

# Material Handling Equipment using Air Operated Conveyor and Pick Place Mechanism

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**Abstract**— Selection of suitable material handling equipment for typical conditions and material handling environment is found to be a multi-criteria decision-making problem. The selection procedure is found to be unstructured, granule particle. The optimal material handling equipment under a specific handling environment. The high flow material conveying vacuum pumps provide a simple, reliable and cost-effective method of in-line transfer of bulk materials, complex shapes, individual objects, and selvage. The input pressure to adjust and control the transfer speed.

**Key words:** Air Operated Conveyor, Pneumatic Pick and Place Mechanism, Rotary Actuator, The Vacuum Generator

## I. INTRODUCTION

In the engineering field, machines use the compressed air to develop the motion for various applications. A system which is operated by compressed air is known as the pneumatic system.

### A. Pneumatic components

In the engineering field, the pneumatic systems are used in industrial automation are usually powered by compressed air. The Pneumatic system uses a cylinder that is typically controlled via manual, air-piloted valves or solenoid valves.

### B. Air compressor

It converts the mechanical energy of motors or engines to potential energy of compressed air. The task performed by a compressor is the same as the cycle pump instead of using a motor.

### C. F R L Unit

The F R L unit is a filter which regulates and lubricates the fresh air into the pneumatic components. The compressed air should be filtered in the range from 5 to 40-micron level and the regulated air pressure in the unit should be maximum of 5 bar and the minimum oil level should be collapsed to pressurized air for the effective work of the pneumatic components.

### D. Pneumatic pipes

The hollow polyurethane pipe transfers the air from one component to another component.

### E. Control valves

There are two types of control valves. One is flowing control and another one is direction control valve. The flow control valve is used to control the volume of air flow in the system and the direction valve controls the direction of flow in the system.

### F. Pneumatic cylinder

Pneumatic cylinder is the mechanical device, which uses the compressed air to a reciprocating linear motion. It is basically

of two types, Single acting cylinder, and double acting cylinder.

## II. BACKGROUND IDEA

For designing a system for material conveying and material handling, work is divided into three parts.

- 1) Study of material conveying mechanism
- 2) Study of material handling and vacuum generator
- 3) Study of Rotary actuator mechanism.

### A. Study of material conveying mechanism

#### 1) Study of mechanical conveying system

The material conveying system is the material transport the one place to another place in which the with or without the human involving system. The conveyors especially transport small or bulk size materials. Which is used in the material handling and material packing and large size quantity assembly industries Many conveying systems are used to the different application on the industries. But all over the mechanical conveying system, is pneumatic conveying system is very economical and efficient process.it has the very less moving parts in the system and power consumption compared to another process.

Types of mechanical conveying system

- 1) Salt/Apron
- 2) Ball conveyor
- 3) Chain conveyor
- 4) Beltless magnetic conveyor
- 5) Bucket conveyor
- 6) Chute conveyor
- 7) Overhead conveyor
- 8) Roller conveyor
- 9) Screw conveyor

#### 2) Introduction of Pneumatic conveyor

The pneumatic conveyor is the material handling system, which is used to the air pressure or vacuum pressure.



Fig. 1: Air operated conveyor

Transport the materials or item through the closed tubes or duct tubes along the surface. Pneumatic conveyors are used to collecting the dust, paper partials, chemical powders, granules, food industries. They can transfer the metallic or non-metallic partials. They can also transfer the various size and different shapes, for the requirement of the conveying system.

3) *The principle of air operated conveyor*

Air operated conveyor have the no moving parts, conveys air at the high velocity for long distance. The high vacuum is created inside the conveyor due to the low pressure of air supply. Then the material should be suction from the reservoir to the delivery transfer the place.

4) *Sequence of operation*

- 1) The air operated conveyor is connected to the air compressor
- 2) The direction control valve has controlled the flow of air directions
- 3) To actuate the conveyor by low-pressure air created
- 4) The required material should be to transfer one place to another place.

5) *Selection of air conveying parameters*

- Material properties
- Conveying distance
- Available of air pressure and velocity of air
- Transfer capacity
- Transfer rate

6) *Advantages of the pneumatic conveying*

- Energy efficient
- Easy to operate and install the system
- Increase the plant efficiently
- Lower material costs

7) *Application of air operated conveyor*

- Venting gas
- Hopper loading
- Package filling operations
- Material transfer
- Food industries
- Transfer the coal in power plants
- Abrasive or corrosive chemical industries

Technical data of air operated conveyor

- Operating media : Filtered compressed air
- Mounting position : Fixed at the angle
- Max. vacuum level : 85%
- Operating pressure : 3.5 to 7 bar
- Ambient temperature : 0- 80 °C

B. *Study of material handling and holding devices*

Material handling equipment is the mechanical device that is used to the transfer and stores the materials in the manufacturing system.

