the R.P.M of prime mover
	4).Excessive or shock loads.	4). Excessive load due to operating pressure may damage bearing so reduce operating pressure.

SUB-DISCIPLINE: HYDRAULICS (LESSONS: 11 SESSIONS: 12)

Lesson-IV: Pressure Control Valve **Session–4:** Working and Construction of Relief Valve, Unloader Valve, Pressure Reducing Valve, Trouble shooting.

WORKING AND CONSTRUCTION OF RELIEF VALVE:

RELIEF VALVE:

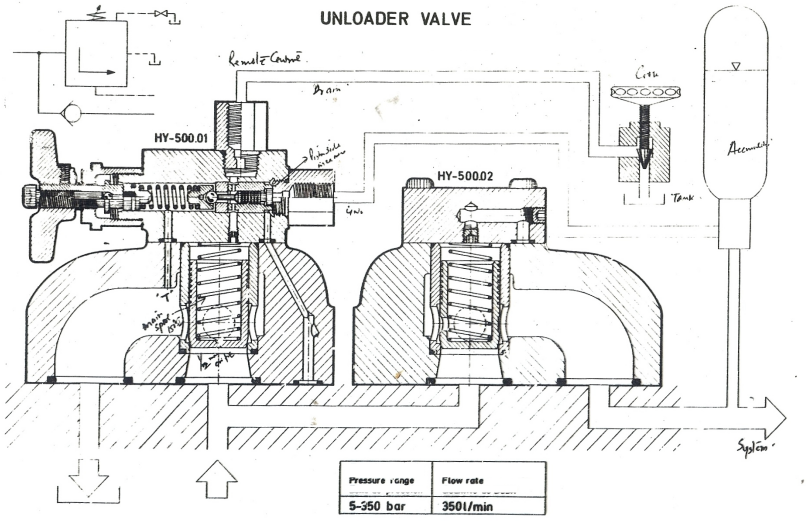


It is found in virtually every hydraulic system. It is a normally closed valve connected between the pressure line and the tank. Its purpose is to limit pressure in the system to a preset maximum by diverting some or all of the pump's output to tank when the pressure setting is reached.

Relief valve consists in two sections (1). Cover section which includes poppet, spring, and adjusting screw & vent connection. (2). Body section which contains the piston, spring& seat. The valve pressure setting is determined by the adjusting screw position which varies the heavy spring compression. The balanced piston is normally held against the set by the light spring. System pressure is present in lower chamber of piston and also passes to the upper chamber through a pilot line. With system pressure less than the valve setting the pilot poppet is held against its seat by spring force. Pressure in both chambers equalizes and the piston is hydraulically in balance and held against its seat by the light spring.

When system pressure exceeds the heavy spring setting and forces the poppet away from its seat. Fluid then flows through poppet seat to tank port. The pressure in upper chamber is limited by the setting of the heavy spring. When pressure in lower chamber exceeds upper chamber sufficiently, pressure unbalance overcomes the force of the light spring and lifts the piston. Excess fluid then flows past the bottom of the piston to tank. When system pressure drops below the valve setting, the popper reseats. Control flow through pilot line stops and pressures in both chambers are again effectively equalized. The light spring then forces the piston towards the seat when the balanced piston is closed against its seat, the unloading stops. The pump delivery now goes to the system.

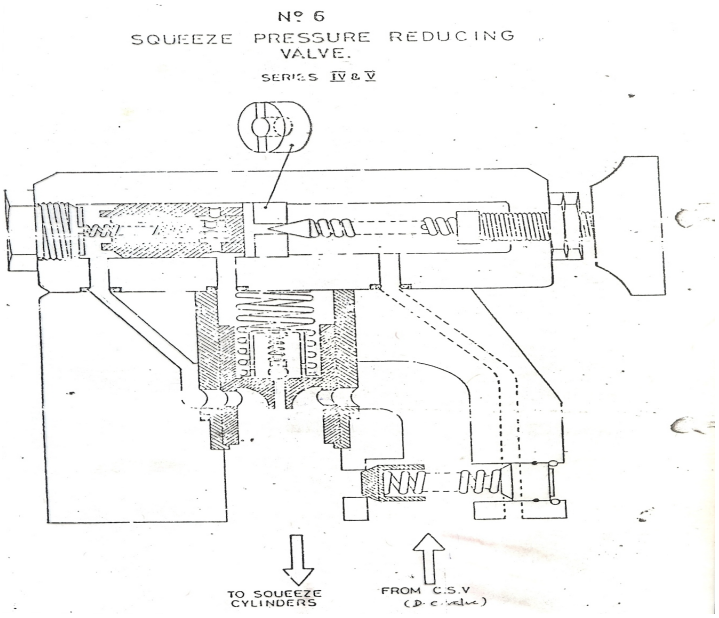
UNLOADER VALVE:



An unloader valve is used in accumulator charging circuit to (i) limit max. pressure and. (ii) unload the pump when the desired accumulator pressure is reached. In construction, it contains a compound, balance piston relief valve, a check valve to prevent reserve flow from the accumulator & a pressure operated plunger which vents the valve at the selected pressure.

