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Selection of Actuation Drive for Automation of Food Packaging Process

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ABSTRACT

All major industries create wealth but if there is one industry that plays a unique role by way of both creation of wealth through a wide range of manufacturing activities and also by way of preserving the wealth or value created by many, many other industries, it is packaging - primary as well as secondary. The paper deals with the selection of drive or means of actuation for design of special mechanism for secondary packaging of strips of snack packets in carton. The problem comes under the category of secondary packaging or end of line packaging where a mechanism has to be selected for stacking primarily packed strips of packets in carton. The selection of drive depends on different parameters and feasibility of it for particular task.

Keywords: Mechanism, Automation, Packaging

I. INTRODUCTION

In India, the major thrust in research and development in the agriculture-food sector has been on the processing of food rather on developing equipment in this sector. But now with the food processing sector being identified as a high priority industry in India, the processing as well as packaging equipment sector is also gaining importance. Major research and developments are taking place in the packaging equipment sector as a consequence of the thrust in the food processing sector as a whole.

In India [1], packaging machinery manufacturers find most of the demand for their products in the food processing sector. Approximately 50% of the packaging machinery and materials produced is absorbed by the food processing sector, personal products (10%), the tea and coffee industry (10%), and industrial products account for the remaining portion of the demand.

Another factor, which has provided substantial stimulus to the packaging machinery industry, is the emphasis on the rapid growth of exports. With this, the need for adopting better packaging methods, materials and machinery to ensure quality, has become very urgent for Indian food products in the international market, which demands high quality standards.

The process of food packaging has been broadly categorized into two types:

- Primary packaging is the material that first envelops the product and holds it. This usually is the smallest unit of distribution or use and is the package which is in direct contact with the contents.

- Secondary packaging is outside the primary packaging; perhaps used to group primary packages together, used for bulk handling, warehouse storage and shipping. The most common form is a palletized unit load that packs tightly into containers.

This kind of packaging is also known as “end of line” packaging. The end of line packaging is when the “formed, filled and sealed” product is to be further packed into a carton/container/cardboard box which is done at the end of line. “End of line” packaging or “secondary packaging” play a vital role in packaging

industries. Many special purpose machines have been patented for stacking/sorting of primarily packaged food in cartons/cardboard boxes.

So in this paper one such problem of the need of identifying drive for automatic packaging machinery for packing strips of snack packets in carton is dealt. The problem comes under the category of secondary packaging or end of line packaging where a special mechanism has to be developed for stacking primarily packed strips of packets in carton.

II. METHODS AND MATERIAL

The manual process of stacking/ case packing of strips of snack packets in cartons/cardboard boxes is to be automated. The snack packets leave the conveyor belt in the form of 6 packets per strip which is then processed manually. As the time required by workers to complete the process is much, it leads to production loss. So there is a need to develop an automatic mechanism which packs the strips of snack packets in the carton without any human intervention.

The input parameters to the problem are as follows:

- The packets of snack are received in the form of 6 packets per strip which means around 100 snack packets are received at the conveyor end/ minute.

Figure 1 : Strips of packets received at the conveyor end

- The capacity of the single cardboard box is to contain 9 strips of 6 packets per strip i.e. 54 packets.
- The strips of packets are placed in the container/carton/cardboard box in a zigzag manner without separating each individual packet from the strip.
- Each zigzag strips are placed side by side and then one over another manually after receiving them at the conveyor end and in this way boxes are filled/stacked with snack packets for shipping.

Figure 2 : Strips of packets placed in box

The packaging process is divided into two phases.

- 1st phase: Converting the strip into zigzag form.
- 2nd phase: Placing the zigzagged strip into the box in correct position without losing its zigzag form.

The drive for required actuation can be chose amongst the following:

1. Pneumatic drive
2. Hydraulic drive
3. Electromechanical drive

The drive identified for the successful solution of the problem as per Table I is: [2]

Pneumatic cylinder actuators

A pneumatic system is a system that uses compressed air to transmit and control energy. It is the best suited for food industry as the operation of pneumatic systems does not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness.

III. RESULTS AND DISCUSSION

TABLE I
COMPARISON OF PNEUMATIC CYLINDER ACTUATOR WITH OTHER ACTUATORS [3]

Features	**Comparison between available options**		
	Pneumatic	**Hydraulic**	**Electro-mechanical**

Overload safe	***	***	*
Easy to limit force	***	***	*
Easy to vary speed	***	***	*
Speed	***	**	**
Robustness	***	***	*
Installation cost	***	*	**
Ease of service	***	**	*
Reliability	***	***	***
Safety in damp environments	***	***	*
Safety in explosive atmospheres	***	***	*
Safety risk with electrical installations	***	***	*
Risk of oil leak	***	*	***
Clean, hygienic	***	**	*
Standardised measurement	***	***	*
Service life	***	***	*
Hydraulic system required	***	*	***
Weight	**	**	**
Purchase price	***	**	*
Power density	**	***	*
Noise level during operation	**	***	**
High force for size	**	***	*
Positioning possibilities	*	***	***
Total energy consumption	*	**	***
Service interval	*	*	***
Compressor capacity required	*	***	***

*=good, **=average, ***=excellent

It is a knowledge that any system must consist of a group of components which work together to perform a task. A pneumatic system consists of a group of pneumatic components connected together so that a signal (compressed air) is passed through the system to make something happen at the output. This group of components can be divided into five categories according to their function in the pneumatic circuit as follows: [2]

1. Supply elements: These elements are the sources of power that drives the system which are the compressors.

2. Input elements: These elements are used to send signals to the final control elements and come in two forms; either as components that is actuated by the operator like push buttons or sensors that determine the status of the power elements such as limit switches and proximity sensors.

3. Processing elements: These elements may perform operations on the input signals before sending the signal to the final control elements such as nonreturnable valves, directional control valves and presser control valves.

4. Final control elements: To control the motion of actuators such as directional control valves.

5. Power elements (actuators): These are the outputs of the pneumatic system which use the stored potential energy to perform a certain task such as pneumatic cylinders and motors.

The advantages of pneumatic systems are as follows:

Pneumatic control systems are widely used in our society, especially in the industrial sectors for the driving of automatic machines. Pneumatic systems have a lot of advantages. [4]

- High effectiveness: Many factories have equipped their production lines with compressed air supplies and movable compressors. There is an unlimited supply of air in our atmosphere to produce compressed air. Moreover, the use of compressed air is not restricted by distance, as it can easily be transported through pipes.

- High durability and reliability: Pneumatic components are extremely durable and cannot be damaged easily. Compared to electromotive

components, pneumatic components are more durable and reliable.

- Simple design: The designs of pneumatic components are relatively simple. They are thus more suitable for use in simple automatic control systems.

- High adaptability to harsh environment: Compared to the elements of other systems, compressed air is less affected by high temperature, dust, corrosion, etc.

- Safety: Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded.

- Easy selection of speed and pressure: The speeds of rectilinear and oscillating movement of pneumatic systems are easy to adjust and subject to few limitations. The pressure and the volume of air can easily be adjusted by a pressure regulator.

- Environmental friendly: The operation of pneumatic systems does not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.

- Economical: As pneumatic components are not expensive, the costs of pneumatic systems are quite low. Moreover, as pneumatic systems are very durable, the cost of repair is significantly lower than that of other systems.

IV. CONCLUSION

With the above selection of drive automated mechanism can be developed using pneumatic cylinder actuators of various specifications available in market. Thus strips of packets can be packed automatically in the carton without any human intervention. Among all the drives available, the pneumatic drive selected is clean, hygienic and best suited for food industries.

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