DESIGN OF AN ELECTRO SYSTEM FOR PACKAGING SEALING PROCESS IN DAIRY FACTORY " El LABRADOR " 2015-2016

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Abstract**.** The present work was made with the purpose of designing an electro-pneumatic system for a machine prototype test sealed packaging for dairy factory " El Labrador " , commanded by a PLC and will be implemented in the Laboratory of the Engineering in Electrical Maintenance ; in order to improve methods of student learning in the field of industrial control , so that further expand their knowledge in different areas of study and knowledge gained in the classroom implement them performing laboratory tests on the prototype

I BACKGROUND

The creamery " El Labrador " is located in the province of Carchi, canton Mirror, parish of San Isidro. This aims at the development and distribution of dairy products, and it makes packaging processes and sealing of milk and its derivatives.

In this factory, the process of sealing containers of yogurt is essential to ensure proper conservation and distribution of products. However , the techniques used for this process do not have an automated system to avoid wasting time and to dispatch all orders placed , a process that helps supply the requirements of the products in the shortest possible time with high quality and production efficiency

A. General Goal

Designing a training module for an electro-pneumatic system that will uncover the optimization of the production process of sealing containers of yogurt in the dairy factory " El Labrador "

B. Justification

Currently pneumatic systems are a great help for process automation in industries. The air within industrial automation has become a very useful tool. Through pneumatic components, it is given simpler, more profitable and future industry application solutions.

By using this type of technology which can be operated by the person who is responsible and allocates a certain area, help improve production in less time.

This project will be aimed at improving the factory so that help optimize time, performing sealing work more driveability and a high degree of quality.

II DIAGNOSIS OF CURRENT SITUATION OF THE FACTORY

The company currently performs the work of sealing the packages manually or traditional way, which leads to production is not greater than the defendant.

Table 4

Sealed data processed products not automated.

	Production	**Time**	**Time**
Liter containers	40	daily	15 minutes
Small packages	100	daily	1 hour
Small packages	500	weekly	5 hours

III SELECTION OF ELEMENTS ELECTRICAL, ELECTRONIC, TIRES, AND MECHANICS.

A. Module Operation

1) The conveyor belt performs the transport of containers in a continuous and regular basis.

2) When the sensor located opposite the cylinder B detects the presence of container, this cylinder pushes the container to the sealing position.

3) When the package is located in the proper sealing position sensor cylinder A perform the sealing process while the cylinder B is retracted to advance the sealed container.

4) The sealed container and advances from the side until the cylinder C sensor push it out for a rail where all already sealed containers for final review will be stored.

B. Design parameters of the conveyor belt

- Diameter transport container
- Band length
- Productivity System
- Diameter of drums
- Maximum weight per package
- Number of packages within the band

For the construction of the conveyor belt iron material was used for part of the structure, also as for mechanical parts and bearings.

It has been made perforation a part of the structure horizontally so serves as guides for tuning the conveyor.

Figure 1: Drilling to adjust the band

As illustrated here is building one of the rollers of the conveyor, the same will have a longer axis of which is coupled to a pulley and a rotating side which will be coupled to the motor. The other roller is so performed in the same way with the difference that their axes are the same length, this roller will be the anger in the space where the guide conveyor belt adjustments were made.

Figure 2: Design of the roller shaft to the gear motor

As shown in figure 3, before attaching the bearings to the structure proceeded to conduct verification with each of the rollers to avoid any inconvenience later.

Figure 3: Check roller shafts for bearings

Once it verified that all elements are in perfect condition they proceeded to assemble the bed of the conveyor belt

Ilustración 4: Ubicación de elementos en estructura principal

Finally, we proceeded to locate the nylon band in the structure and to make the respective settings of each of its elements.