Normally, the relief valve piston is in balance and is held seated by its light spring. Flow is through the check valve to the accumulator/system. When preset pressure has been reached, the relief valve poppet has unseated limiting pressure above piston and on the poppet side of the plunger. Further increase in system pressure acting on the opposite end of the plunger has caused it to force the poppet completely off its seat, in effect, venting the relief valve and unloading the pump. The check valve has closed permitting the accumulator to maintain pressure in the system.
Because of the difference in area between the plunger & poppet seat (approx. 15%), when pressure drops to about 85% of the valve setting, the poppet & piston reseat & the cycle is repeated.

PRESSURE REDUCING VALVE:



Pressure reducing valves are normally open pressure controls used to maintain reduced pressure in certain portions of the system. They are actuated by pressure sensed in the branch circuit & tend to close as it reaches the valve setting thus preventing further build-up.

The pilot op. pressure reducing valve has a wider range of adjustment & generally provides more accurate control. The op. pressure is set by an adjustable spring in the pilot stage in the upper body. The spool is hydraulically balanced through an orifice in its centre and the light spring holds it in the wide open position.
When pressure has reached the valve setting and the pilot valve is diverting flow to the drain passage limiting pressure above the spool. Flow through the orifice in the spool creates a pressure difference that moves the spool up against the spring force. The spool partially closes the outlet port to create a pressure drop from the supply to the branch system.

TROUBLE SHOOTING:

Sl. No.	**Problems**	**Causes**	**Remedies**
1.	Valve flutters	1. Valve seat defective	Exchange parts
		2. Pilot control defective	Repair pilot control
		3. Oil speed too high	Install valve of greater nominal size
		4. Wrong oil grade	Respect oil recommendations
		5. Dirt in system	Flush system if needed pickle and flush out
		6. Damping defective	Repair valve or change spring
2.	Valve sticks	1. Valve stressed	Loosen bolts and tighten uniformly
		2. Oil temperature too low	Warm up system through pump or install heating
		3. Piping stressed	Incorporate balancing bends
		4. Drain line lacking or under pressure	Install line or separate form return
		5. Dirt in system	Flush system or if needed pickle and flush
		6. Wrong oil grade	Respect oil recommendations
		7. Water condensation in system	Check cooler and check system for condenser effect
		8. Oil gumming	Clean spool and if needed change oil
		9. Body parts wrongly fitted	Observe assembly sequence in service instructions
		10. Wrong seals	Replace seals prescribed
3.	Valve does not function	1. Valve spring broken	Change spring
		2. Valve sticks	Establish cause and repair defect
4.	Valve overheats	1. System temperature too high	Observe maximum pressure
		2. Oil speed too high	Install valve of greater nominal size

SUB-DISCIPLINE: HYDRAULICS (LESSONS: 11 SESSIONS: 12)

Lesson-V: Direction Control Valve **Session–5:** Function and Types such as Spring Centered valves, Spring offset valves, Check valve, POC valve, Troubleshooting.

FUNCTION:

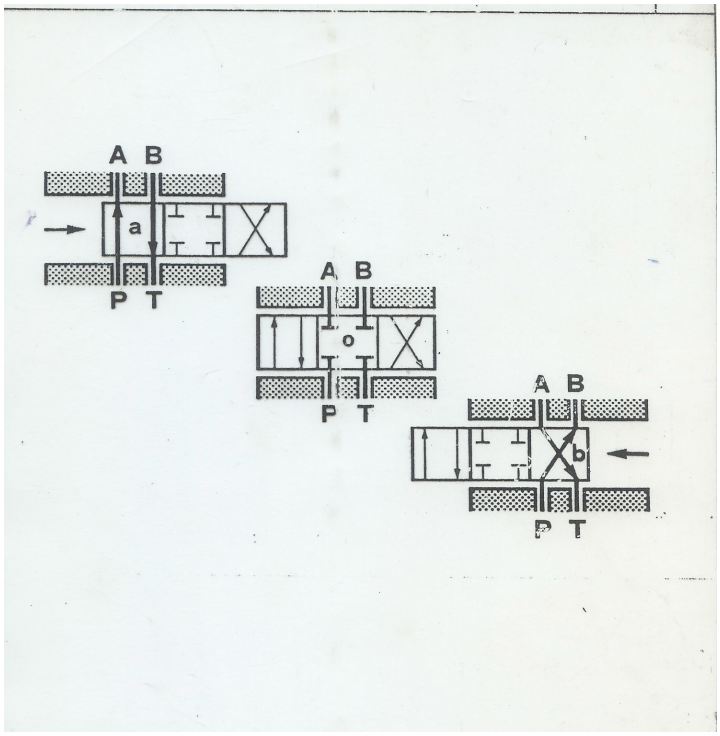
There are several types of valves in hydraulic system. Some are used to limit and regulate the pressure, while other controls the direction of fluid flow. The direction of pressurized fluid is controlled by D.C. valve and thus the direction of movement. They can be simple check valve, more complicated pilot and solenoid operated valves. It can be manually or automatically operated. Valve body has a precision machined bore in which a very close tolerance spool is suspended on a film of hydraulic fluid. Spool lands and body cavities are designed to divide the bore openings into separate chambers. Ports in the body lead into this chambers so that spool positions determine which ports are opened or closed.

