HYDRAULICS AND PNEUMATICS

Chapter – 2

UNIT V TROUBLE SHOOTING AND APPLICATIONS

The Failure of Hydraulic components ,Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

DESIGN OF PNEUMATIC CIRCUITS FOR PICK AND PLACE APPLICATIONS

FUNCTION OF THE PICK AND PLACE ROBOT ARM

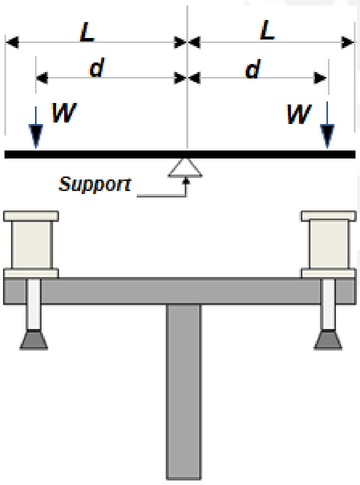
After the modeling of all parts, they are assembled with proper constraints and relations. The assembly is checked for the working of the designed rack and pinion mechanism through simulation. At the end, the part list is finalized. The following are the major parts used in this system and are modelled. Base frame, rack, pinion, flange, bearing, lead screw and nuts, arm, pneumatic cylinders, vacuum cups, etc. The rotation is fully defined and precise rotation in the arms could be attained with the help of pneumatic system and the micro switches. For incorporating the pneumatic system for rotating the lead screw, moving the gripers to pick and place the object at correct places, the cylinder should have enough capacity, stroke length.

The type (single or double acting) and its control elements (DCV, Solenoids etc.,) should be appropriately selected. The conduits tubes should have more than minimum diameter for avoiding blockages or pressure surge. Filters, Regulator and Lubricators (FRL) unit is connected to the system. Productivity is directly related to the operating method followed, which could be classified as manual, mechanized and electro-pneumatic. The cost and time taken would be large in the case of manual operation, which could be reduced by semi automation. Usage of appropriate mechanical elements have proven the improvement in the productivity. Further introducing electro-pneumatic with control systems will lead to low cost automation.

One complete cycle involves pick of the object at station 1 and rotated through 180° in clockwise direction and place the object at station 2. Further, after placing, the rotation of arm is brought back 180° in the counterclockwise direction. Three double acting pneumatic cylinders are involved for pick, place and rotation. The Festo Fluidsim software was utilized in simulating the developed pneumatic logic circuit. The layout of the electrical circuit was done and incorporated into the control panel to regulate the movement of the pneumatic parts. For the standard parts like cylinders, flow control valves, filter regulator and lubricator, selection was done through the methods.

Arm Design:

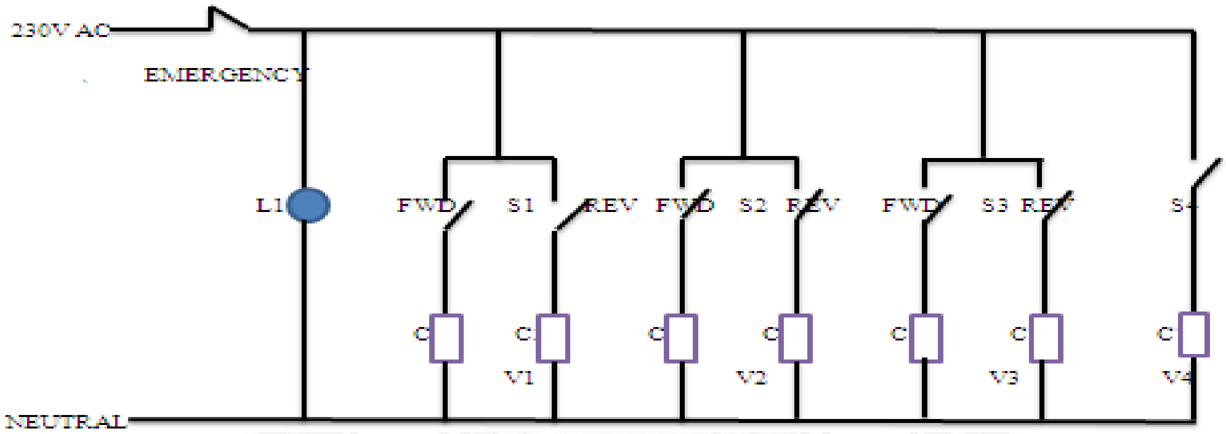
The arm is designed such that the flexural stiffness is enough to take up the load of the object. The cross-section and its variation along the length are designed limiting the permissible value of deflection at the free end. In this arrangement, uniform hollow rectangular cross-section is selected. From the material properties of the arm, the weight of the arm over the length L on one side from the center axis is . Fixing the material of the arm, E becomes constant. With the constraint of maximum permissible deflection at the end of the arm as less than , the minimum required second moment of area should satisfy



