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TEMA

¨ DESIGN AND CONSTRUCTION OF A SPLICER FOR TEXTILE GARMENTS FACTORY MAQUILA.¨

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Design and construction of a splicer for Textile Garments Factory Maquila.

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Abstrac — In the present job it develops the design of a textile unit, with the aim of giving a support in the textile area to the small and average enterprise in Imbabura's Province.

The textile unity is designed to achieve the union of the fabric with the interlaced fabric with the aim of giving a support in collar of shirts, pockets, bichungas, etc. By means of the use of adequate temperatures, pressures, and times. So it gets using conveyor belts for the move of the fabric and interlaced fabric, electrical resistances for the control of the temperature, rollers for the movement of the conveyor belt also to fulfill the pressing of the fabric with the interlaced fabric and to get the union and an electrical motor for the control of the time of the union of the fabric with the interlaced fabric in the with it will have a variation of time of five to twenty seconds.

The PLC and together with complementary elements such as electrical protections electrical relays, buttons, control of velocity, borneras, stop of emergency, electrical cable ship it gets the control and automatization of the unifying textile.

The content of the present job is summarized of the following way:
CHAPTER ONE: PROCESS OF UNION TEXTILE.
CHAPTER TWO: ALTERNATIVES AND PROTOCOL OF PROOFS.
CHAPTER THREE: DESIGN OF THE UNIFYING TEXTILE.
CHAPTER FOUR: CONSTRUCTION AND ASSEMBLY LINE OF THE UNIFYING TESTILE.
CHAPTER FIVE: ANALYSIS OF COSTS.
CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS.

1. INTRODUCTION

In the globalized world of competition and free market economy, the textile development to achieve short-term results, which involves the use of equipment and machines of high productivity, reliable in the production process, in order to obtain the best prices for customers.

Ecuador is a source of textile products that provide variety and quality in their products, and maintains a proper process, open to new technologies that facilitate and speed up production, creating a labor easier handling equipment.

In the textile processes required improvement in their machines, or building new, improved technology that is usually manufactured or imported from other countries, which in some processes, applying knowledge of Mechatronics Engineering can be designed and constructed in country, a case analyzed in this paper is the design of a textile splicer used in the textile garment industry.

In the present study has considered CONFECCIONES MAQUILA factory to apply knowledge in the design and construction of a textile machine splicer, which will help in the process of making garments as shirts, heaters, bags, etc. In some parts of these garments to be made up such as: collars, bichungas, tapas pockets, cuffs, etc. Which require the analysis of a machine which performs the process of fusing the fabric and interlining.

This process used in making garments is continuous, now it is done using a manual process, so that the factory MAQUILA CONFECCIONES has seen the need to implement a machine that facilitates this process and reduce the time of this phase and improve quality and quantity of production.

2. GENERAL

2.1 Textile Operating Process.

It is known as a textile operation to fix the fact fusible or bald to a garment fabric, through joint action of temperature and pressure for a certain time. This process is also called seamless union.

The process of fusion begins with the selection of the interlining, it should be selected according to the main fabric, after choosing the interlining we proceed to select the parameters of fusion, these parameters are: temperature, time and pressure, which depend on the specifications given by the manufacturer. If properly selected materials and manufacturer's recommendations a quality result is obtained in the fusion.

Figure 1: Gusset.

2.1.2. Considerations process operation.

1. Speed, running time is very short and can be processed several pieces at a time, and with proper control of the technical parameters of the process, the union is of good quality. In the manufacturing process the union of two pieces, a fused and the other is performed no, then do the sewing process, resulting in increased performance.

2. Improving the aesthetics of the clothes: to be united intimately feet and interlining fabric, make a single material, avoiding wrinkles and imperfections that often occur when the junction is biased, through seams.

3. Improved performance when working with synthetic fiber fabrics.

4. It is useful to stabilize lighter fabrics, which normally cause problems slip.

2.2. Current Situation Of The Company.

2.2.1. OPERATION MANUAL (Electric Iron).

The process with the iron boots with the machine operator, fitting fabric and fusible, then verify the following parameter that is to have the right temperature in the electric iron according to the resin, with a pressure applied manually in five passes on the workpiece. The merging process culminates in a two minute time average in one piece with these materials.

Figure 2: Manual operation with the iron..

2.2.2. Operation Manual (Stamping).

- First finish: Start the process with the temperature control on the press according to the resin, and then make the preparation of the fabric and fusible three pieces, and then apply pressure manually programmed with a time stamping and reach the finish first fusion. This process takes an average of two minutes. In Figure the first finish is observed.

