DESIGN AND CONSTRUCTION OF SEALING THERMAL LINE COVERS FOR CLOSE-EASY TERRAFÉRTIL COMPANY SA "

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I SUMMARY

This research arises from the need for resolving the sealing system covers the company closes easy Terrafertil SA, especially in the area of production and packaging, on the difficulty you have when not to use a sealing process continuous and adequate, the same as is done manually using sealing pedal, whose performance is not commensurate with production.

This machine comprises a control that is based on synchronization of multiple drive mechanisms, this new system is to replace an electromechanical control that requires excessive maintenance due to mechanical and electrical wear suffered machines. The system reduces the time of commissioning of the machine and enables the operator to change the production of one product to another, because it is not necessary to perform mechanical adjustments to give the length of the bag sealed.

II INTRODUCTION

The company Terrafertil SA has come to represent one of the pioneers at the national and international level, in the category of small and medium enterprises, whose social and economic activity is the development, production, and marketing of nuts and dried, intended for human consumption, ensuring their safety at each of its processes.

For the process, now sealed in the business of used sealing pedal, as shown in (Figure 1.1), with a throughput of 15 to 20 cases per minute and having a productivity so high it is difficult to control the tightness and aesthetic sealing sleeve to sleeve.

Figure: Current process sealing

For the preparation of each of these products the company is governed by several standards. They have even come to implement good manufacturing practices BPM's, in each of its processes, which begins with the careful selection of raw materials, in which providers are subject to evaluations of quality character.Then the transformation of matter that is channeled and implemented by the department of quality control, which are responsible for releasing batches of both raw material and finished product.

For product packaging doy pack bags are used which are prefabricated sleeves and are equipped with a closed-easy on top as detailed in Figure 1.2.

Figure: Composite Covers

III PROBLEM

Heat sealing is the most critical in the food processing industry, as this depends on the life of the product, but there are industries where this process is still done manually causing cosmetic problems and even more if affects the production time .

In the company the process of sealing covers closed-easy sealing is done by foot, where the pressure and temperature of sealants are not controlled, therefore can not guarantee tightness and product presentation.

It is producing a revolution with new technologies, of which increasing accuracy and reliability in the different processes obtain therefore the sealing of covers for closers easy wealth will improve productivity in the company, include that, thanks to new technologies, pollution control and occupational health is growing.

Developing this project a real need for a process to renew the local industry solution will be provided, as well as demonstrating the machines and processes they can be improved with technology and with high business vision.

IV GENERAL PURPOSE

Design and build a thermal sealing machine covers online closers easy to meet the needs of production, the company Terrafertil SA

V SPECIFIC GOALS

- Determine the variables involved in the sealing process to have a previous design of the prototype.
- Design and select different mechanical, electrical, and control elements to meet expectations initially raised design.
- Build and assemble each of the elements of the machine.
- Perform the various tests and adjustments for optimum performance of the sealant.

VI THEORETICAL BASIS

SEALING TECHNIQUES

For sealing plastics some methods used in industry, including you have used:

- Heat sealing
- Ultrasonic sealing
- Adhesive sealing

HEAT SEALING

The heat seal is to seal two overlapping portions of material, by using heat generated by heating elements on hot rods joining the portions of material.

Among its features are:

- Simple in implementation and use.
- It does not require sophisticated machinery and controls.
- It is low cost of implementation.
- Does not use solvents or fillers.
- Reliable and resistant seal.
- It requires prior niquelinas time for heating and bars.

ULTRASONIC SEALING

The ultrasonic sealing is an innovative technique in which the frequency of ultrasound is used for bonding together two parts of a molecularly materials

Among its features are:

- Very fast process.
- High control and status monitoring process.

- Rugged and reliable sealing without visual imperfections.
- Technology low energy consumption very friendly with the environment.
- Does not use solvents or fillers for sealing.
- Waterproof packaging.
- It does not require preheating of the machine.

SEALING ADHESIVE

This sealing process involves the use of glues and adhesives for bonding plastic parts and forming the sheath.

Among its features are:

- Sealing materials compatible with the type of glue.
- Sealing is not completely waterproof.
- Times moderate process.
- Low power consumption.
- Use of adhesives, silicones or resins sealing.
- Resistant seal without possibility of re use of packaging.

POLYMERS

The Polymers are macromolecules (geneeralmente organic) formed by the union of smaller molecules called monomers, macromolecules body case are polyethylene and ethylene monomers correspond.