Fabrication of PICK AND PLACE ROBOT ARM

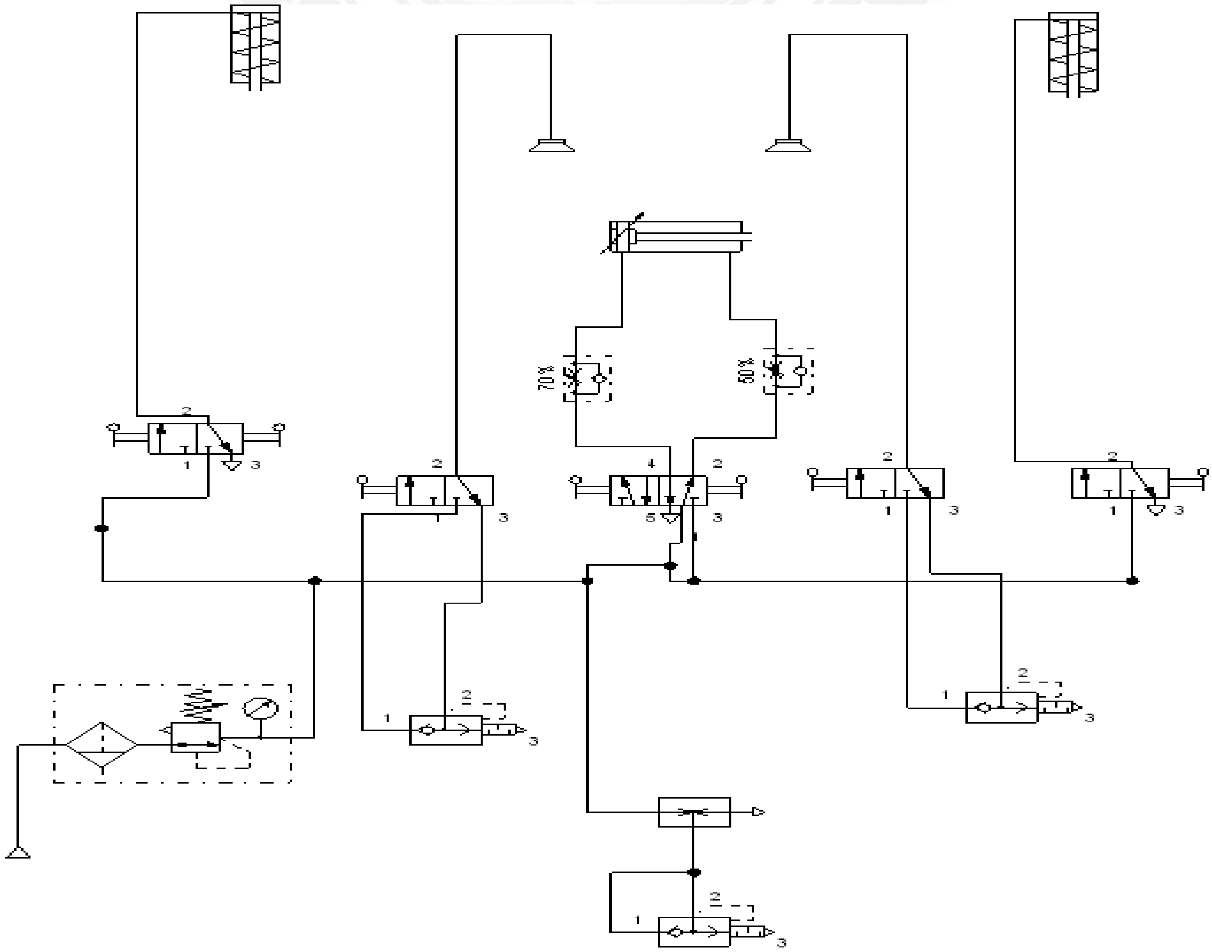
After completing of fabrication and assembly for achieving functionality the PPAR was checked for its accuracy and repeatability. Since the robot has two modes, manual and auto mode for transferring of parts, this model proves worthy in scaling up for handling heavy objects. This will also reduce human fatigue and error in terms of transferring objects from a place to other. From the observation made, the complete experimental setup took about 8 seconds for the transferring the objects from one place to another. The work could be altered with a different stroke length of cylinders with varying weights up to 100 grams.