Figure 3: First finish with the press.

- Second finish: Start entering the missing area of the three pieces to fuse with the temperature as obtained in the first finish, the pressure is applied to a programmed on the press time, ending the process with an average of two minutes and thirty seconds in three parts. Importantly, when the stamper is used running simultaneously three pieces.

Figure 4: Process operation with the press.

2.3. Selecting The Type Of Splicer.

2.4. Type 1: Textile Sublimator Splicer.

2.4.1. Description.

This type of sealing works by a pneumatic pressure system that performs with a cylinder, and obtaining the temperature by electric irons, applied to the fabric and the fusible for joining, and a system of support trays are for the raw material.

The fusion is performed by the temperature generated in the electric irons, and distributed evenly across the fabric surface, which are controlled by temperature sensors, and are maintaining the proper temperature for the solid bond in one piece.

Figure 5: textile Sublimator splicer.

2.4.2. Advantage.

• Greater uniformity of heat transfer.

• High reliability.

2.4.3. Disadvantages.

• Pneumatic drive.

• High energy consumption.

• Increased cost.

• complex maintenance.

• Process varied.

• Only for sizes suitable fabric.

2.5. Type 2: Textile Splicer.

2.5.1. Description.

This type of fusion splicer, makes the joining process fabric with fusible by heating conveyor belts, which use electric irons that distribute the heat evenly, and by rollers driven by an electric motor, which also obtained pressure, achieving strong bonding of the interlining cloth, making the process continuous.

Figure 6: Textile splicer.

2.5.2. Advantage.

• Easy transportation and easy handling of the machine.

• Easy maintenance.

• Variety of spare parts on the market.

• Using a single power source.

• Continuous process.

• For different sizes of fabric.

• relatively low cost.

2.5.3. Disadvantages.

• Availability of information.

• slow heating load.

2.5.4. Detail Operation Of The Machine.

As shown in the figure, the part to be fused is placed on the lower conveyor belt and then be guided by means of an upper conveyor belt. These conveyors are parallel and to drive a set of rollers is used. By one of the rollers of the conveyor belt is coupled to a motor generating the movement of this roller and through this transmit motion to the other rollers using toothed wheel and chain.

Between the two conveyors, a heating system, heat radiation is absorbed by these conveyors and transfer heat by conduction to the whole fabric and interlining is installed. The heat gained by the piece will allow the fusion of resin interlining, during the journey from admission to the starting point.

For strong bonding of the fabric with the interlining in the exit zone, an additional roller is positioned in an area of the bottom conveyor belt and is parallel to one of the rollers of the top conveyor belt, generating process lamination.

Once the piece by this process goes to the end zone of the lower conveyor belt, same that will be collected by the operator.

The pressure required for the fusion is obtained by moving the drive roller of the upper band to the additional roller, thereby obtaining a uniform for the strong bonding of the fusible fabric with pressure, thus achieving a continuous pressure system in the machine.

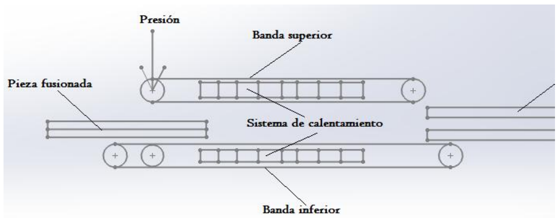


Figure 7: System performance.

Selecting motor speed is achieved the time required for the workpiece reaches the melting temperature of the resin of the interlining from the entry point to the exit point, distance between the rollers of the top conveyor. The temperature should be controlled by the amount of heat supplied by the heating system and the distance between the rollers in the lamination process the pressure required for bonding the fabric and interlining is obtained.

3. TEXTILE DESIGN SPLICER.

3.1. The Design Parameters For Textile Splicer.

3.1.1. Functional parameter.

3.1.2. It is a known fact for the operation and manufacture of the machine, such as the amount of production per hour, the dimensions of the materials, etc. For our particular case, and functional parameters for the design they have been considered splicer machine production capacity and dimensions of the part to be fused.

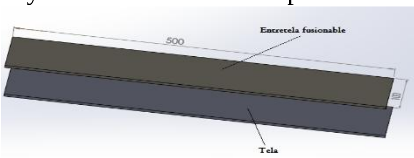


Figure 8: Dimensions fabric and interlining.

3.1.3. Fundamental parameter.

It is an important fact underlying the design of the machine is referred to the material properties, temperature, operating conditions and job requirements to fulfill its function. The fundamental parameters to produce the fusion between the fabric and fabric are indicated in the table information is obtained from manufacturers fusible interlinings.