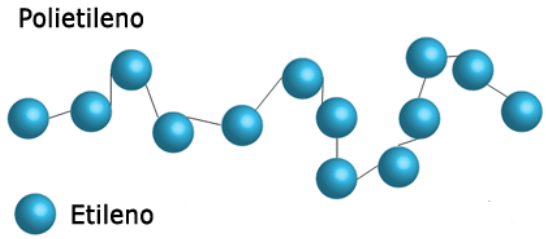

Figure: Composition of a polymer

To be aware of where arises polyethylene, which is the raw material of prefabricated sleeves have a chart where you can see that belongs to thermoplastics.

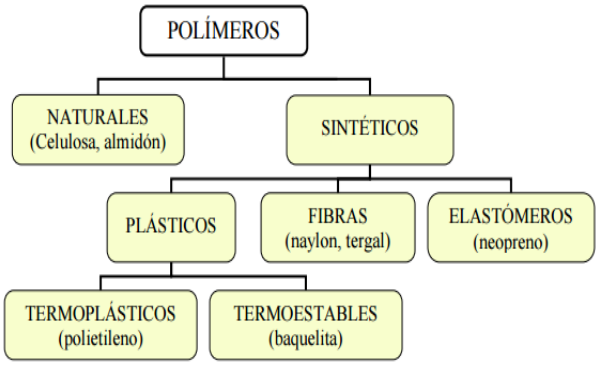

Figure: Classification of polymers

PROPERTIES OF LOW DENSITY POLYETHYLENE

Low density polyethylene is the raw material of the container to be used for the presentation of products, so you are going to see some necessary characteristics of these plastics for analysis.

Table: Mechanical properties of low density polyethylene

MECHANICAL PROPERTIES	
E elastic modulus (N / mm 2)	200
Tensile modulus (GPa)	0.1-0.3
Tensile strength (MPa)	5 - 25
Breaking strength (N / mm 2)	8 - 10
Elongation at break (%)	20

Table: Thermal characteristics of low density polyethylene

THERMAL PROPERTIES	
Specific heat (JK $^{-1}$ kg -1)	1900-2300
Expansion coefficient (× 10 ^{6} K -1)	100-200
Thermal conductivity at 23 ° C (W / mK)	0.33
Softening point (° C)	110
Crystallization temperature (° C)	105-110

Table: Electrical characteristics of polyethylene

ELECTRICAL PROPERTIES	
Dielectric constant at 1 MHz	2.2 to 2.35
Dissipation factor at 1 MHz	1-10 x 10 $^{-4}$
Dielectric strength (kV mm -1)	27
Surface resistance (ohm / sq)	1013
Volume resistivity (ohm cm)	October ^{15} -10 ^{18}

DESIGN PARAMETERS

The company Terrafertil SA as producers of nuts and dried seek to obtain very good results with the sealing, save time and also have a greater production, which must meet the following design requirements.

FUNCTIONAL

Tasks to be performed

- Manual entry of the cases.
- Horizontal feed of the sleeves.
- Dragging covers the area of the sealing rollers by means of silicone bands.
- Sealing sleeves that are fed to the machine.

- Rear drag of the sheath to maintain stability by silicone roller.
- Help the packing stage to go through a conveyor belt.
- Dispatch bag for subsequent packaging.

Design parameters

- Packaging type seal: Prefabricated covers Doy pack.
- Operating temperature: 100-160 ° C
- Product ambient temperature seal 18 ° C.
- Energy supply must be single-phase 110 Vac, 60 Hz.
- Adjusted to facilities (small and medium businesses), dimensions being lightweight and versatile.
- As for the control parts is purely electric and easy exchange and replacement parts.
- 304 stainless steel construction materials and sanitary grade, suitable for contact with food according to international standards.

OPERATIONAL

- It should be easy to move and adjust.
- Make it easy disassembly.
- Design for the operator to unskilled personnel.
- Ergonomically designed for personnel safety.
- Easy installation and operation, easy understanding.

BUSINESS

- The dimensions of the machine must match the spaces in the micro, small and medium enterprises.
- Shelf life: about 10 years.
- Use of materials or parts preferably local suppliers.
- Little use of degradable materials ensure life.

DEVELOPMENT OF ALTERNATIVE DESIGN

In the formulation of design alternatives you have a bank options then be chosen strategically both the sealing mechanism and the drive mechanism for moving the equipment, alternative choice will be that by studying in a decision matrix and the appropriate option will be in a higher score is obtained.

SEALED

- *Induction sealing (option A)*
- *Sealing jaws (option B)*
- *Sealing rollers (option C)*
- *Ultrasonic sealing (option D)*

Table: Decision matrix sealing system

TECHNICAL CHARACTERISTICS	DESIGN ALTERNATIVES				
	TO	B	C	D	IDEAL
Security	20	20	25	18	30
Low initial cost	4	8	12	1	fifteen
Silent	8	5	7	8	10
Low cost of operation and maintenance	1	4	4	1	5
Good performance	4	3	4	4	5
Small size and light	2	1	4	4	5
Ease of manufacture	2	1	4	3	5
Ease of service and replacement parts	5	3	4	3	5
Ease of Operation	4	3	5	4	5
Components readily available on the market	2	4	4	2	5
TOTAL %	52	52	73	48	100

Most suitable for the design of the sealing system, alternative is sealed by heat rollers with a percentage of 73%. The second option is the induction sealing or jaws.