ELECTRICAL CIRCUIT DIAGRAM



ELECTRO PNEUMATIC CIRCUIT DIAGRAM

Figure indicates a schematic representation of the typical Pneumatic circuit which developed by using Festo- Fluidsim software. With three cylinders, each of the



cylinders works individually. It indicates the operations at each station of the PPAR. Every cycle involves one pick of the object at station 1 through the Cylinder 1 and vacuum cup and rotate the arm through 180° in clockwise direction and place the object at station 2 by retraction of Cylinder 2. Further, after placing, the rotation of arm is brought back 180° in the counter clockwise direction for continuing with next cycle. For this cycle operation, two modes (manual or Automatic) provisions are available.

LOW COST AUTOMATION:

Automation is the technology by which a process or procedure is accomplished without human assistance. It is implemented using a *program of instructions* combined with a *control system* that executes the instructions. To automate a process, power is required, both to drive the process itself and to operate the program and control system. Although automation can be applied in a wide variety of areas, it is most closely associated with the manufacturing industries.

Automated manufacturing systems operate in the factory on the physical product. They perform operations such as processing, assembly, inspection, or material handling, in some cases accomplishing more than one of these operations in the same system. They are called automated because they perform their operations with a reduced level of human participation compared with the corresponding manual process. In some highly automated systems, there is virtually no human participation. Examples of automated manufacturing systems include:

- automated machine tools that process parts
- transfer lines that perform a series of machining operations
- automated assembly systems
- manufacturing systems that use industrial robots to perform processing or assembly operations
- automatic material handling and storage systems to integrate manufacturing operations
- automatic inspection systems for quality control

Thus, Automation is a technology concerned with the application of mechanical, electronic, and computer-based systems to operate and control production. This technology includes:

- Automatic machine tools to process parts
- Automatic assembly machines
- Industrial robots
- Automatic material handling and storage systems
- Automatic inspection systems for quality control
- Feedback control and computer process control
- Computer systems for planning, data collection, and decision making to supportmanufacturing activities

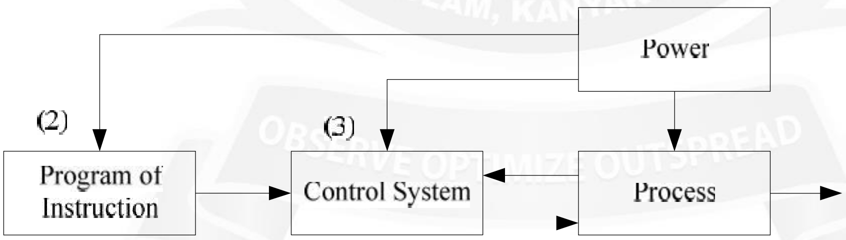
ELEMENTS OF AUTOMATED SYSTEM

An automated system consists of three basic elements:

(1) *power* to accomplish the process and operate the system.

(2) a *program of instructions* to direct the process, and

(3) a *control system to* actuate the instructions.



Elements of an automated system

Power to accomplish the automated process

An automated system is used to operate some process, and power is required to drive the process as well as the controls. The principal source of power in automated systems is electricity. Electric power has many advantages in automated as well as non-automated processes

- Electrical power is widely available at moderate cost.