Table 1: Key parameters.

PARAMETER	MINIMUM	MAXIMUM
TEMPERATURE (°C)	100	170
TIME (seg)	5	20
PRESSURE (Kgf/cm²)	0,25	0,5
DOUGH (gr/m²)	40	256

3.2. Conveyor types.

Table 2: Conveyor belts.

Type band.	Characteristics
Rubber band and canvas.	-Several layers Of rubberized fabrics. -Polyamide fibers polyester or nylon. -Flexibles. -low Weight -Tramas metálicas o textiles. -Based on natural rubber. -Good temperature. -Good breaking strength, temperature, shock and moisture.
Synthetic bands.	-Flexible. -Wear resistant. -Elongation under. -Excellent traction. -They are used to process food.
Modular belt.	-Buoyancy in water. -temperatures between -40 °C a + 104 °C. -Excellent chemical resistance. -Resistant to penetration by microorganisms. -Excellent impact strength.
Teflon band.	-Flexible. -Fatigue resistance. -Excellent sliding properties. -Scratch resistance. -High tensile strength. -Chemical resistance. -Scratch resistance -Does not react with chemicals. -They are not toxic. -Tensile strength and tear. -Impermeability to maintain its qualities in wet environments. -It is not altered by the action of light. -It withstands temperatures -73 °C, until 270 °C.

3.3. Selecting The Bandwidth.

With features and data of the conveyor belt Teflon optimum working width is chosen for a capacity of 800 pieces / hour, with a maximum length of the piece of 0.5m width 0.1m. According to the manufacturer to achieve fusion fabric with interlining, estimates of output per hour are performed.

Table 3: Production based on the width of the conveyor belt.

bandwidth (mm)	wide piece (mm)	Time (seg)	fused parts(pieces/hour)
300	100	20	540
400	100	20	720
500	100	20	900

With table data, it is observed that for a maximum width of the part of 100 mm, the optimum width on the conveyor belt Teflon is 500mm, the width is stan manufacture, with which production capacity is obtained 900 pieces / hour.

3.4. Features Roller Motor And Support Roller.

3.4.1. Motor roller.

Covered drive roller for cylindrical roller, which is responsible for moving the conveyor belt, it will be dragged by friction by the drive roller, this in turn is driven by a motor is selected. The drive roller to be in direct contact with the conveyor belt, must have strength properties at high temperatures, its features rollers that come to the ideal for the design of the splicer machine, the rollers are coated with Teflon.

A similar roll is related to the characteristics and measurements drive roller is copiers and printers.

Figure 9: Kyocera pressure roller Photocopying.

3.4.2. Support roller.

The function of the support roller is supporting the web and the material to be transported, the impact produced by the fall of materials, contributing to focused and web tension, roll alignment is selected.

Figure 10: Motor roller and support roller.

3.5. Selection of the engine and gearbox.

To achieve actuation of the system arises the following scheme, as shown in Fig. Which has a drive sprocket coupled to the motor, and driven sprockets attached to the rollers that give movement to the bands.

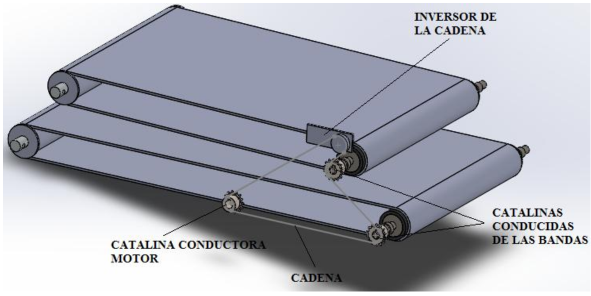


Figure 11: Power Transmission.

Analyzing the actual power with engine efficiency by 90%, the power transmission chain 98%, conveyor system by 96% and reducing engine efficiency of 98% is performed.

$$P_r = \frac{P_b}{(n_{motor} * n_{motorreductor} * n_{ct} * n_{cadena})}$$

$$P_r = \frac{47}{(0.9 * 0.98 * 0.96 * 0.98)} = 56.64 \text{ W}$$

With the calculated power is necessary to select the engine, which is responsible for transmitting the motion to the driving wheel, which will be selected by the table.

Table 4: Motor type.

