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| **Course Name:** | **Automation and Control Systems lab** | **Semester:** | **V** |
| **Date of Performance:** | **23/10/2024** | **Batch No:** | **B1** |
| **Faculty Name:** | **Prof. Shila Dande** | **Roll No:** | **16014022050** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** |  |

**Experiment No: 8**

**Title: Automation of Double Acting Pneumatic cylinder**

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| **Aim and Objective of the Experiment:** |
| 1. Design and development of electro-pneumatic circuits to control DAC in semi and fully automatic mode. 2. Applications of DCV and FCV. |

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| **COs to be achieved:** |
| CO4. Explain various actuators used in control systems |

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| **Theory:** |
| Pneumatic cylinders, rotary actuators and air motors provide the force and movement for the most of pneumatic systems, for holding, moving, forming, and processing of materials. To operate and control these actuators, other pneumatic components are needed such as air service units for the preparation of the compressed air and valves for the control of the pressure, flow and direction of movement of the actuators. A basic pneumatic system consists of the following two main sections.  • Compressed air production, transportation, and distribution system  • Compressed air consuming system  The main components of the compressed air production, transportation, and distribution system consist of air compressor, electric motor and motor control Centre, pressure switch, check valve, storage tank, pressure gauge, auto drain, air dryer, filters, air lubricator, pipelines, and different types of valves. The main components of air consuming system consist of intake filter, compressor, air take off valve, auto drain, air service unit, directional valve, actuators, and speed controllers.  Intake filter also known as air filter is used to filter out the contaminants from the air.  Air compressor converts the mechanical energy of an electric or combustion motor into the potential energy of compressed air. There are several types of compressors which are used in the compressed air systems. Compressors used for generation of compressed air is selected on the basis of desired maximum delivery pressure and the required flow rate of the air The types of compressors in the compressed air systems are (i) piston or reciprocating compressors, (ii) rotary compressors, (iii) centrifugal compressors, and (iv) axial flow compressors. Reciprocating compressors are (i) single stage or double stage piston compressor, and (ii) diaphragm compressor. Rotary compressors are (i) sliding vane compressor, and (ii) screw compressor.  Electric motor transforms electrical energy into mechanical energy. It is used to drive the air compressor.  The compressed air coming from the compressor is stored in the air receiver. The purpose of air receiver is to smooth the pulsating flow from the compressor. It also helps the air to cool and condense the moisture present. The air receiver is to be large enough to hold all the air delivered by the compressor. The pressure in the receiver is held higher than the system operating pressure to compensate pressure loss in the pipes. Also the large surface area of the receiver helps in dissipating the heat from the compressed air.  For satisfactory operation of the pneumatic system the compressed air needs to be cleaned and dried. Atmospheric air is contaminated with dust, smoke and is humid. These particles can cause wear of the system components and presence of moisture may cause corrosion. Hence it is essential to treat the air to get rid of these impurities. Further during compression operation, air temperature increases. Therefore, cooler is used to reduce the temperature of the compressed air. The water vapor or moisture in the air is separated from the air by using a separator or air dryer.  The air treatment can be divided into three stages. In the first stage, the large sized particles are prevented from entering the air compressor by an intake filter. The air leaving the compressor may be humid and may be at high temperature. The compressed air from the compressor is treated in the second stage. In this stage temperature of the compressed air is lowered using a cooler and the air is dried using a dryer.  Air drying system can be adsorption type, absorption type, refrigeration type, or the type that uses semi permeable membranes. Also an inline filter is provided to remove any contaminant particles present. This treatment is called primary air treatment. In the third stage which is the secondary air treatment process, further filtering is carried out.  Lubrication of moving parts of cylinder and valves is very essential in pneumatic system. For this purpose compressed air lubricators are used ahead of pneumatic equipment. Lubricator introduces a fine mist of oil into the compressed air. This helps in lubrication of the moving components of the system to which the compressed air is applied. Correct grade of lubricating oil usually are with kinematic viscosity around 20- 50 centistokes.  Control valves are used to regulate, control and monitor for control of direction flow, pressure etc. The main function of the control valve is to maintain constant downstream pressure in the air line, irrespective of variation of upstream pressure. Due to the high velocity of the compressed air flow, there is flow-dependent pressure drop between the receiver and load (application). Hence the pressure in the receiver is always kept higher than the system pressure. At the application site, the pressure is regulated to keep it constant. There are three ways to control the local pressures which are given below.  • In the first method, load vents the air into atmosphere continuously. The pressure regulator restricts the air flow to the load, thus controlling the air pressure. In this type of pressure regulation, some minimum flow is required to operate the regulator. If the load is a dead end type which draws no air, the pressure in the receiver rises to the manifold pressure. These type of regulators are called as ‘non-relieving regulators’, since the air must pass through the load.  • In the second type, load is a dead end load. However the regulator vents the air into atmosphere to reduce the pressure. This type of regulator is called as ‘relieving regulator’.  • The third type of regulator has a very large load. Hence its requirement of air volume is very high and cannot be fulfilled by using a simple regulator. In such cases, a control loop comprising of pressure transducer, controller and vent valve is used. Due to large load the system pressure may rise above its critical value. It is detected by a transducer. Then the signal is processed by the controller which directs the valve to be opened to vent out the air. This technique is also used when it is difficult to mount the pressure regulating valve close to the point where pressure regulation is needed.  Air cylinders and motors are the actuators which are used to obtain the required movements of mechanical elements of pneumatic system. Actuators are output devices which convert energy from compressed air into the required type of action or motion. In general, pneumatic systems are used for gripping and/or moving operations in various industries. These operations are carried out by using actuators. Actuators can be classified into three types which are (i) linear actuators which convert pneumatic energy into linear motion, (ii) rotary actuators which convert pneumatic energy into rotary motion, and (iii) actuators to operate flow control valves- these are used to control the flow and pressure of fluids such as gases, steam or liquids. The construction of hydraulic and pneumatic linear actuators is similar. However they differ at their operating pressure ranges. Typical pressure of hydraulic cylinders is about 100 kg/sq mm and that of pneumatic cylinders is around 10 kg/sq mm. |