- Electrical power can be readily converted to alternative energy forms: mechanical, thermal, light, acoustic, hydraulic, and pneumatic.
- Electrical power at low levels can be used to accomplish functions such as signal, transmission, information processing, and data storage and communication.
- Electrical energy can be stored in long-life batteries for use in locations where an external source of electrical power is not conveniently available.

Power is required in automation for the followings:

- Processing operations
- Loading and unloading the work unit
- Material transport between operations
- Controller unit
- Power to actuate the control signals
- Data acquisition and information processing

Program of Instructions

The actions performed in an automated process are defined by a program of instructions. Each part or product style made in the operation requires one or more processing steps that are unique to that style, These processing steps are performed during a work cycle. A new part is completed during each work cycle (in some manufacturing operations, more than one part is produced during the work cycle; e.g., a plastic injection molding operation may produce multiple parts each cycle using a multiple cavity mold). The particular processing steps for the work cycle are specified in a work cycle program.

Work Cycle Programs. In the simplest automated processes, the work cycle consists of essentially one step, which is to maintain a single process parameter at a defined level. However, the system becomes complicated when the process involves a work cycle consisting of multiple steps with more number of process parameters are required to be controlled. Most discrete part manufacturing operations are in this category.

Process parameters are inputs to the process such as temperature setting of a furnace, coordinate axis value in a positioning system, valve opened or closed in a fluid flow system, and motor on or off. Process parameters are distinguished from process variables, which are outputs from the process; for example, the actual temperature of the furnace, the actual position of the axis, the actual flow rate of the fluid in the pipe, and the rotational speed of the motor. As our list of examples suggests, the changes in process parameter values may be continuous (gradual changes during the processing step; for example, gradually increasing temperature during a heat treatment cycle) or discrete (stepwise changes; for example, on/off).

The work cycle may include manual steps, where the operator performs certain activities during the work cycle and the automated system performs the rest. A common example is the loading and unloading of parts by the operator to and from a numerical control machine between machining cycles where the machine performs the cutting operation under part program control. Initiation of the cutting operation of each cycle is triggered by the operator activating a "start" button after the part has been loaded.

Decision-Making in the Programmed Work Cycle. In automated work cycles the only two features are (1) the number and sequence of processing steps and (2) the process parameter changes in each step. Each work cycle consists of the same steps and associated process parameter changes with no variation from one cycle to the next. The program of instructions is repealed each work cycle without deviation. In fact, many automated manufacturing operations require decisions to be made during the programmed work cycle to cope with variations in the cycle. In many cases, the variations are routine elements of the cycle, and the corresponding instructions for dealing with them are incorporated into the regular part program. These cases include:

- Operator interaction. Although the program of instructions is intended to be carried out without human interaction, the controller unit may require input data from a human operator in order to function.
- Different part or product styles processed by the System. In this instance, the automated system is programmed to perform different work cycles on different part or product styles.

- Variations in the starting work units. In many manufacturing operations the starting work units are not consistent. A good example is a sand casting as the starting work unit in a machining operation. The dimensional variations in the raw castings sometimes necessitate an extra machining pass to bring the machined dimension to the specified value. The part program must be coded to allow for the additional pass when necessary.

In all of these examples, the routine variations can be accommodated in the regular work cycle program. The program can be designed to respond to sensor or operator inputs by executing the appropriate subroutine corresponding to the input. In other cases, the variations in the work cycle are not routine at all. They are infrequent and unexpected, such as the failure of an equipment component. In these instances, the program must include contingency procedures or modifications in the sequence to cope with conditions that lie outside the normal routine.

Control System

The control element of the automated system executes the program of instructions. The control system causes the process to accomplish its defined function which is to carry out some manufacturing operation. The controls in an automated system can be either closed loop

Process parameters are inputs to the process such as temperature setting of a furnace, coordinate axis value in a positioning system, valve opened or closed in a fluid flow system, and motor on or off. Process parameters are distinguished from process variables, which are outputs from the process; for example, the actual temperature of the furnace, the actual position of the axis, the actual flow rate of the fluid in the pipe, and the rotational speed of the motor. As our list of examples suggests, the changes in process parameter values may be continuous (gradual changes during the processing step; for example, gradually increasing temperature during a heat treatment cycle) or discrete (stepwise changes; for example, on/off).