TRACTION MOTION

Drive gear (option A)

Chain drive (option B)

Traction band (option C)

Table Decision matrix drive system

TECHNICAL CHARACTERISTICS	DESIGN ALTERNATIVES			
	TO	B	C	IDEAL
Security	21	26	25	30
Low initial cost	6	12	12	15
Silent	4	6	7	10
Low cost of operation and maintenance	2	4	4	5
Good performance	1	4	2	5
Small size and light	2	4	3	5
Ease of manufacture	1	4	3	5
Ease of service and replacement parts	4	3	5	5
Ease of Operation	4	4	4	5
Components readily available on the market	2	4	2	5
TOTAL %	47	71	67	100

The alternative best suited to the requirements of traction by means of chains, option B, because a percentage of 71% as second choice having tensile bands was obtained.

CAPABILITIES

Figure : Case prefabricated

Equation: Formula to find the amount of sealed bags per minute

$$Q = \frac{Rs}{Ls + Ef}$$

Where:

Ls = Length of the sealing sleeve = 16 cm = 0.16 m

Ef = Space between cover and cover = 15 cm = 0.15 m

Rs = Stroke sealed in a minute: 10 m

Q = Number of sealed bags per minute

Substituting we have:

$$Q = \frac{10\ m}{0{,}16\ m + 0{,}15\ m}$$

$$Q = \frac{10}{0{,}31} = 32{,}2581\ = 32\ \text{fundas por minuto}$$

STRUCTURE DESIGN

The structure is the major part in the design as this depends on the team does not collapse, to perform the calculations necessary to draw up a table like Table, in which the weight of each element of the machine is detailed

Table: Weight of machine components

DESCRIPTION	QTY.	WEIGHT (Kg.)	LOAD (N)
MOTOR - REDUCER	1	2	19.62
Sealing mechanism	1	17.32	169.9
CONVEYOR BELT	1	2,559	25.1
TOTAL		21,987	215.69

SIZE

HIGH: 1350 mm

Width: 750 mm

LENGTH: 450 mm

MAXIMUM EFFORT VON MISES

In analyzing the Von Mises stress with a value of 10.63 MPa it is obtained as shown in Figure.

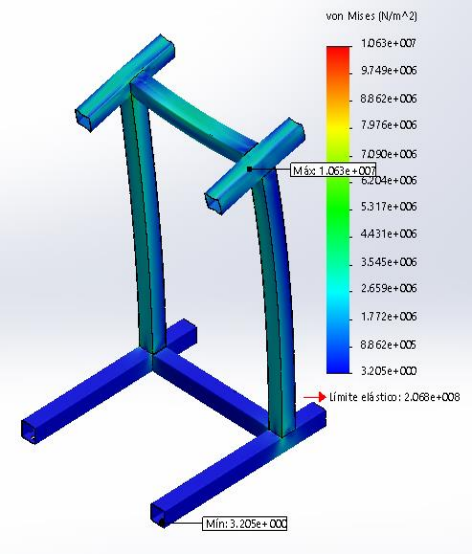

Figure: Maximum stress of Von Mises

Namely:

$$\sigma \cdot \leq S_y$$

Where:

$\sigma \cdot$ Effort = von Mises

S_y = Is the yield strength of the material

$$10{,}63\ \text{MPa} \leq 310\ \text{MPa}$$

It can be concluded that the Von Mises stress is less than the yield strength of the material, which ensures that the system will collapse and is well dimensioned.

SAFETY FACTOR OF STRUCTURE

Structure for 304 stainless steel is used, with the features:

$$\text{Sy} = 310\ \text{MPa} \quad \text{and} \quad \text{Sut} = 620\ \text{MPa}$$

As previously detailed, we proceed to find the FDS in the structure; For this we turn to the equation.

Equation: Safety factor

$$\sigma \cdot = \frac{S_y}{n}$$

Source: (BUDYNAS, 2008)

Where:

n= Safety factor

$S_y =$ Creep resistance of the material

$\sigma \cdot$= Effort von Mises

So:

$$n = \frac{310\ \text{MPa}}{10{,}63\ \text{MPa}}$$

$$n = 29{,}16$$

THERMOSTAT

For the development of this project, in terms of temperature control one Watlow controller 935A-1CC0-000R series will be used, see (Figure 4.4) is a temperature controller with countdown timer for industrial, commercial or scientific applications .