1) *Major four categories of the handling device*

- a) Transport device
  - Conveyors
  - Cranes
  - Industrial trucks
  - Fork lift
- b) Positioning device
  - Industrial Robot
- c) Unit load formation device
  - Four-way pallet
  - slip sheet
- d) Storage device
  - Warehouse
  - Racks
  - Automatic storage

2) *Pick and place the mechanism*

The pick and place processes are the primary operations of the industries and household application in recent trends.to grasp or hold the material or object in the one place to another place to move they using the external source of energy. They used the pneumatic system for the pick place operation to control by using the programmable logic controller device. They used to operate the pick and place mechanism by the action of the linear motion of the movement by the pneumatic cylinder in the piston rod. They used in the two double-acting pneumatic cylinder in mutually perpendicular.

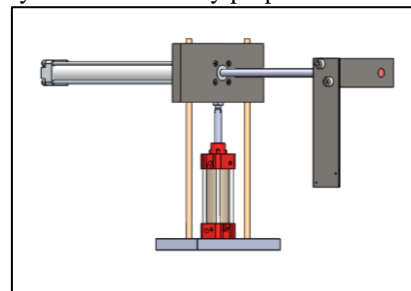


Fig. 2: Design of pick and place mechanism

The vertical positioning cylinder is the up and downwards operation by the action of the supplied the compressed air through the direction control valves. Similarly, the horizontal positioning cylinder is used to the forward and reversed the action of the sequence operations. The pick and place mechanism is operated by the rectangle work envelope operations. They also are known as the horizontal cylinder is named by 'A' and vertical cylinder is named by cylinder 'B'.

Technical specification of the horizontal pneumatic cylinder

- Cylinder bore : Ø 32 mm
- Standard stroke length : 300 mm
- Medium : Compressed air
- Working pressure : 0.5-10 bar
- Working temperature : 5-60°C
- Material : Aluminium

Technical specification for the vertical pneumatic cylinder

- Cylinder bore : Ø 50 mm
- Standard stroke length : 50 mm
- Medium : Compressed air
- Working pressure : 0.5-10 bar
- Working temperature : 5-60°C
- Material : Aluminium

Sequence operation of pneumatic cylinders

Sequence	Cylinder 'A'	Cylinder 'B'
Position 1	Ideal	Extract
Position 2	Extract	Ideal
Position 3	Ideal	Retract
Position 4	Ideal	Extract
Position 5	Retract	Ideal
Position 6	Ideal	Retract

a) Selection of pneumatic cylinders

- Single or Double acting
- Force to be extract
- Distance to be moved
- Air pressure available
- Ambient temperature
- Speed of actuation

- b) The advantage of pneumatic cylinder
- Safety and easy to operate
  - Clean and dry air
  - Lightweight to compare the other system
  - Low maintained
  - Cost-effectively

3) *Study of the vacuum generator*

A vacuum generator has produced the level for the required handling task. The vacuum should be created by using electrically or pneumatically but the system used to the pneumatic operations.

4) *The principle of a vacuum generator*

The vacuum generator should be operated according to the venturi principle. The compressed air is connected to the ejector portion of the vacuum generator. In this section to reduce the cross-section of the venturi nozzle the compressed air is accelerated. The dynamic pressure increased while the static air pressure simultaneously decreased. The air is 'sucked' the vacuum connection into the ejector. The compressed air escape from the ejector through the silencer.

5) *Design of vacuum cup*

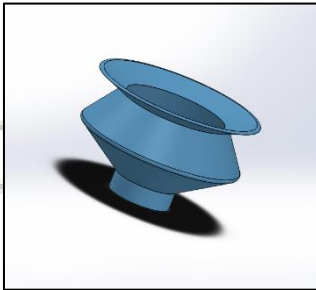


Fig. 3: Design of vacuum cup

The vacuum cup or suction cup are used in the gripper in manual or automatic handling applications. The vacuum cup is produced by rubber or silicon materials.

6) *Design of vacuum generator*



Fig. 4: Design of vacuum generator

The venturi vacuum generator effectively used compressed air to generate a vacuum. The venturi is compact with there are no moving parts. These venturi devices should be created by 0.8 to 2 CFM vacuum flow and the compressed air is 80 PSI is supplied to the system.

7) *Technical specification data for vacuum generator*

Air consumption (cfm)	: 1.8
Vacuum flow (cfm)	: 1.812
Orifice size (mm)	: 1
Air inlet & Exhaust port (BSP)	: 1/4"

C. *Study of Rotary actuator mechanism.*

The pneumatic rotary actuator is commonly used to convert the compressed air into rotary motion.

1) *Design of pneumatic rotary actuator*

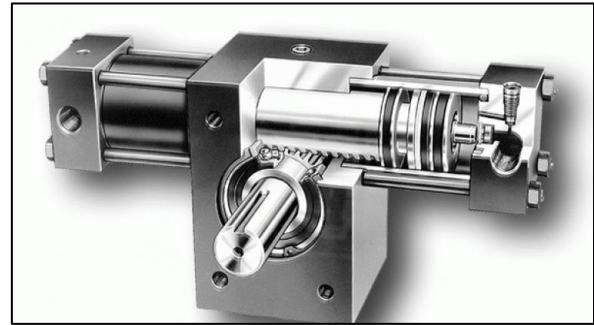


Fig. 5: Design of rotary actuator

A pneumatic rotary actuator is a device an actuator that produces a rotary motion or torque. The actuator is used the pneumatic power to drive the system. The convert the compressed air into cylinder stroke and continues to the oscillating the rotary motion.

