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A REVIEW ON LOW COST AUTOMATION USING PNEUMATIC SYSTEM - A CASE STUDY ON USE OF PNEUMATIC GRIPPERS AND PNEUMATIC POWER CLAMPS

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ABSTRACT

Globalisation is taking place at very high pace. Industries are getting automated to compete in the market. This paper emphasizes on Low cost automation (LCA) using fluid power i.e. pneumatics. This paper also involves case studies of various industries which got automated or solved their problems using pneumatics as low-cost automation. Pneumatic technologies are compact, easy to handle and also safer to use. This Paper provides the usage of various pneumatic technologies in transfer lines, working stations etc.

Keywords:Computer Numeric Control (CNC), Fluid Power System (FPS), Pneumatics, Pneumatic grippers, Pneumatic clamps, Low cost automation (LCA), Vertical Machining centre (VMC)

I.INTRODUCTION

Automation is a set of technologies that results in operation of machines and systems without significant human intervention and achieves performance superior than manual operation. It means to minimize the human control in industry or any work field to increase productivity, increasing product quality, reducing manufacturing time, reducing cost and increasing safety in working operations[1].

With increasing globalisation, industrialization and increasing demand of certain products in market, Industries are concentrating on more and more automation by different methods to increase productivity and to increase competitiveness in the market. Automation requires huge capital investment to replace conventional machines by CNC's, VMC's etc. Large Scale Industries which do have large scale production and sells can afford huge cost automation. But Medium and Small-Scale Industries which do not have that much production cannot afford such huge cost automation, at such case alternative Low-CostAutomation(LCA) proves to be best solution.

Low Cost Automation (LCA) is the technology that is effective or promises to be helpful for any kind of manufacturing organisation.

1.1 Concept of Low Cost Automation (LCA)

Automation means to replace human control through machines and technology. This includes automation in any unit i.e. storage systems, production lines, assembly lines, Software etc. Low Cost Automation (LCA) is defined as technology that creates some degree of automation using existing tools, methods and equipment. Low cost automation involves the introduction of standard equipment, mechanisms and devices to convert manual operations to automatic ones. Investment cost is low, as the term itself implies, and the Return of Investment in terms of improved productivity and better work efficiency is high. LCA may best be paraphrased as "simple automation" Jigs, fixtures, drills etc are the few tools used in LCA.

1.2 Low Cost Automation (LCA) can be achieved by following methods-

- Using mechanical tools or apparatus i.e. using shafts, gears etc.
- Using fluid power I.e. pneumatics and hydraulics
- By electrical or electronicmeans

1.3 Fluid power and its scope in low cost automation

Fluid power means using pressurized gas or liquid in a confined space to control force or to achieve certain movement of the mechanical element. Fluid power consists of pneumatic and hydraulic systems. Pneumatic system makes use of compressed gas for performing the work whereas in hydraulics pressurised liquid, oils, petroleum etc is used for performing the work.

1.4 Merits of using fluid power system

- Fluid power is easy to produce, transmit, regulate, control and can be operated easily.
- Low weight to power ratio.
- Multiplication and variation of forces.
- Frictional resistance is less.
- Noise and vibrations produced is minimal.
- We can start, stop, accelerate, decelerate, reverse or position change with great accuracy using simple levers and push buttons.
- Economical
- FPS can be used where safety is of vital importance. [2]

II. CASE STUDIES

2.1 Low cost automation using pneumatic grippers for pick and place

Gripping means to hold the object firmly. To move the object from one place to another it is needed to grip that object. Traditionally, in industries the products are transferred by gripping the products by labours. This mean is very time consuming and costly so it is needed to atomised. It can be automated by using gripping system actuated mechanically, electrically, pneumatically etc

2.1.1Pneumatic actuation of gripping system

This type of actuation is frequently used for gripping systems, due to its advantages:

- Simple control schemes;
- Possibility of system overloading;

- Easy maintenance;
- Environment-friendly working medium;
- Easily adjustable torques, speeds and forces, by means of simple devices;
- Pneumatic transmissions allow damage-free frequent starting and stopping, as well as sudden changes of direction;
- Compliance etc.

The structure of a pneumatic actuation system generally includes a source of compressed air (compressor), an air preparation system (filter, pressure regulator, and lubricator), adjustment and control elements of the pneumatic quantities and final consumers(motors) that transform the input pneumatic energy into useful work.