Figure 5: Location of the conveyor belt

C. Selection of electrical and electronic pneumatics

Selecting the cylinder B

To select the cylinders was taken into account that the first will be to push the package through the sealing position, with this in mind that will need to calculate a required clamping force for both

Table 5

Experimental data for calculating the cylinder B

Pressure	6 (Bar)
Strength	unknown
Frictional force	90%
Diameter	25mm

$$F = P.A = 10.p.\pi\left(\frac{d^2}{4}\right).n$$

We replace values

$$F = 10.(6|bar|).\pi\left(\frac{(2.5cm)^2}{4}\right).(0.9)$$

$$F = 265.07\ (N)$$

With the strength obtained 265.07 [N] can select a cylinder with a diameter of 2.5 [cm] or 25 [mm] at a pressure of P = 6 [Bar] and 265 F = force [N] and one carrea 80 [mm].

En la siguiente tabla se detallan el modelo del cilindro:

Figure 6: Double-acting cylinder B.

Table 6

Specifications Cylinder B

Technical specifications	
Kind	Double acting Ø 32 ... 200 mm
Material	Aluminium alloy
Temperature	0°C a 70°C ~ 0°F a 158°F
Work pressure	1 a 9 Bar ~ 15 a 130 PSI
Cushioning	Pneumatics, dimmable
Fluid	Filtered compressed air, lubricated or non-lubricated

Selecting the cylinder C

The same calculation is performed taking into account that this will be in charge of taking the conveyor belt to the rail sealing storage container, the actuator must be greater than the previous race.

Table 1

Experimental data for calculating the cylinder C

Pressure	6 (Bar)
Strength	265 (N)
Frictional force	90%
Diameter	25mm

$$F = P.A = 10.p.\pi\left(\frac{d^2}{4}\right).n$$

Punting d we have:

$$d = \sqrt{\frac{4F}{10p.\pi.n}}$$

$$d = \sqrt{\frac{4(265)}{(10)(6)(\pi)(0.9)}} = 2{,}49\ [cm]$$

With the diameter obtained we can select I cylinder we will use, with a diameter of 2.49 [cm] or 24.9 [mm] at a pressure of P = 6 [Bar] and a force F = 265 [N] and career 200 [mm].

Figure 7: Double-acting cylinder C

Table 2

Specifications Cylinder C

Especificaciones Técnicas	
Kind	Double acting Ø 32 ... 200 mm
Material	Aluminium alloy
Temperature	0°C a 70°C ~ 0°F a 158°F
Work pressure	1 a 9 Bar ~ 15 a 130 PSI
Cushioning	Pneumatics, dimmable
Fluid	Filtered compressed air, lubricated or non-lubricated

Selecting the cylinder A

For the selection of this cylinder the following aspects will be taken into account, this cylinder will be in charge of making the covered container, taking into account that should be enough pressure to put the lid in place.

Tabla 3

Experimental data for calculating the cylinder A

Pressure	6 (Bar)
Strength	270 (N)
Frictional force	90%

Diameter	25mm

$$F = P.A = 10.p.\pi\left(\frac{d^2}{4}\right).n$$

Punting d we have:

$$d = \sqrt{\frac{4F}{10p.\pi.n}}$$

$$d = \sqrt{\frac{4(270)}{(10)(6)(\pi)(0.9)}} = 2{,}52\ [cm]$$

With the diameter obtained we can select I cylinder we will use, with a diameter of 2.52 [cm] or 25.2 [mm] at a pressure of P = 6 [Bar] and a force F = 270 [N] and career 80 [mm].

Figure 8: Double-acting cylinder A

Table 4

Specifications Cylinder A

Technical specifications	
Kind	Doble efecto Ø 32 … 200 mm
Material	Aleación de Aluminio
Temperature	-5°C a 70°C ~ 23°F a 158°F
Work pressure	2 a 9 Bar ~ 28 a 130 PSI
cushioning	resilient
Fluid	Filtered compressed air, lubricated or non-lubricated

Selecting maintenance unit

To choose the maintenance unit each of the elements to choose from and installed according to the specifications we analyzed a FRL, filter-regulator - lubricator was chosen.

Figure 9: Maintenance unit

Solenoid valves

The selection of the solenoid valves is performed using the data obtained when the dimension of the cylinders to be used, for which the solenoid valves 5/2 monostable type were chosen.