TYPES:

There are three types of D.C. valves:-

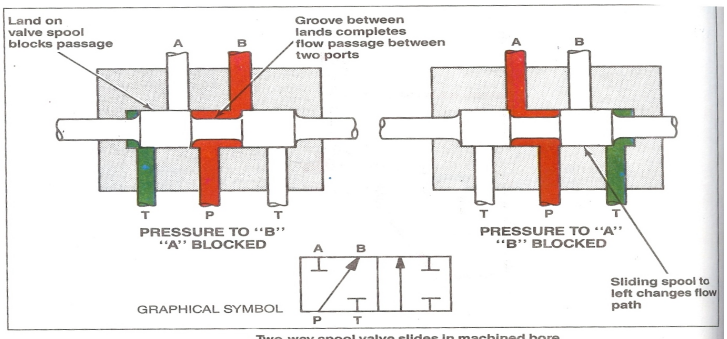
1. Spring centered valve.
2. Spring offset valve.
3. Pilot operated valve.

<u>Spring centered valve</u>:

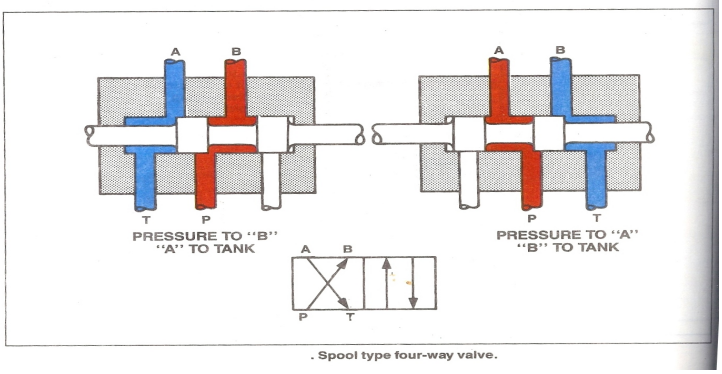


This valve is provided with spring and centering washer at each end of spool. The spring and washer centre the spool with in the valve body when solenoids are de-energized where it is necessary to stop or hold an actuator at some mid point in its travel, a 3 position valve is used. The third position is achieved by centering springs. Flow conditions in this centre or neutral position are determined by the work requirement of the system.

Spring offset valve:



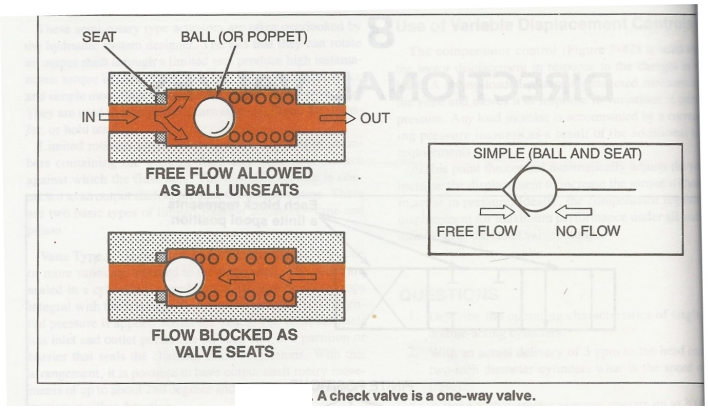
. Two-way spool valve slides in machined bore.



. Spool type four-way valve.

These valves use one solenoid only. Spring returns the spool to offset position when the solenoid is de-energized.

NON RETURN VALVE (CHECK VALVE):



. A check valve is a one-way valve.

Non-return valves block the flow in one direction and permit free flow in the other. As there must be leaks in the closed direction, these valves are always of poppet design and are constructed according to the following basic principle.
The sealing element (generally a ball or cone) is pressed against an appropriately shaped seat. The valve is opened by volumetric flow in the flow direction, the sealing element being lifted from the seat.

PILOT OPERATED CHECK VALVE:

Pilot operated check valve designed to permit free flow in one direction and to block return flow until opened by a pressure signal. This valve is used to support vertical cylinders which come downwards due to leakage in D.C valve. Normal position of D.C valve is always A – B to tank. It is a variation of directional poppet valve and commonly used in hydraulic system. It works on the principle that in order to allow and additional flow over the valve seat in opposite direction a small cylinder with a piston and piston rod acts on the closing part and lifts it from the seat when pressured the area ratio between control piston and valve seat is the deciding factor for the operation of valve.