Indication of Motor

4 IK 25 GN – A M

Dimension	Type	Output	Motor Shaft	Voltage & Pole	Accessory
2 : 60mm 3 : 70mm 4 : 80mm 5 : 90mm	IK: Induction TK: Torque RK: Reversible * Instantaneous switching of rotation direction * 30 mins rating	6 : 6W 15 : 15W 25 : 25W 40 : 40W 60 : 60W 90 : 90W 120 : 120W	A : Round Shaft A(K): Round Shaft with keyway AK: Worm gear GN: Pinion Shaft under 40W GU: Pinion Shaft 60W above GA: Alloy Worm GS: Clutch Brake (Thick) (40-120W) Note: Add "R" means SS-series speed Control motor.	A : 1Ø100/110V4P B : 1Ø100/110V2P C : 1Ø200/220V4P CE : 1Ø220~240V4P(50Hz) D : 1Ø200/220V2P S : 3Ø200/220V4P T : 3Ø200/220V2P U : 3Ø380V4P X2 : 3Ø415V4P Y : 3Ø220/380V4P Y1 : 3Ø230/460V4P Y2 : 3Ø240/480V4P Y3 : 3Ø208/415V4P Y4 : 3Ø220/440V4P (2P: High Speed) (4P: Low Speed)	F: Fan (60W above is standard type) M: Power off Brakes T : Terminal Box (55*55) FF: Forced Fan

The calculated power is 56.64 W, table engine type 5IK60A-C is selected, this engine has the characteristics of being induction, with a power of 60 W, single phase 220V / 4P, you have to is 1550 rpm, in the figure the observed motor selected.

Figure 12: Type of Motor

For proper operation of the machine has a minimum speed of 13 rpm, and a maximum of 54 rpm, engine above the selected speed of 1550 rpm, making it necessary to use a speed reducer to reach operating speeds of the machine, using tables and the type of reducing speed range is selected.

Table 5: Selecting the gearbox.

Dimension (mm)

Model	Output (w)		A	BC	BD	BE	I	G	P	Z	E	CC	Output Shaft S	Output Shaft D	Output Shaft WxYxLK	Weight (KG)
5	40W (GN)	3~18R	90	246	105	35	34	2.2	104	6.4	73.6	18	12	9.5	4x4x25	5.52
		20~180R	90	262	121	35	34	2.2	104	6.4	73.6	18	12	9.5	4x4x25	5.54
	60W (GN)	3~18R	90	265	105	35	34	2.2	104	6.4	73.6	18	12	9.5	4x4x25	5.52
		20~180R	90	281	121	35	34	2.2	104	6.4	73.6	18	12	9.5	4x4x25	5.54
	60W(GU)		90	287	127	35	34	2.2	104	6.4	73.6	18	15	12	5x5x25	5.54
	90W(GU)		90	313	127	38	34	2.2	104	6.4	73.6	18	15	12	5x5x25	6.39
	120W(GU)		90	313	127	38	34	2.2	104	6.4	73.6	18	15	12	5x5x25	6.39

Table 6: Specifications reducer.

Standard Specification

Item	Standard Specification
Ratio	1 : 10 Decimal Gearhead
Type	Model 2, 3, 4, 5

Dimension (mm)

Model	Output (w)	A	B	C
2	6W	60	39	26
3	15W	70	39	26
4	25W	80	39	26
5	GN 40W~60W	90	59	40
	GU 60W~120W	90	59	40

Table 7: Motor speed.

60Hz Maximum Permissible Torque(Kgcm)

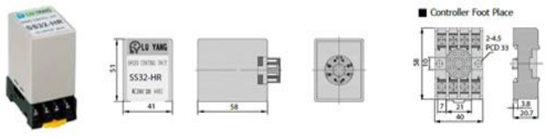
Output (W)	Ratio (R)	3	5	6	7.5	9	12.5	15	18	25	30	36	50	60	75	90	100	120	150	180
	RPM	600	360	300	240	200	144	120	100	72	60	50	36	30	24	20	18	15	12	10
6W	Torque (T)	1.0	1.5	1.8	2.3	2.8	3.9	4.7	5.6	7.0	8.3	10	13.8	16	20	24	30	30	30	30
15W		2.6	3.9	4.7	5.8	7.0	9.8	11.8	15	19	23	27.6	38.4	46	50	50	50	50	50	50
25W		4.1	6.3	7.6	9.5	11.4	16	19	23	31	37	45	62	75	80	80	80	80	80	80
40W		6.3	10	12	15	19	26	30	37	45	54	65	90	100	100	100	100	100	100	100
60W		10	16	19	24	28	40	47	55	69	83	100	138	160	175	200	200	200	200	200
90W		14	24	28	35	42	60	70	80	103	124	149	200	200	200	200	200	200	200	200
120W		19	30	37	46	55	70	83	100	125	150	180	200	200	200	200	200	200	200	200
150W		26	39	48	60	72	82	98	125	150	180	200	200	200	200	200	200	200	200	200

The selected gear is the type 5-60 (GN), shown in the tables, which has a transmission ratio 1:10, seen in the tables, reducing torques observed at different speeds in the figure you can see the type of reducing chosen.

