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Engineering

A pneumatic system is a system that uses pressurised gas to operate mechanical devices. It is powered by a compressor which then powers the mechanical devices through solenoid valve. Advantages of pneumatics: Simplicity of design and controlReliabilityCheaperMore flexibleSafety

Air compressor

This is a device that converts power into kinetic energy usually from an electric motor or engine. It works by compressing and pressurizing air which when needed can be released in quick bursts. Positive-displacement or negative-displacement are some method of air compression.

Motor

A motor works by expanding and compressing the air produced to mechanical through either rotary or linear motion. A piston air motor or vane type air motor usually is rotary and a piston or diaphragm actuator is linear.

Vacuum Pump

It produces a partial vacuum by removing gas molecules from a sealed volume. ReservoirThis is a vessel to store the fuel which is pumped to the compressor. The used fuel from the compressor is then recycled and pumped back to the reservoir and this cycle is repeated. Pressure SwitchWhen the pressure reaches a set unit on the input the electrical contact will close and switch on/off depending on what you want it to do. This switch can detect pressure drop and pressure rise depending on the design.

Pressure Regulator

This is used as a safety measure to allow high-pressures to be reduced when the system reaches a certain pressure and the regulator will shut off the flow of gas. Flow Meters or Mass Flow Controllers are some of the components that are used to regulate gas flow rates. Pressure sensor

This measures the pressure in the system and is similar to a transducer because it creates a signal as a function of the pressure imposed.

Single-acting cylinder (SAC)

Single-acting cylinders usually use a spring for the cylinder to return to home position and compressed air to force the cylinder out. Most often than not SACs are normally used for applications that only has a stroke of 100mm or less, this limited extension is because of the lack of space due to the spring. Also another problem is that the force produced as it pushes against the spring is lost so you will not get as much pressure on the cylinder.

Double-acting cylinders (DAC)

DACs have two ports which will allow air into the cylinder one for the instroke and one for the outstroke. The cylinders move in both directions for the extension and the retraction as the compressed air through one of the ports. The problem with this type of cylinder is that the piston rod is prone to buckling and bending. Buffer CylindersBuffer cylinders are used to prevent damage to the system because when the pressure drops there will be impulses through the system causing constant shock which causes damage. These cylinder are installed on the inlet and the outlet pipes and are filled

with nitrogen to act as a buffer when the system pulses thus giving a more stable working pressure and flow rate.

Primary filters

These will remove particles such as dirt and water droplets from the air to protect the devices from damage caused by these contaminates.

Pneumatic solenoid valves

These are used to route air to the required devices such as an actuator which sends a small signal to control the large devices. Directional control valveThere are two types of these valves used, a poppet type which is normally used for small flow rates and a slider type usually used to carry larger flow rates. They control the passage of air signals by generating, cancelling or redirecting signals. Flow Control ValveThe flow control valve is used to control the flow by restricting or throttling the air in a particular direction. These valves should be fitted close to the working element and must be adjusted accordingly to match the application.

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Hydraulic System

The principle of hydraulics is the transmission of force through the medium of liquid. Specifically, it is the science of forces and movements transmitted by means of liquids. Advantages of Hydraulics: Smooth and steady movement. Greater transmission of power for weight of equipment. Simpler installation in that pipelines can be easily routed around obstructions. Variation of speed of operation can be achieved without the need for gears as would be required in a mechanical system.

Components of a Hydraulic System

Hydraulic ReservoirThe reservoir is a container for the hydraulic fluid used in a system. It’s purpose is to: Provide fluid for the pumps. Receive return fluid from the system. Allow for variation of level due to jack ram displacement. Provide a reserve of fluid to compensate for small leaks. There are numerous components which the reservoir contains and these are: Air ventAir filterSight gaugeBaffle plateFiller capDrain plugAir vent allows air to be drawn in and pushed out depending on the level of the fluid. Air filter is fitted to the air vent to prevent dust from be sucked into the reservoir. Sight gauge is to monitor the level of the fluid to ensure the correct level. Baffle plate divides the outlet fluid to inlet fluid to dissipate air bubbles, preventing contaminate to settle and to allow cooling of fluid before reaching the pump. Filler cap allows filling of the reservoir. Drain plug allows drainage of system. Diagram of a reservoirStrainers and filtersStrainers and filters are used in a hydraulic system to remove any contaminates from the fluid. The reservoir or the inlet line to the pump normally contains the strainer. The filter is normally located where only a small amount of fluid would be lost after a filter change. Normally where the filter is positioned there would be a fluid bypass valve which allows the fluid to bypass the filter if it would get clogged up. Hydraulic PumpsA hydraulic pump is a device for the conversion of mechanical energy into the hydraulic energy. The mechanical action of the pump traps the fluid within the pumping cavities, transports it through the pump, and forces the flow of fluid into the hydraulic system. By repeating this operation a continuous flow of hydraulic fluid is produced. Hydraulic ActuatorsAn actuator is used to convert hydraulic energy into linear