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| **Circuit Diagram/ Block Diagram:** |
| **DAC Single cycle Automation Circuit: (Direct Control)**    **DAC Single cycle Automation Circuit: (Indirect Control)**    **DAC Full Automation Circuit: (Direct Control)**    **DAC Full Automation Circuit: (Indirect Control)** |

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| **Stepwise-Procedure:** |
| 1. Simulate Pneumatic circuits in Fluidsim 2. Use DCV and FCV as control element. |

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| **Output snaps:** |
| **DAC Single cycle Automation O/P snap on FLUIDSIM: (Direct and Indirect Control)** |
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| **Post Lab Subjective/Objective type Questions:** |
| **1. Applications of Single Acting Cylinder Semi-Automatic Control:**   * **Clamping and Holding Devices**: Used in manufacturing for holding materials in place temporarily, such as in fixtures or clamps. * **Pressing Operations**: Used in machines for light pressing tasks where the return stroke can be powered by a spring. * **Packaging Systems**: Used in packaging machines to push products or materials into a specific position. * **Lifting Devices**: Single acting cylinders can be used in lifting operations where a load can be lifted with air pressure and lowered by gravity or a spring. * **Door Openers**: Used in automatic door systems where the door opens automatically and closes using a spring mechanism.   **2. Applications of Double Acting Cylinder Fully-Automatic Control:**   * **Automated Production Lines**: Used in assembly lines for tasks like pushing, pulling, lifting, and placing materials in a fully automated system. * **Robotics**: Double acting cylinders are used to control robotic arms for precise movement and repetitive tasks in automation. * **Material Handling Systems**: Used in conveyor systems, lifts, or other equipment for moving products in multiple directions (push and pull). * **Injection Molding Machines**: These cylinders control the mold closing and opening operations in fully automatic cycles. * **Press Brakes**: Used in sheet metal bending machines where both extension and retraction need to be powered for accurate and automatic control.   Top of Form  Bottom of Form  Top of Form |

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| **Conclusion:**  The experiment successfully demonstrated the design and automation of a double-acting pneumatic cylinder in both semi and fully automatic modes, showcasing the functionality of control elements like DCV and FCV. This highlighted the versatility of pneumatic systems in various industrial automation applications. |

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| **Signature of faculty in-charge with Date:** |