Figure 13: Type Reducer.

The reducing chosen for the engine 1550 rpm, a speed reduced to 155 rpm, using its transmission ratio of 1:10, obtaining a speed that does not reach the operation of the machine. For operation of the machine it requires that the varié speed to 13 rpm 54rpm, making it necessary spindle speed control, in the table the type of speed controller is shown.

Table 8: Speed Controller.



Model	Voltage (V)	Frenqu-ency (Hz)	Rated Current (A)	Output (W)	Speed Range	Speed Rate of Change (%)	Velocity Reaction	Electronic Brake	Velocity Safety	Ambient Condition
SS31-HR	110V	60	5	6-120	90~1600	5%	0.5 秒 (Sec)	good	great	-10°C~+50°C
SS32-HR	220V									
SS32E-HR	220~240V	50	5	6-120	90~1350	5%	0.5 秒 (Sec)	good	great	-10°C~+50°C

With the table selected speed control SS32-HR is that its control range is 90 to 1,600 rpm, obtaining a minimum speed reducer 9 rpm, the connection is made via the control diagram is observed in Fig.

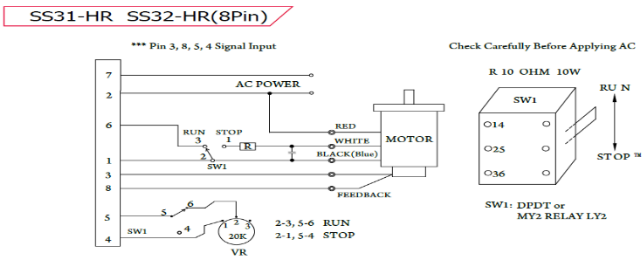


Figure 14: Diagram control

The figure shows that the use of a potentiometer 20 KΩ, which is responsible for providing the variable speed of 13 rpm to 54 rpm operation of the machine is required to perform control 90 at 1600 rpm.

3.6. Power Transmission.

For the transmission of engine power to the rollers, you choose to use a system of transmission by chain.
Depending on the engine power of the transmission ratio, synchronous, selection of the sprocket and the chain to be used may vary, the figures indicate the elements of a simple roller chain.

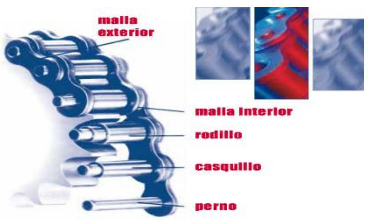


Figure 15: Main parts of a roller chain

Figure 16: Simple roller chain

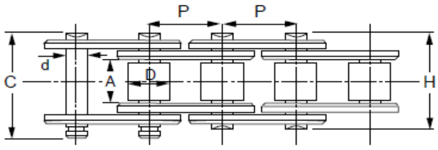


Figure 17: Main characteristics of roller chain

P = pitch.

A wide =.

D = diameter of the roller.

C = Width of connecting pins.

d = diameter of the shaft.

M = maximum axle width.

In the figure, the transmission system chain is observed, which by driving sprocket and chain transmits the motion to the driven sprocket, which are responsible for moving the conveyor belts.

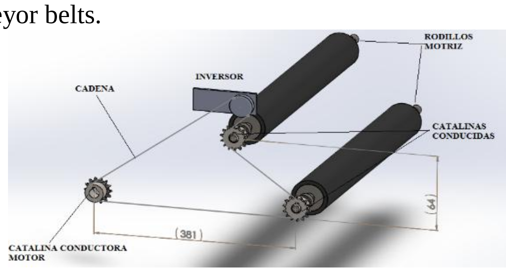


Figure 18: Transmission system via chain.

3.6.1. Calculation Of Design Power.

$$H_{design} = P_{gearmotor} * f_s$$

Where:

H_{design} = Power design [hp]
$P_{gearmotor}$ = Power output of the gearmotor [w] = 60 [w].
f_s = Service factor = 1.3

$$H_{design} = 60\ w * 1{,}3 = 78\ [w]$$

3.6.2. Selecting The Type Of Roller Chain Used.

The chain and the number of teeth on the pinion necessary for power transmission are determined from tables or graphs prepared from the necessary rpm. Tables and graphs are produced by commercial and home for the next calculation is based on Joresa trading house, which is distributed in Ecuador for HIVIMAR.