mechanical motion. Actuators can take several with the two most common being the single ram (differential area) jack and the double ram (equal area) jack. Actuators comprise of a cylindrical body housing a piston, which may travel along the length of the cylinder. Attached to the piston will be one or two rams extending out of the body. On either rend of the cylinder are ports, which allow hydraulic fluid to enter and leave. The piston are designed such that the fluid on either side is kept separate by use of sealsPipe and HosesPipes (rigid) and hoses (flexible) carry fluid from one part of a system to another via the various hydraulic components. Flexible hoses are used where movement or high level of vibration are involved which could cause a rigid pipe to fracture. CouplingsThe purpose of couplings is to join length of pipe or hoses together or a component ensuring a positive seal. AccumulatorsAn accumulator is a cylinder and floating piston assemble with openings on each end. One chamber contains hydraulic fluid at system pressure and the other chamber contains gas under pressure. Hydraulic system fluid pressure enters one port and forces the piston against the gas charge. The purpose of an accumulator include: Providing the emergency store of oil. Giving initial impetus to hydraulically operated components. Damping out pulse pulsations. Compensating for temporary drop in supply pressure on selection of service. Compensating for thermal expansion of the fluid. Directional Control Valves (DCV)The purpose of the DCV is to direct the flow of the fluid to either side of the jack or piston, and to provide a return path for the fluid to the reservoir. There are many possible configurations of the control valve, for instance it may have two inlet and two outlet ports, and have two possible control positions, a 4/2-way valve.

(4/2 way valve hydraulic symbol)

Hydraulic FluidAll liquids are virtually incompressible but not all liquids are suitable for hydraulic systems. In general oil is used in hydraulic systems and require certain properties such as: Be free flowing at all operating temperatures. Have a low freezing and high boiling point. Does not affect, and is not affected by, the materials in the components. Have good lubricating properties. Does not deteriorate or form sludge i. e. chemical stable. Has a high flash point. Seals and GlandsSeals are fitted to hydraulic components to prevent leakage and are therefore a critical component. Seals are made from different material to suit the properties of different oils. To avoid damaging the seal they must be removed with care using a spatula which will not damage the seating area. There are many types of seal such as: Square section sealO ringU section sealBonded sealWiper ringPressure Relief Valve (PRV)A PRV is fitted to protect a circuit or component from possible damage caused by hydraulic over pressurisation. Pressure regulatorA pressure regulator is used to cut off the supply of fluid to those services deemed to be non-essential and to ensure that the available fluid pressure is directed to those services deemed to be essential in the event of hydraulic pressure failure. Non –return valve (NRV)NRV permit flow in one direction, and block any flow in the reserve direction. Due to their flow characteristics, NRVs are used to isolate components or sub-systems from each other. An arrow on the valve body indicates the direction of free flow through the valve. Pressure release valveBefore carrying out certain hydraulic maintenance tasks or procedures, it is essential to ensure that system pressure is dissipated. Pressure release valves allow system pressure

to be dissipated to return and are manually operated. Pressure switchThe pressure switch is an electro-hydraulic component that uses hydraulic pressure to operate a micro-switch. If the system pressure falls below a pre-determined level the micro-switch will produce a warningPressure transducerA transducer is a device for converting one form of energy to another. In hydraulic system, the pressure transducer proportionally converts hydraulic energy into electrical energy to supply a gauging system. Hydraulic Fluid StrainerA fluid strainer is a filter. The reason this is used instead of a regular filter is because it is a lot coarser and can handle higher pressures. Hydraulic Fluid Return LineThis is a line attached to both ends of the tank. When there is no fluid flowing to the circuit the tank will continuously keep the fluid flowing through the return line and into the reservoir. Hydraulic Pump Suction LineThis allows the fluid to travel upward from the reservoir to parts of the hydraulic circuit. This is usually connected to a fluid strainer to make sure that the fluid passing to the circuit through it has been cleaned to the appropriate level first. Cleanout PlateThis is a plate that is usually located at both ends of the reservoir. It can be quickly removed to get inside the reservoir for maintenance purposes. This is mainly used as a pro-active type of maintenance.