2) *Classification of the rotary actuator*

- Vane type
- Rack & pinion type
- Screw type
- Crank type
- Wheel gear & chain type

a) *Vane type*

The vane type is used to operate the pneumatic air pressure that operates the fixed wall installed on the cylinder.

Angle of rotation

Single vane	: 270° to 300°
Double vane	: 70° to 120°
Triple vane	: below 60°

b) *Rack & pinion type*

The centre that is geared to the Rack gear linked directly to the piston, torque is applied. The horizontal thrust on the backside of gear occurs will be the efficiency of 80° to 90° could be obtained.

c) *Screw type*

The linear movement changes to rotational movement by the crank. They only limited angle should be rotated. The efficiency ratio is about 80%.

d) *Crank type*

The linear movement changes only at the rotational movement by the crank operation. They only rotated at 110°.

e) *Wheel gear & Chain type*

The chain linked is connected to the piston arrangement in parallel is geared to the wheel gear with the built in the oil on the part linked to the wheel gear. The efficiency is more than 90% is possible.

3) *Selecting of the rotary actuator*

Size of the load to actuate

- 1) Required torque when static power is required
- 2) Changes are in load weight

Required allowed energy

- 1) Calculation of the angular velocity
- 2) Calculation of the inertia energy of the load

4) *Technical specification for a rotary actuator*

Material	: Anodized aluminium
Torque	: 7 Nm
Bore size	: 28 mm
Operating media	: Compressed air
Type of operation	: Double acting

- Operating temperature : 0 to50 °C
- Rotation angle : 180°
- Weight applied force : 2.890 kg

5) *Design of the material storage tank*

The material storage tank should be produced for the storage the material in certain quantity and time of operation to be stored the materials in the storage tank.

- a) The requirement of the storage tank design
  - Less weight of the storage tank
  - No corrosion and abrasive
  - It should be don't bend in the material storage time
  - Easy to grasp the vacuum gripper

III. CONTROL SYSTEM

In this pneumatic system is controlled by the direction and flow control of the air circulating system.

A. *Types of valves used*

- Poppet valve
- Solenoid operated poppet valve
- Non return valve
- Safety valve

1) *Poppet valve*

The direct pilot operated valves can be used with air media where quick, positive control is required. With optional seals, they require no lubrication, making them ideal for non-lube air service.

- a) Application
  - Air compressors and controls.
  - Industrial air dryers and controls for auto drain purpose.

b) *Solenoid operated poppet valve*

The solenoid operated poppet valves can be used with air media where quick, positive control is required. With optional seals, they require no lubrication, making them ideal for non-lube air service.

- c) Application
  - Industrial air dryers and controls for auto drain purpose.
  - Utility facilities for controlling the flow of gasses.
- d) Non return valve
  - Opens a very long cracking pressure and close at a low differential open high pressure.
  - The valve will only in one direction.

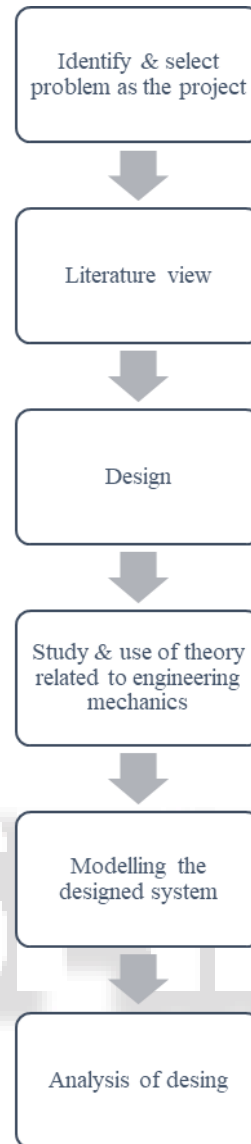
- e) Application
  - Air compressor and controls.
  - Industrial air dryers and controls

2) *Safety valve*

Safety valve or pressure relief valve is an automatic pressure relieving device that is mounted on a pressurized system to relieve the system of excess pressure when abnormal operating conditions cause the pressure the exceed a set limit.

- a) Application
  - Food and Beverage Industry
  - Chemical Industry
  - Petrochemical Industry

IV. WORK METHODOLOGY



V. RESULT

The specified materials should be followed by the velocity of the material conveying.

MATERIAL	VELOCITY IN (FPM)
Powered coal	4000
Cement	7000
Sand	7000
Sawdust	4000
Wheat	5800
Oats	4500
Corn	5600
Sugar	6000
Flour	3500

The following material should be conveyed by the air operated conveyor to transfer the materials.

VI. CONCLUSION

Pneumatic conveyors are a popular choice among many industrial facilities because of their efficiency, reliability and easy access for cleaning. Pneumatic conveying reduces dust

and protect materials from contamination during transfer, making it one of the best solutions to the problem of how to move material. From agriculture to food processing to chemical engineering and beyond; pneumatic conveyors are relied upon every day to complete important functions and safely transfer products that end up in our homes and workplaces.

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