Figure 10*:* Solenoid valves 5/2 monostable

Table 11

Technical Data for valve 5/2

Technical specifications	
Model	5/2 solenoid valve
Operating pressure	0-8 Bar ~ 0-114 PSI
Fluid	Filtered compressed air, lubricated or non-lubricated
Work temperature	-5 ° C to 60 ° C ~ 23 ° F to 140 ° F
Answer time	0.05 seconds
Maximum cycling	5 Cycles / second
Material	Aluminum

Sensors

The sensors were chosen to occupy the network switch type sensors for its versatility, easy installation and cost. The work of this sensor is detecting the position of the pneumatic cylinder rod during operation of the machine.

Similarly photoelectric sensors which are going to be responsible for detecting the presence of the package during the sealing process was chosen.

Figure 11: Sensor reed switch

Table 12

Technical specifications of reed switch sensor

Technical specifications	
Contact	Normally open
Indicator	led top
Temperature	0 to 60 ° C ~ 32 to 140 ° F
Protection	IP 67
Voltage Range	5 ~ 380V AC , 240V DC 5 ~
Current Rating	AC 5 ~ 50 mA , 60 mA DC 5 ~
Vibration Resistance	10 ~ 50 Hz
Answer time	1ms
Cable length	2 Mts

Figure 12: Photoelectric Sensor

Table 13

Technical specifications of the photoelectric sensor

Technical specifications	
Kind	50x50 compact plastic body
Diffuse Range (m)	1
Scale polarized reflex (m) (With reflector accessory)	4
Scale background suppression (m)	0.4
Through-beam (m) (with accessory)	twenty
Dimensions (mm)	SS 50x18x50
Temperature	Relay 50x18x50

Pipeline

In this part the selection of the pipes performed taking into account the connectors to use with cylinders and other actuators type, making it proceeded to elect the hose in polyurethane. This type of hose for its flexibility, its duration, its weight q is very light and is ideal for pneumatic connections was chosen.

Figure 13: Tubería

Table 14

Technical data pipe

Technical specifications	
Fluid	Compressed air
Work pressure	0 to 10.3 Bar ~ 0-150 PSI
Vacuum pressure	-750mm Hg (10Torr)
Work temperature	0 ° C to 60 ° C ~ 32 ° F to 140 ° F

Fittings and mufflers

As the pipe is to use a hose fittings ¼ millimetric be used straight union, union elbow, union T, depending on the connection we wish to do likewise air mufflers were selected.

Figure 15: *Fittings*

Tabla 5

Especificaciones para los racores

Technical specifications	
Fluid	Compressed air
Work pressure	0 a 10.3 Bar ~ 0 a 150 PSI
Vacuum pressure	-750mm Hg (10Torr)
Work temperature	0°C a 60°C ~ 32°F a 140°F

Figure 16: Mufflers

Tabla 6

Specifications for mufflers

Technical specifications	
Fluid	Compressed air
Work pressure	0 a 10 Bar ~ 0 a 142 PSI
Vacuum pressure	zinc plated bronze
Work temperature	0°C a 70°C ~ 32°F a 158°F

Compressor selection

For compressor selection was guided in the different parameters were obtained by choosing the different cylinders which will be responsible for the job.

Figure 18: Compressor

Tabla 7

Technical data compressor

Especificaciones Técnicas	
Voltage	110 V
Frequency	60 Hz
Engine	550 W – HP: 0.75
Air Production	70 l/min
Air pressure	0.75 Mpa
Container volume air.	32 L – 7 Gal.
Noise	56-65 dB(A)
Weight	30 Kg
Dimensions	56x56x70 cm

Selection and sizing of conductors protection

To make the design of the electrical conductors we will build on the engine power that would be the biggest load within the system, for which tables specified electrical conductors where both current, permissible operating voltage and temperature were used.

For this we use the equation of electric power:

mechanical power

$$P = V.I$$

Where power P = W

Electrical power

$$W = V.I$$

Then as data have the engine power that is ¼ HP and voltage is 220 V will replace these values in equation 9 to calculate the current and determine the type of driver.

$$I = \frac{186.425\ W}{220\ V} = 0.846\ A$$

The following table shows the type of conductor according to the allowable operating temperature specified.