2.1.2 Case study on pneumatic gripper used for Low Cost Automation

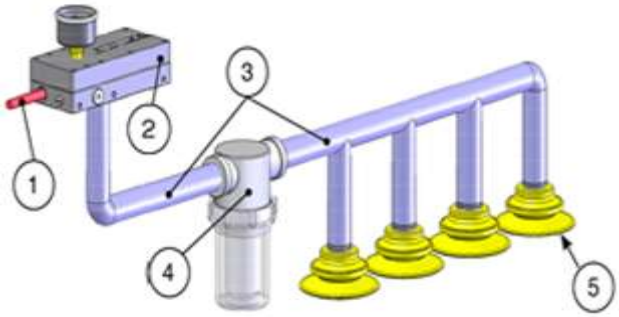
Problem definition

The Solar Panel manufacturing company was facing the problems in transferring the solar panels from one station to another. The solar panel are made up of glasses and it is very delicate, so most of the time while transferring, it was breaking. The company was breaking more panels than they were manufacturing. Also, they were facing the problem of transferring the huge dimensioned solar panel. The 14" diameter parabola shaped glass bowl solar panel they made was very delicate so every time while transporting, it was either being dropped or being squeezed to their breaking point. They were disappointed with the downtime and broken product they had suffered with what had been commercially available. Most available grippers in the market was not able to handle the fragile glass. Also, the magnetic pick and transport is not possible as the glass is not magnetic. So, they turned to pneumatic grippers which can grip the glass with the help of compressed air and can transport it with ease. And due to breaking of glasses it caused many injuries to workers like cuts etc. which created unsafe working conditions for workers.

Solution

The Pneumatic grippers were used which is specifically a type of pneumatic actuator that involves either a parallel or angular motion i.e. the 'tooling jaws, fingers or rubber suction diaphragm' that will grip on object. In pneumatic grippers, the vacuum is created in the rubber cups by creating pressure difference with the help of the force from the compressed air by compressor. The gripper is placed directly on a product and with vacuum generation the rubber cups creates sucking action which in turn grip the object firmly and tightly. The 14" parabolic shaped glass bowl solar panel is gripped firmly and is being transferred from one station to another with ease and without breakage. Thus, the loss of company due to breaking is minimized by automating the transfer line of the company using pneumatic gripping system.

Fig 1.- Image showing lifting of solar panel using pneumatic gripper



1)Air line 2) Compressor and vacuum generator 3) Vacuum line 4) Filter 5) Suction cups

Fig. 2- Image showing use of pneumatic grippers in other industries

Fig. 3- Components of Pneumatic gripping system

2.1.3 Results

1. Breakage of the solar panels got reduced.
2. Ease in transfer of solar panels.
3. Production rate increase.
4. More safe working conditions.

2.2 Low Cost automation using pneumatic power clamping system for machining processes

Power clamping is a phenomenon in which number of clamps can be operated simultaneously. It is classified as

1. Fluid power clamping.
   a. Pneumatic actuation clamping
   b. Hydraulic actuation clamping
   c. Air to hydraulic booster circuit clamping
2. Magnetic clamping
3. Electrostatic clamping

2.2.1 Pneumatic Actuation Clamping

- Compressed air is used for power transmission
- Depressurized air is exhausted directly into atmosphere
- As load resistance increases speed of pneumatic devices drops and vice versa.

- Moisture in air causes rusting of pneumatic cylinders and valves which can be minimized by using lubricator
- Pressure regulator can be used to vary system pressure. [3]

2.2.2 Construction and Working

- It consists of three stations
- At first station, the power in the form of pneumatic pressure (6-12 bar) is produced through pressurized air system
- Pressurized air system consists of following components
    a. Air inlet
    b. Filter, lubricator, regulator device
    c. The safety valve and release valve
- The second station of the system consists of hydraulic booster consisting of booster, check valve and manifold.
- The third and final station is clamping system to hold, support and support the workpiece.

2.2.3 Advantages

- Increased production rate
- Controlled clamping forces
- Automatic sequencing of operations
- Remote clamp operation
- Consistent and repeatable operation
- Automatically adjusting work support

2.2.4 Case Study on pneumatic power clamping system for low cost automation

Problem definition

In industry a plastic filter core was needed to be trimmed, drilled in length and ends to be reamed. The machining on the plastic filter core was to be done on three separate working stations.so transferring the work pieceafter each operation was very time consuming. Also, the set-up and material movement time resulted in a bottleneck. As all the machining operations were done manually, many errors were present and the required precision was not achieved. Also, as all operations were done manually so quality of the product was an issue. Quality, slow production rate and low precision were the problems of the industry.

Solution

There is a machine that would perform the required operation of trimming, reaming, drilling etc. The machines consists of the grippers mounted on the slides, take the 12” long core blank and placed it on the first station of operation. The pneumatic hold-down clamps hold the tube blank firmly and the pneumatic clamp with a knife blade mounted on the clamp arm, cuts the end of the tube at precise length. Then grippers grip the work piece and then with the help of the sliders it is moved to the next station where it is drilled along the length. Then, again with the help of the grippers and the sliders the work piece is moved to the final station where the inner diameter of the tube is reamed on both ends. Pneumatic swing clamps hold the tubes during the operation.

Fig. 4 - Pneumatic toggle clamp

Fig 5 - Pneumatic swing clamp

Fig. 6 - Image of pneumatically clamped workpiece undergoing drilling

2.2.5 Results

1. Working speed and rate increases.
2. Clamping is tight and firm. So, ease in operations.
3. Précised job is done.
4. Quality of the job is increased.
5. Safety of the workers.

III. CONCLUSION

The requirements of the industries like high productivity, low cost, etc. can be fulfilled by automating the industries using pneumatics i.e. by using pneumatic grippers and pneumatic power clamped system at a very

low cost. This technology is also portable and reliable as it has very small machine structures and can give the large tonnage. Apart from this it also provides safety to the workers.

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