TROUBLE SHOOTING

PROBLEM	CAUSE	REMEDIES
1.Valve spool stick.	1). Dirt in the system.	1). Disassemble, clean and re- assemble
	2).Body parts wrongly fitted.	2). Fit properly. Clean
	3).Rusting due to water Condensation	3). Clean or replace if required.
	4). Solenoids not operated	4). Check electrical supply and source
	5). Spool is stressed.	5).Check surface, clean, tighten the bolts. Oil film should be available between valve body and spool.
2.Solenoid not function-ing	1).Faulty electrical circuit.	1). Check and rectify.
	2).No current.	2). Check the electrical wires and supply.
	3).Coil burnt out.	3). Replace
3.Leakage in valves	1).Connections not sealed	1).Check and rectify.
	2).Wrong seals	2).Replace by proper size.
	3).Defective valves, cracks .	3).Repair or replace. in body.
4. Valve overheats	1) System pressure too high	Reduce pressure setting
	2) Wrong oil grade	Use proper grade oil
	3) Dirt in the system	Flush system and clean the valve
	4) Faulty electric circuit	Check electric circuit
	5) Spool defective	Repair spool

SUB-DISCIPLINE: HYDRAULICS (LESSONS: 11 SESSIONS: 12)

Lesson-VI: Proportional Valve, Servo Valve and Flow Control Valve
Session–6: Function and Troubleshooting.

PROPORTIONAL VALVE:

FUNCTION:

- Proportional valves control and vary pressure, flow, direction, acceleration and deceleration.
- They are adjusted electrically are actuated by proportional solenoids.
- Output flow is proportional to the input signal.
- By varying the input signal solenoid adjusts the spool movement to vary the flow through the valve.
- To control the speed of the spool a gradually increasing or decreasing signal (a ramp function) is fed to the control amplifier and thus we get a smooth, shock free movement.
- Used for Tamping unit lifting-lowering and satellite drive.
- Maximum voltage 24V DC, current range-250mA to 750mA
- For Tamping Unit Lowering current-650mA
- For Tamping Unit Lifting current-600mA

TROUBLESHOOTING OF PROPORTIONAL VALVE:

Sr.No.	Trouble	Causes	Rectification
1.	Spool sticks	a) Spool stressed	Loosen union and tighten uniformly.
		b) Dirt in the system	Clean the valve and flush the system.
		c) Body parts wrongly fitted	Dismantle valve, observe assembly sequence and reassemble.
		d) Wrong seals	Replace seals prescribed.
		e) Oil temperature too high	Check cooling circuit.
		f) Spool defective	Repair or replace.
		g) Return pipe under high pressure	Dismantle the connection and clean. If required lead pipe separately to tank.
2.	Proportional valve does not function.	a) Proportional solenoid defective	Replace.
		b) Electric circuit faulty	Check circuit & PCB.
		c) Proportional filter clogged	Replace.
		d) No current	Check electrical installation.
3.	Proportional valves overheat.	a) Oil temperature too high	Check cooling circuit, reduce pressure setting.
		b) Wrong oil grade	Use recommended oil.
		c) Dirt in the system	Flush system.
		d) Faulty electrical circuit	Check and rectify.
		e) Spool defective	Repair or replace.

SERVO VALVE:

FUNCTION:

- Servo valve is a directional valve that may be infinitely positioned to control of both the amount and the direction of the flow. A servo valve coupled with the proper feedback sensing devices provides very accurate control of the position, velocity, or acceleration of an actuator.
- Small input signal causes a large output of hyd. Power.
- A low power control signal can produce output of several hundreds horse-power.
- In airplanes, jet planes servo valves are used for fast response.
- Used in lifting and lining circuit in 09 CSM, 09-3X, Unimat-3X, new Duomatic.
- For track lifting – 2nos and for alignment- 1no servo valve is provided.
- Voltage-3V DC, Current-15mA.
- Contaminated oil is not desirable.
- Maintain the oil cleanliness to NAS-5 class.
- Before installing the servo valves flush the system.
- Filter should be replaced in non-contaminated atmosphere.
- Null should be adjusted properly, if null gets disturbed.

TROUBLESHOOTING IN SERVO VALVE:

Sr. No.	Fault	Causes	Rectification
1.	Servo valve spool sticks.	a) Feed tube dirty	Check system for dirt and clean filter.
		b) Fine filter dirty	Check system for dirt and clean filter
		c) Mechanical return sticks	Valve should be dismantled.
		d) Valve stressed	Loosen unions and tighten uniformly
2.	Servo valve does not function.	a) Electric circuit defective	Check electric circuit.
		b) Rotary magnet system defective	Repair system or replace torque motor.
		c) No differential current	Check electrical installation.
		d) No pressure	Check pump and relief valve.
		e) Oil gummy	Clean valve, flush system and change oil if needed.
		f) Oil temperature too high	Check cooling circuit, check for any line restrictions and reduce pressure setting.
		g) Servo filter clogged	Replace filter.
3.	High null basis (High input current required to maintain the hydraulic cylinder stationary)	a) Incorrect Null adjustment	Readjust the null.
		b) Partially plugged inlet orifice assembly	Clean the inlet.
		c) Partially plugged filter element.	Replace the filters element.
		d) Partially plugged Nozzle	Servicing required.
4.	Out flow obtain from one part only	Plugged inlet orifice	Clean inlet orifice.
5.	Low flow gain (Problem in getting high speed)	Plugged button filter	Replace the filter element.
6.	High threshold (jerky, hunting motion)	Sticky spool	Servicing.