Figure 4.4: Watlow temperature controller 935A-1CC0-000R

It can be seen below in figure, the controller features:

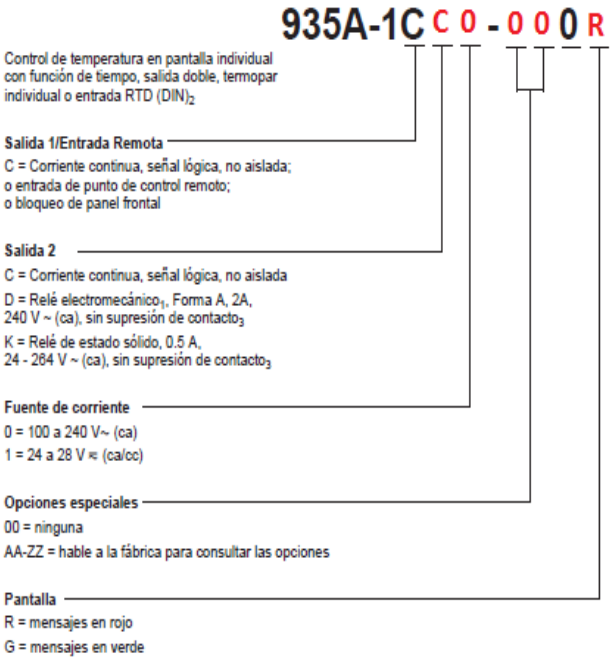

Figure 4.5: Features Watlow 935A pyrometer

TEMPERATURE SENSOR

In this case a thermocouple type J see figure, which is only two wires of different materials joined at one end and the other connects to the pyrometer, when applying heat in the attached tip is used comes a differential voltage on the order of millivolts it varies proportionally with temperature.Thermocouple type j is fully compatible with the pyrometer Watlow, allowing readings of 0 to 750 ° C. Then see characteristics table.

Figure: Thermocouple type J

Table: Characteristics of type J thermocouple Termokew

PARAMETER	VALUE
Material	Iron -constantán
Temperature range	0-760 ° C
Tolerance	± 2.2 - 0.75%
Covering	Stainless 304
Diameter	3/16

SPEED CONTROL AND

ADJUSTMENT

For controlling machine speed you will have chosen a purely adaptive controller for a DC motor see Figure, based on a triac circuit which consists of voltage variation and in turn proportional to this speed.

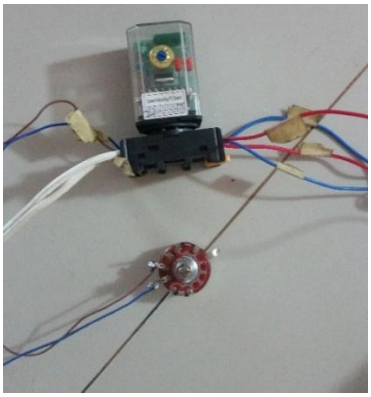

Figure: Variable speed

VIII CONCLUSIONS

- It complies with the main objective of the project is the design and construction team, managing to meet expectations and initially set parameters.
- With the implementation of online heat sealing process efficiency by 40%, and in turn increased the production rate increased by 75% in the company.
- It should take into account before executing the project's progress, conduct a preliminary study of the variables of temperature and speed of sealing gaskets to seal, as these variables constitute an essential pillar in the design.
- 304 stainless steel used is an excellent material because it is able to withstand the stresses to which the machine will be subject, as well as their properties are in an aseptic and suitable material to work with food.
- While the continuous sealing is designed to seal bags with easy gauge closes 94 μ, it can adapt to your work in any other case smaller or larger caliber.
- In the field of design must have the tools necessary to make a prototype which in turn provide the necessary guarantees, in this case it was decided by two software computer aided design such as Autodesk Inventor and Solid Works that were be helpful for implementation and validation of each of the pieces, simulations and corroboration of measures.

IX RECOMMENDATIONS

- Keep in mind when making a previous design, the materials and spare parts needed to manufacture the equipment can be easily

achieved in the industrial market, and thus prevent or calculated the dimensions assigned to each item are inconsistent with the available material .

- Ensure that the materials used in the manufacture of machine governed based on standardized food regulations and internationally accepted to avoid possible contamination of the product and ensure the safety and cleanliness of the process.
- To run a project to implement a machine in the industry, it is necessary to conduct a preliminary economic analysis, where you will realize whether or not prematurely make the project feasible for both the designer and the company.
- To validate the design data is necessary to rely on software design and modeling, simulations both to generate manufacturing drawings.
- Perform maintenance work following one by one the activities proposed in the maintenance plan to prevent premature damage to the machine and maintain a longer life.

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