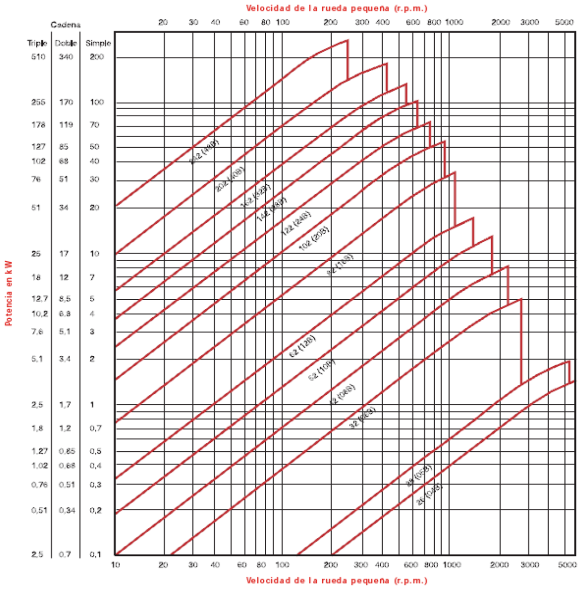


Figure 19: Selection of chains ISO

The following string is selected.

- Simple Chain 42- 08B.

It has the following features.

- Step: p = 12,70 mm = 1/2 in
- Anchovy = 7.75 mm
- Breaking load = 2000 da-N
- articulation area = 0.50 cm2

3.7. Tension Of The Conveyor Belt.

An analysis of the tension of the conveyor belt is performed, for which it has a contact angle between the roller and the conveyor belt and the tension on each side of the conveyor.

(a) **(b)**

Figure 20: a) belt tension on each side, b) Free body diagram.

3.7.1. Voltage required to move the tape in a vacuum.

$$T_x = f * G * (l + l_o)$$

Where:

T_x = Voltage required to move the tape in vacuum.

f = Coefficient of friction of the rollers.

$$T_x = 0.03 * 343 * (0.9 + 59.82) = 624.80 \text{ N}$$

3.7.2. Voltage required to move the load horizontally.

$$T_y = f * q_m * (l + l_0)$$

Tension forces required for overcoming overload.

Where:

P_2 = Voltage to move the load horizontally tape.

q_m = Weight of transported material.

$$T_y = 0.03 \text{ x } 58.99\ (0.9 + 59.82) = 107.46 \text{ N}$$

3.7.3. Voltage Necessary To Overcome The Resistance Offered By Possible Resistance.

$$T_z = x * \frac{Q_t}{v}$$

Where:

T_z = Any stress resistance.

x = Constant depending on the width of the tape.

$$T_z = 0.337 * \frac{520}{24} = 7.30 \text{ Kg} = 71.54 \text{ N}$$

$$T_E = T_x + T_y + T_z$$

$$T_E = 624.80 + 107.46 + 71.54 = 803.08 \text{ N}$$

Once the effective stress, calculate the stresses on the sides of the band, the same as the effective stress calculated by multiplying the coefficient of friction between the belt and the drive roller. It is considering the type of tension that was used for the design, which is screw type and contact angle of 180 ° band.

$$T1 = T_E K_1$$
$$T1 = 803.08 \text{ x } 1.84$$
$$T1 = 1440.6 \text{ N.}$$

With the data obtained calculate T2:

$$T2 = T_E K_2$$

Where:

$$K_2 = K_1 - 1$$
$$K_2 = 1.84 - 1$$
$$K_2 = 0.84.$$

Once K_2 found, we replace in the equation to find T2.

$$T2 = 803.08 \text{ x } 0.84$$
$$T2 = 658.56 \text{ N}$$

3.8. Calculation Of The Reactions On The Shaft.

Obtained the forces acting on the shaft of the drive roller, the calculation for the reactions in the XY plane and the XZ plane is performed.

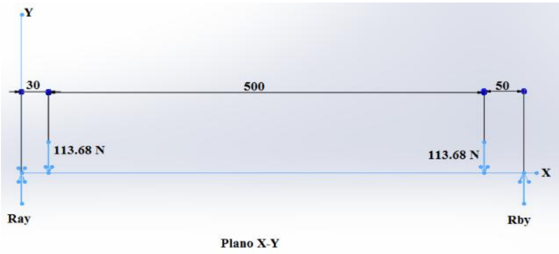


Figure 21: Forces in the X-Y plane.