FLOW CONTROL VALVE:

FUNCTION:

By controlling the rate of flow in a hydraulic circuit, it's possible to control the speed of hydraulic cylinder or motors. A more typical method is to use a flow control valve. By varying the size of opening, one can vary the amount of oil entering the cylinder and thus control its speed. Three factors affect flow rate: pressure, fluid temperature, and orifice size. If any one of these factors is increased, the flow rate increases.

TYPES:

Control of flow in hydraulic circuits can be accomplished with a meter-in circuit, a meter-out circuit or a bleed-off circuit.

Meter-In circuit:

In meter-in operation, the flow control valve is placed between the pump and actuator. In this way, it controls the amount of fluid going into the actuator. Pump delivery in excess of the metered amount of diverted to tank over the relief valve.

Meter-Out circuit:

The flow control is on the outlet side of the cylinder to control the flow coming out. This is known as a meter-out circuit. If the flow control were closed completely, the oil could not exhaust from the cylinder and it could not move. Regulating the size of the opening controls the flow rate and thus the speed of the cylinder. Although metering into the cylinder is fine with an opposing load, but if the load tends to run away, a better way is to meter out. In fact, a meter-out circuit works if the load pushes or pulls.

Bleed-Off circuit:

The flow control is simply bleed off the main line to control cylinder speed. For instance, with the flow control completely closed, the full flow from the pump would go into the cylinder. However, the moment the flow control is opened up, some bleed off of that pump delivery occurs and the cylinder starts to slow down. Adjusting the size of the opening will bleed off any amount necessary to control how fast the cylinder moves. In the case, unlike the meter-in or meter-out circuits, there is no excess flow going over the relief valve and the pump operates at only the pressure that is needed to move the work load on the cylinder, which saves energy.

TROUBLESHOOTING IN FLOW CONTROL VALVE:

Sr. No.	Fault	Causes	Rectification
1.	Device does not function	a) Device stressed	Loosen bolt and tighten uniformly.
		b) Seat defective	Exchange seat.
		c) Throttle valve defective	Exchange cone.
		d) Non-return valve sticks	Check cone and seat, if needed exchange it.
		e) Fine throttle-valve sticks	Exchange restrictor
		f) Compensator mechanism defec	Disassemble controller and exchange defective parts.
		g) Piston sticks	Check system for dirt, exchange piston.
		h) Spring broken	Exchange spring.
		i) Corrosion on setting mechanism	Clean if needed change.
		j) Wrong choice of device	Install controller of correct nominal size.

SUB-DISCIPLINE: HYDRAULICS (LESSONS: 11 SESSIONS: 12)

Lesson-VII: Hydraulic Cylinder and Motor **Session–7:** Function, Types and Parts, Working of Vane Motor, Gear Motor and Axial Piston Motor, Troubleshooting

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HYDRAULIC CYLINDER:

FUNCTIONS:

Cylinders are drive components which converts hydraulic power in to mechanical power. They generate linear movement through the pressure on the surface of the movable piston. Cylinders are linear actuators.

TYPES:

1. **Ram type:** It is perhaps simplest actuator. It has only one fluid chamber and exerts force in only one direction, most are mounted vertically and retract by the force of gravity on the load. Ram type cylinders are used in elevators jacks and automobile hoists.

2. **Single acting cylinders:** A single acting cylinder has only one port allowing pressurized oil for its actuation. The return stroke of the piston or plunger is achieved either by gravitational action or spring force releasing the oil back to the tank. The oil flow in single acting cylinder is controlled by reversing directional control valve.

3. **Double acting cylinders:** A doubling acting cylinders has got two ports through which oil flow is controlled by directional control valve (generally solenoid valve) in such a way that if one of the two ports is connected to the in flow of liquid from pump the other is connected for back flow to tank and vice-versa. Such cylinders are called differential cylinders.

4. **Telescopic cylinders:** A telescopic cylinder is used where collapsed length must be shorter than could be obtained with a standard cylinder upto 4 to 5 sleeves can be used.

5. **Double rod cylinders:** Cylinder has two equal power stroke. Such cylinders are called non-differential cylinder as they have equal areas on either side.

PARTS OF A CYLINDER:

1. BARRELS: Barrels are usually seamless tubings, honed to a fine on the inside, bore to be parallel and without longitudinal scratches. Other wise oil will leak from one side to other during working due to high working pressure and frequent bursting of seals will occur.

2. PISTON: Piston usually made of cast iron or steel, incorporate seals to reduce leakage between it and cylinder barrel. Step cut automotive type piston rings are used where some leakage can be tolerated.