Tabla 8

Calibers electrical conductors

Amperaje que soportan los cables de cobre

Nivel de temperatura:	60°C	75°C	90°C
Tipo de aislante:	TW	RHW, THW, THWN	THHN, XHHW-2, THWN-2
Medida / calibre del cable	Amperaje soportado		
14 AWG	15 A	15 A	15 A
12 AWG	20 A	20 A	20 A
10 AWG	30 A	30 A	30 A
8 AWG	40 A	50 A	55 A
6 AWG	55 A	65 A	75 A
4 AWG	70 A	85 A	95 A
3 AWG	85 A	100 A	115 A
2 AWG	95 A	115 A	130 A
1 AWG	110 A	130 A	145 A
1/0 AWG	125 A	150 A	170 A
2/0 AWG	145 A	175 A	195 A
3/0 AWG	165 A	200 A	225 A
4/0 AWG	195 A	230 A	260 A

60°C	
SPT	
Medida / calibre del cable	Amperaje soportado
20 AWG	2 A
18 AWG	10 A
16 AWG	13 A
14 AWG	18 A
12 AWG	25 A

Tabla 19

Conductors and electrical protection

Protection and conductor sizes	
Schneider electric breaker	110 V a 2 A
Schneider electric breaker	220 V a 6 A
Contactor	24 VDC
Relays	24 V
Fuses	2 A
Guard engine	1.6 a 2.5 A
Power supply	24 V
Conductors	3x12 AWG concentric conductor Conductor # 22 AWG

Figure 20: Internal Control Panel view

IV VALIDATION MODULE DESIGN

A. Determination parameters

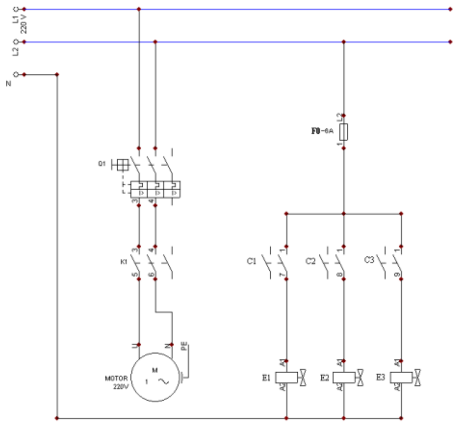
The parameters were set times and number of sealed containers, these data were taken with the training module already in operation stage.

Tabla 20

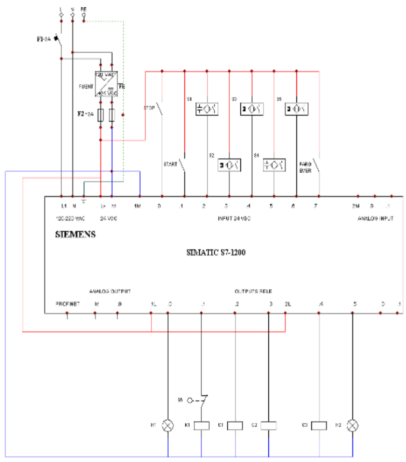
Comparison of results

Validation of the training module					
Before			**After**		
Minutes	15	40	**Minutes**	1.10	6
Hours	1	100	**Hours**	1	327
Weekly	5	500	**Weekly**	5	1635

A. Diagrama de fuerza



B. Diagrama de bloques



V CONCLUSIONS

With the construction of an automated packaging module sealing it is shown to be possible to automate this process on an industrial scale.

Automation package sealing process leads to increase the production capacity of the factory, by reducing processing time and reducing losses or waste default.

The implementation of the training module, will be very useful to expand and strengthen the knowledge of students of the School of Engineering in Electrical Maintenance in the area of electro-pneumatic control.

VI RECOMMENDATIONS

It is recommended that a periodic review of each element of the module, prior to its implementation to avoid possible damage during operation of the machine, keep in good condition and preserve the module sensors and pneumatic actuators.

Students would be wise to seek ways to expand the module by implementing new sensors or actuators.

Before operating the module and make changes should read the manuals for each of the equipment and programming manual developed in this paper grade to ensure proper operation of the instructions that are programmed into the PLC.

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