The work cycle may include manual steps, where the operator performs certain activities during the work cycle and the automated system performs the rest. A common example is the loading and unloading of parts by the operator to and from a numerical control machine between machining cycles where the machine performs the cutting operation under part program control. Initiation of the cutting operation of each cycle is triggered by the operator activating a "start" button after the part has been loaded.

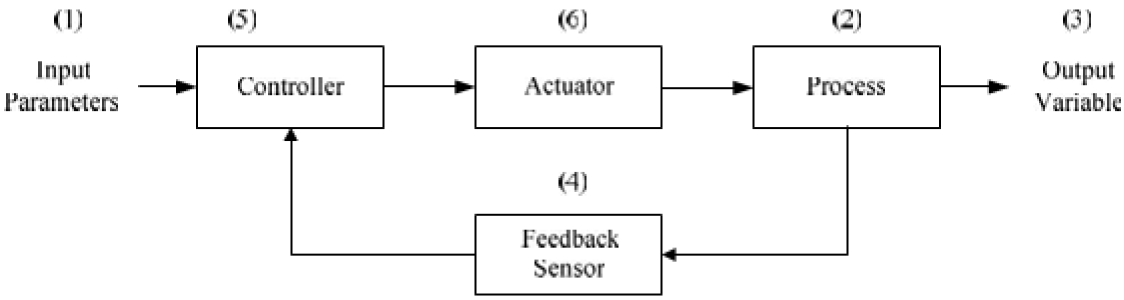
Decision-Making in the Programmed Work Cycle. In automated work cycles the only two features are (1) the number and sequence of processing steps and (2) the process parameter changes in each step. Each work cycle consists of the same steps and associated process parameter changes with no variation from one cycle to the next. The program of instructions is repealed each work cycle without deviation. In fact, many automated manufacturing operations require decisions to be made during the programmed work cycle to cope with variations in the cycle. In many cases, the variations are routine elements of the cycle, and the corresponding instructions for dealing with them are incorporated into the regular part program. These cases include:

- Operator interaction. Although the program of instructions is intended to be carried out without human interaction, the controller unit may require input data from a human operator in order to function.
- Different part or product styles processed by the System. In this instance, the automated system is programmed to perform different work cycles on different part or product styles.
- Variations in the starting work units. In many manufacturing operations the starting work units are not consistent. A good example is a sand casting as the starting work unit in a machining operation. The dimensional variations in the raw castings sometimes necessitate an extra machining pass to bring the machined dimension to the specified value. The part program must be coded to allow for the additional pass when necessary.

In all of these examples, the routine variations can be accommodated in the regular work cycle program. The program can be designed to respond to sensor or operator inputs by executing the appropriate subroutine corresponding to the input. In other cases, the variations in the work cycle are not routine at all. They are infrequent and unexpected, such as the failure of an equipment component. In these instances, the program must include contingency procedures or modifications in the sequence to cope with conditions that lie outside the normal routine.

Control System:

The control element of the automated system executes the program of instructions. The control system causes the process to accomplish its defined function which is to carry out some manufacturing operation. The controls in an automated system can be either closed loop or open loop. A closed loop control system, also known as a feedback control system is one in which the output variable is compared with an input parameter, and any difference between the two is used to drive the output into agreement with the input. As shown in Figure 1.2, a closed loop control system consists of six basic elements: (1) input parameter, (2) process, (3) output variable, (4) feedback sensor. (5) controller and (6) actuator.



The input parameter often referred to as the set point, represents the desired value of the output. The process is the operation or function being controlled. In particular, it is the output variable that is being controlled in the loop. A sensor is used to measure the output variable and close the loop between input and output. Sensors perform the feedback function in a closed loop control system. The controller compares the output with the input and makes the required adjustment in the process to reduce the difference between them. The adjustment is accomplished using one or more actuators, which are the hardware devices that physically carry out the control actions, such as an electric motor or a flow valve. The model in Figure 2 shows only one loop, however, most industrial processes require multiple loops, one for each process variable that must be controlled