Figure 21: Forces in the X-Y plane.

$$\sum F_y = 0$$

$$R_{ay} + R_{by} = 227.36\ N$$

$\sum M_A = 0$

Whereas positive clockwise.

$$(R_{by} * 0.58) - (113.68 * 0.03) - (113.68 * 0.53) = 0$$

$$(R_{by} * 0.58) = (113.68 * 0.03) + (113.68 * 0.53)$$

$$R_{by} = 109.76\ N$$

Substituting we have:

$$R_{ay} + 109.76 = 227.36\ N$$

$$R_{ay} = 117.6\ N$$

In the graphs, diagrams shear and bending moment for the XY plane shown.

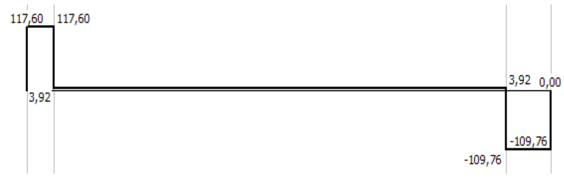


Figure 22: Diagram XY plane shear - drive roller shaft

Figure 23: XY plane bending moment diagram - drive roller shaft

Reactions in the plane X-Z.

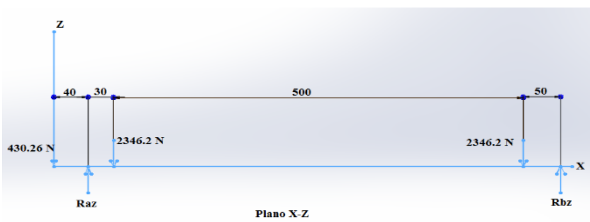


Figure 24: Forces in the X-Y plane

$$\sum F_y = 0$$

$$R_{az} + R_{bz} - 430.26\ N - 2346.2\ N - 2346.2\ N = 0$$

$$R_{az} + R_{bz} = 5122.66\ N$$

$$\sum M_A = 0$$

Whereas positive clockwise.

$$(R_{bz} * 0.62) - (2346.2 * 0.58) - (2346.2 * 0.07) + (430.26 * 0.04) = 0$$

$$R_{bz} = 2431.96\ N$$

Substituting we have:

$$R_{az} + 2431.96\ N = 5122.66\ N$$

$$R_{az} = 2690.69\ N$$

In the graphs, diagrams shear and bending moment for the XY plane shown.

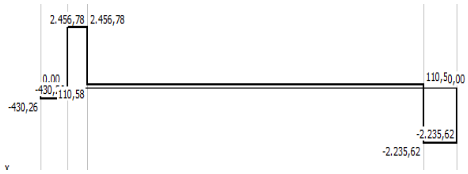


Figure 25: Diagram of shear plane XZ- drive roller shaft.

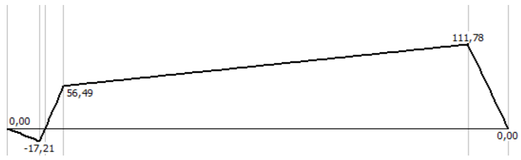


Figure 26: Diagram plane bending moment XZ- drive roller shaft.

From the above diagrams, the resulting moments supporting the shaft is determined; these are:
Therefore we have:

$$M_{A=0.07\ m} = \sqrt{3.53^2 + 56.49^2} = 56.60\ N - m = 509.97\ \text{Lb-in}$$

$$M_{B=0.57\ m} = \sqrt{5.49^2 + 111.78^2} = 111.91\ N - m = 990.57\ \text{Lb-in}$$

$$M_{C=0.04\ m} = \sqrt{0^2 + 17.21^2} = 17.21\ N - m = 152.33\ \text{Lb-in}$$

3.9. Safety Factor Calculation With Motor Roller Diameters.

After obtaining the resulting moments, and the diameters of the roller clearance is perform for the safety factor.

$$D = \left[\frac{32N}{\pi} * \sqrt{\left[\frac{K_t * M}{S_n'}\right]^2 + \frac{3}{4} * \left[\frac{T}{S_y}\right]^2}\right]^{1/3}$$

Where:

Shaft diameter = 17 mm = 0.66 in
N = Safety factor.
K_t = To chafan with sharp edges = 2.5

$M\_max = \text{maximum moment} = 73.66 = 15.35 \text{ Nm lb} - \text{in.}$
$S\_n = \text{resistance for durability.}$
$T = \text{Torque} = 161 \text{ lb} - \text{in.}$
$S\_y = \text{Tensile strength of the shaft material steel A} - 36.$

The safety factor at the point C where the Fb has a torque of 161 lb-in with a diameter of 17 mm is analyzed.

$$D = \left[\frac{32N}{\pi} * \sqrt{+\frac{3}{4} * \left[\frac{T}{S_y}\right]^2}\right]^{1/3}$$

$$\frac{0.66^3}{\sqrt{\frac{3}{4} * \left[\frac{161}{51000}\right]^2}} = \frac{32N}{\pi}$$

$$105.16 = \frac{32N}{\pi}$$

$$N = 10.32$$

The safety factor obtained in our design, with the use of rolls of copiers is N = 10.32, with a diameter on the shaft of 17 mm, which ensures that the torque generated in the driven sprocket proper operation of machine.