3. END CAPS: The end caps plug the barrel ends and provide cylinder ports. These are secured with the help of tie bolts.

4. SEALS: Various types of seals are used in the cylinder to prevent leakage and contaminants.

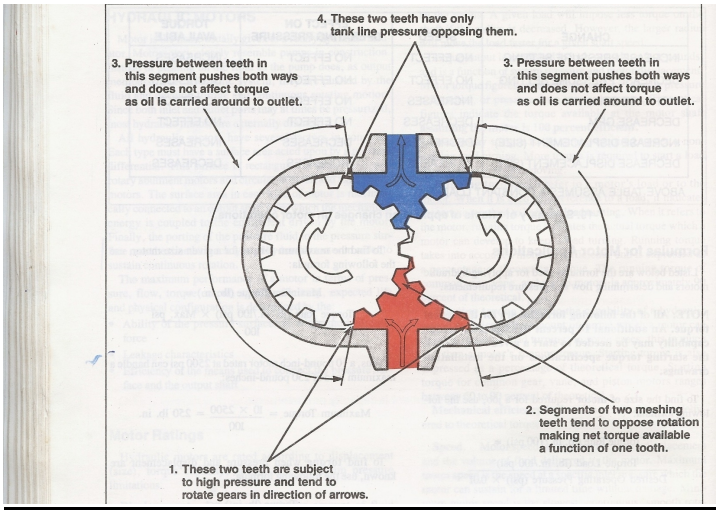
HYDRAULIC MOTOR:

DEFINITION:

Hydraulic motor converts the movement (Kinetic energy and pressure – potential energy) of a stream of hydraulic fluid in the continuous rotating force or movement. More specifically the kinetic energy of a fluid is converted into the kinetic energy of a fluid is converted into the kinetic energy of a rotating shaft in a hydraulic motor.

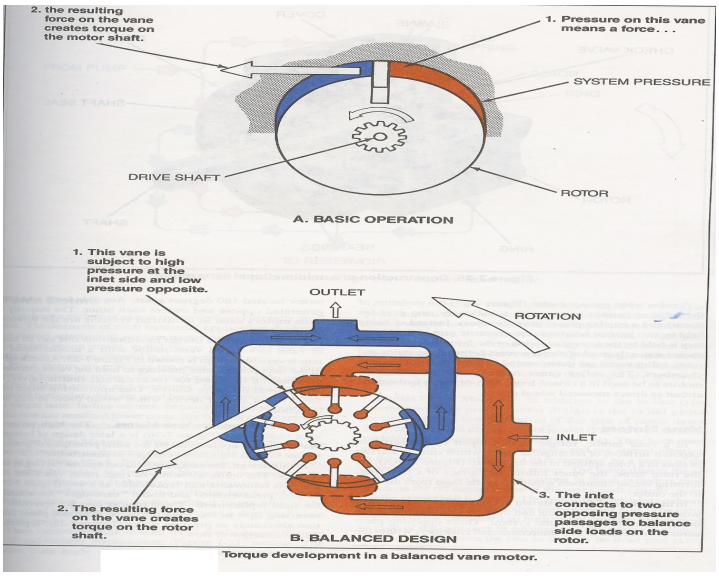
WORKING:

1. **Gear motor:**



A gear motor develops torque through pressure on the surfaces of gear teeth. The two gears mesh and rotate together, one gear coupled to drive shaft. The displacement of a gear motor is fixed and is equal to volume between two teeth multi plied by number of teeth. Generally gear's are not in balance with respect to pressure at the outlet result in high side loads on the shaft and gears as well as the bearings. Gear motor's are simple and more dirt tolerant.