In contrast to the closed loop control system, an open loop control system operates without the feedback loop, as in Figure 1.3. In this case, the controls operate without measuring the output variable so no comparison is made between the actual value of the output and the desired input parameter. The controller relies on an accurate model of the effect of its actuator on the process variable. With an open loop system, there is always the risk that the actuator will not have the intended effect on the process, and that is the disadvantage of an open loop system. Its advantage is that it is generally simpler and less expensive than a closed loop system. Open loop systems are usually appropriate when the following conditions apply:

(1) The actions performed by the control system are simple, (2) the actuating function is very reliable, and (3) any reaction forces opposing the actuation are small enough to have no effect on the actuation. If these characteristics are not applicable, then a closed loop control system may be more appropriate.

Figure 1.3 An open loop control system

HYDRAULIC POWER PACK:

A hydraulic system is any component that uses a fluid to generate and transmit energy from one point to another within the enclosed system. This force can be in the form of linear motion force or rotary motion. This is based on the Pascal's Laws.

Components of hydraulic power pack

They include:

- Electric or diesel motors
- Hydraulic valves
- Reservoirs
- Hydraulic gear pumps/li>

- Suction Filters
- Air breathers for fill oil into Hydraulic Reservoirs
- Central manifold blocks
- Electrical Control systems, like buttons remote and wireless remote

It is these parts that are interconnected to form an electric driven power unit, i.e., a single component. Other power units may have more components depending on the complexity of the design.

Type of Power Packs Based on Construction/Design

- Single acting hydraulic power pack
- Double acting hydraulic power pack

In **single acting hydraulic cylinders**, the hydraulic fluid acts on only one end of the piston. Therefore, to push the piston back to its original position (retraction), the cylinder uses a compressed air, mechanical spring, a flying wheel or gravity load.

A double acting hydraulic cylinders

A double acting power pack unit is where the working hydraulic fluids acts alternately on the two ends of the piston. That is, it uses the hydraulic power to extend and retract the piston.

Types of Power Packs Based on Size

In most cases, describing this hydraulic equipment based on its size or capacity is a common phenomenon. Basically, the classification criteria describe various performance specifications.

The main common performance specifications include:

- Flow rate
- Working pressure
- Tank volume
- Electric motor power
- Fluid type, i.e. mineral oil HL or HLP

Micro Power Pack Units

The Micro hydraulic power packs are suitable for applications where space is limited. They are portable due to their small size.

A micro hydraulic power pack

They are compact in size and available as either single or double acting. Due to their flexibility, you can operate them in either single or double acting without necessarily having a solenoid control valve.

All you need to do is reverse the motor movement. Such micro power packs have dual pressure relief valves, giving separate control options.

Also, a dual check valve reduces the effects of noise and induced pressure. Their tank capacity may range between 0.1 to 3 liters.

To drive the hydraulic pumps, the micro hydraulic power pack uses either 150 to 800 watt DC motors.

Mini Power Pack Units

The mini hydraulic power packs are suitable for mobility applications. They are slightly larger than the micro power pack units.

A mini hydraulic power pack

Due to their size, they are also referred to as small hydraulic power packs or small hydraulic power units.

They are available in different configurations such as horizontal or vertical mounting with a reservoir tank capacity ranging between 0.8 and 30liters. It uses a DC 0.8kW to 4.0kW motor, or AC 0.75kW to 7.5kW motor. The voltage of DC motors is DC 12V/24V or DC36v/48v, and the voltage of AC motors is AC 110V/220V/230V/380V/415V.

Standard Hydraulic Power Pack Units

The standard hydraulic power pack units are designed for in-plant operations. They are mainly used for industrial applications.

Such hydraulic power packs create huge power and high flow rates. They can handle heavy loads for a long period of time.

Standard Hydraulic Power Pack Units

The standard hydraulic power pack units are designed for in-plant operations. They are mainly used for industrial applications.

Such hydraulic power packs create huge power and high flow rates. They can handle heavy loads for a long period of time.

Hydraulic Power Unit Stations

The Hydraulic power unit stations are designed for specific applications. These may include sewage treatment, construction and mining applications, just to mention a few.

The Hydraulic power unit stations are designed for specific applications. These may include sewage treatment, construction and mining applications, just to mention a few.