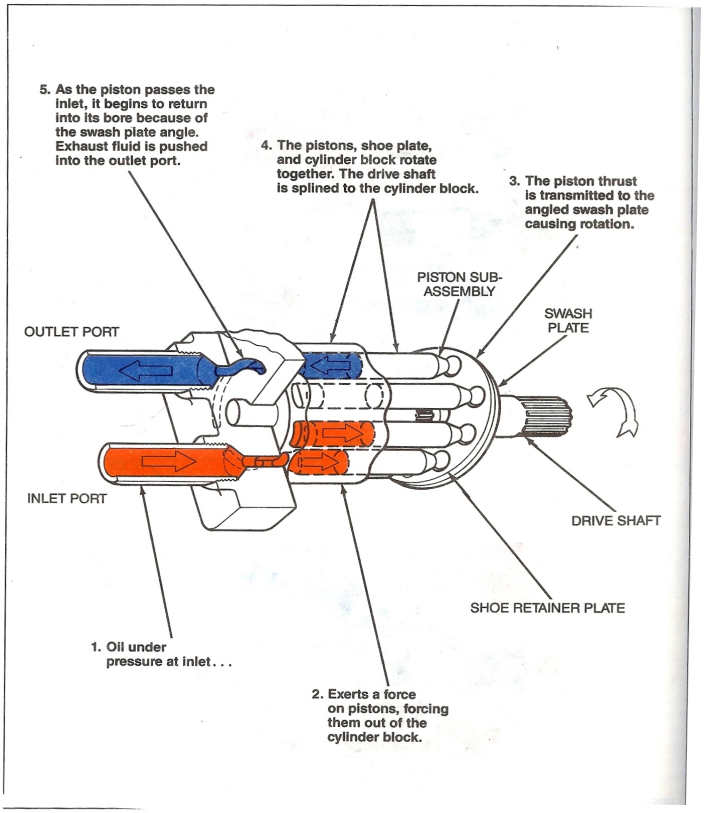
2. **Vane motor:**

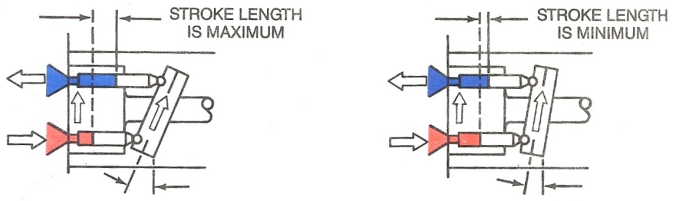


Torque development in a balanced vane motor.

In vane motor torque is developed by pressure on exposed surface of rectangular vanes, which slides in and out of slots in a rotor to drive shaft. As the rotor turns the vanes follow the surface of cm ring, carrying the fluid from inlet to outlet. In operation pressure under the vanes also holds them in contact with cam ring some devices are used to hold the vanes, may be spring clips or small springs beneath each vane pushing it out.

AXIAL PISTON MOTOR:





MAXIMUM SWASH PLATE ANGLE AND MAXIMUM TORQUE CAPABILITY

MINIMUM SWASH PLATE ANGLE AND MINIMUM TORQUE CAPABILITY

ɔtor displacement varies with swash plate angle.

The axial piston motor is an energy converter with an axial piston arrangement in a barrel shaped body in swash plate-design motor circular arrangement of 9 pistons is located parallel to the drive shaft in a fixed housing. The pistons run in a cylinderal barrel which his firmly fixed to the drive shaft by means of a key. The piston ends or of burn and surface design and run on slipper pads. These are held on a swiveling but not rotating swash plate by means of holding discs. On the fixed displacement model the swash plate forms a part of the housing and therefore has a fixed swash angle which determines the pump displacement. The function of hydraulic motor is the reverse of that of the pump. Energy laden fluid is directed to the hydraulic motor while fluid is being directed at atmospheric pressure from a tank to the pump which then receives a specific amount of energy via the drive motor and the fluid is supplied

to the system as pressure fluid. By charging the direction of the active components of this pressure fluid, hydraulic energy is converted into mechanical energy (as a torque) via the driven shaft. The energy- free fluid is now returned from the hydraulic motor to the tank. On this particular design too, 4 pistons are pressurized 4 are connected to the tank, and 1 is in an intermediate position. The bores in the pistons leading to the ball and socket serve to reduce the high surface pressure in the ball and socket and on the sliding disc that is to say – they serve to provide a hydro-static bearing. For special applications these hydraulics motors can also be equipped with any of the control and regulating devices.

TROUBLE SHOOTING:

PROBLEMS	CAUSES	REMEDIES
1. Motor not running	1. No incoming pressure	1. Check pump and relief valve.
	2. Shaft seizure due to misalignment.	2. Align correctly the shaft with work load.
	3. Shaft seizure due to excessive load.	3. Check load and load capacity of motor.
	4. Too much play in the shaft.	4. Replace bearing.
	5. Oil spill at motor.	5. Check if port plate is in contact.
	6. O-ring on port plate effective.	6. Replace O-ring.
	7. Motor type too small.	7. Replace for larger type.
2. Slow motor operation.	1. Inlet pressure too low.	1. Increase pressure by setting relief valve.
	2. Motor parts defective	2. Replace defective parts.
	3. Oil temperature too high.	3. Check for line restrictions, wrong fluid viscosity and also check cooling circuit.
	4. Outlet pressure too high	4. Check outlet line
	5. Port plate does not make contact.	5. Disassemble motor and repair.

SUB-DISCIPLINE: PNEUMATICS (LESSONS: 03 SESSIONS: 03)

Lesson-I: Pneumatic Symbols and Pneumatic Components **Session–13:** Pneumatic symbols and Application of air on Track machines, Working and maintenance of Air Compressor, Cooling Coil, Safety valve, Air dryer, Water separator, Air oiler, DC Valve, Cylinder and Pneumatic Hoses.

PNEUMATIC SYMBOLS:

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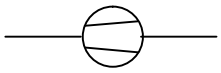
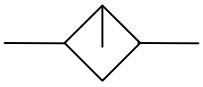
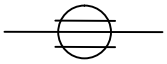


Compressor

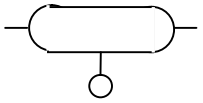


Air Oiler

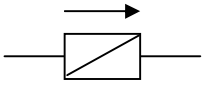
Cooling Coil



Plug in Coupling

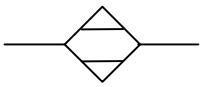


Air receiver with drain valve

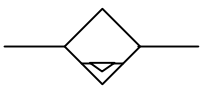


Spill Valve

Safety Valve



Air Dryer



Water Separator (Automatically Operated)

APPLICATION OF AIR ON TRACK MACHINES:

1. Application of brakes.
2. Locking & unlocking of tamping unit, lifting unit, boogies.
3. Lifting and lowering of different bogies.
4. Clapper cylinder.
5. Pneumatic horn.
6. Lubricating system.
7. Application of datum.
8. Wiper.
9. Tightening of leveling / chord/ lining/ chord.
10. Filling the diesel tank.
11. Spray painting.
12. Engaging / disengage pinion to satellite gear.
13. Engaging / disengage the dog clutch for work drive in CSM /UNIMAT.

WORKING OF AIR COMPRESSOR:

A reciprocating compressor can be single or multiple piston compressors. The more the number of piston in a compressor. the more powerful a compressor is. The multi piston cylinder block of a compressor has crank shaft having same number of crank connection has the number of piston and cylinder in it. The crank shaft is connected to the prime mover .With each cylinder. there are two ports known as inlet and exhaust port depending on their functions.

When the crank shaft of compressor rotates and the piston of air compressor takes an inward stroke, atmospheric pressure being higher than the pressure in the compressor cylinder, the flow of air takes place through the inlet port when the crank rotates further and piston moves forward stroke, the inlet valve closes and exhaust port opens thus sending the compressed air to the system/ air container (air tank). The compressor reduces the volume of air thereby increasing its pressure.

If the compressor is a multi stage, one piston sends compressed air to another cylinder and thus to tank. The capacity of a compressor is depending upon the number of cylinder in it. The term single or multistage depends upon the no. of stages or steps that a reciprocating compressor uses to compress air to its final pressure.

COOLING COIL:-

As the compressed air has get its temperature risen due to compression, the temperature has to be brought down. This is done by cooling coil which is a helical copper tube by which the cooling coil comes in contact with atmospheric air and therefore the compressed air inside the cooling coil cools down.

PRESSURE REGULATING VALVE:

The role of this valve is to maintain constant pressure even with fluctuating supply. The input pressure must be greater than the required output pressure.

PRESSURE LIMITING VALVE:

The pressure limiting valves are used mainly as safety valves (pressure relief valves). They prevent the maximum permissible pressure in a system from being exceeded. If the maximum pressure has been reached at the valve inlet, the valve outlet is opened and the excess air pressure exhausts to atmosphere. The valve remains open until it is closed by the built-in spring after reaching the preset system pressure.

AIR DRYER:-

Condensate (water) enters into the air network through the air intake of the compressor. The accumulation of condensate depends largely on the relative air humidity. The relative air humidity is dependent on the air temperature & the weather condition.

The service life of pneumatic system is considerably reduced if excessive moisture is carried through the air system to the components. Therefore it is important to fit the necessary air drying equipment to reduce the moisture content to a level which suits the application & the components used.

WATER SEPERATOR:

The first step in process of compressed air after pressure regulation is its filtration or removal of moisture contents which is harmful not only that it may result in rusting but also it may form emulsion with lubricating oil which will block the pneumatic assemblies. The air under pressure enters through inlet of a specially designed water separator having provision for baffle and quite zone. The water droplets are thrown from air stream by virtue of their centrifugal force when they strike the deflector with louvers at the entrance. The water collected at the bottom of quite zone is drained out through the drain tap provided at the bottom or by removing the transparent bowl container.

AIR OILER:

There are certain pneumatic tools and equipments which require lubricated air to reduce wear and corrosion and there are certain other components which do not tolerate oil in the air stream. The importance of lubrication can be well imagined as it not only decreases friction but also prevent corrosion of pneumatic assemblies and simultaneously increases the efficiency.

D.C. VALVES:

Direction control valves used in pneumatic system are similar to those used in hydraulics. Their primary function is to direct flow of air from one place to another in the system. Normally this involves one or all of the following:

- Opening the passage of air and directing it to particular air lines.
- Canceling air signals as required by blocking their passage.
- Relieving the air to atmosphere via an exhaust port.

CYLINDERS:

A pneumatic cylinder converse compressed air pressure into mechanical linear force. When the compressed air enters on of the ports of the cylinder, it transmits movements to the piston and its rods and becomes mechanical force to do some work. The flow rate of the pneumatic power determines the piston speed and output in horse power.

PIPING, HOSES AND FITTINGS:

Piping is an important part of pneumatic system. It is not only to transmit the pneumatic power to various components, but also to keep it clean and free from contaminants. The pipes utilized on the machines should be flexible and strong enough to withstand the working pressure of the system.

As a thumb rule, the testing pressure of a pipe should be double that of working pressure and bursting pressure double that of the testing pressure.

The working pneumatic pressure on track machine varies between 6.5 – 7.0 kg/cm^2. The inside diameter of pneumatic pipe is 6.3 mm and 12.6 mm are used for general transmission and brake system of the machine.