To static structures with high confidence in the knowledge of the material properties, loads and degree of magnitude that it is appropriate stress analysis N = 2.

3.10. Design Temperature Control.

The temperature system of the machine is done through direct contact of the plate with the conveyor band, the transfer process is known as heat conduction.

3.10.1. Driving.

It is a heat transfer mechanism, that is presented and molecular contact of this level, where the molecules with higher energy (higher temperature) release heat to lower energy (lower temperature) as shown in Fig.

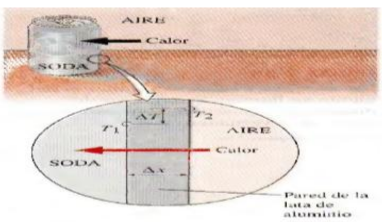


Figure 27: Driving Mechanism

3.10.2. Heat Consumed By Iron.

$$\dot{Q}_{cond} = -k_t A \frac{dT}{dx}$$

The equation determines the amount of energy required to convey the sheet, which is a function of temperature. Table 3.34 can be displayed different values for different temperatures.

Tabla 9: Resultado de cálculos de potencia.

Number	T2 (k)	T1 (k)	AT(k)	k_t (kW/m-K)	A(m2)	dx (m)	POWER (kW)
1	293,15	373,15	80	0,45	0,05	0,05	36
2	293,15	383,15	90	0,45	0,05	0,05	40.5
3	293,15	393,15	100	0,45	0,05	0,05	45
4	293,15	403,15	110	0,45	0,05	0,05	49.5
5	293,15	413,15	120	0,45	0,05	0,05	54
6	293,15	423,15	130	0,45	0,05	0,05	58.5
7	293,15	433,15	140	0,45	0,05	0,05	63
8	293,15	443,15	150	0,45	0,05	0,05	67.5

To vary the temperature in a range between 20 and 170 [° C], the power of the resistor is approximately 67.5 [kW], since the time estimated to reach this temperature is 10 [min], the energy consumed to reach the desired temperature is 11.25 kW-h.

3.11. Control Circuit Design.

To control the textile splicer LOGO PLC is a compact controller that consists of a base module and expansion modules depending on user requirements is used. This modular concept makes a flexible, economical and easy to use solution, the LOGO robust and compact design makes it easy to use equipment of universal application.

3.11.1. Characteristics PLC.

The logo has a capacity of maximum extension of 24 digital inputs, 16 digital outputs, 8 analog inputs and 2 analog output modules using the following entries.

LOGO integrates the basic and special functions that facilitate the development of programs.

Which they are 8 basic functions with which they can obtain and NC combinations in series or parallel, as well as investors and switches 31 Special functions among which are: on delay, off delay, up / down counters relays self-retaining, pulse generators, hour meters, generator, generator of random output, switch switching comparator for analog signal either expansion modules or the LOGO, clock function with weekly and annual programming, analog multiplexer, PWM control block IP block for closed loop control, etc.

The elements required for the control system is detailed in FIGS.

Figure 28: PLC AC / DC 115 ... .240V LOGO.

Figure 29: SCREEN LOGO TD.

Figure 29: SCREEN LOGO TD.

4. RESULTS.

3.8. Physical Control Of Dimensions.

Once built the splicer, should be compared with design dimensions, for which a tape measure, a scale, controlling the physical dimensions used indicated in the table.

Table 10: Control of physical dimensions.

PROOF	RESULT REQUIRED	OBTAINED RESULT
Dimensions basic	Weight 120Kg	Weight 150kg
	overall width 1m	overall width 0,95
	Total length 3m	Total length 2m
	overall height 1,50 m	overall height 1,15m
	Camera depth heat 1m	Camera depth heat 0,75m

3.9. Angular Velocity Control.

Because the angular velocity is low, the number of revolutions per minute (rpm) shaft splicer makes it visually and using a timer indicated in the table.

Table 11: Control angular velocity.

PRUEBA	RESULTADO REQUERIDO	RESULTADO OBTENIDO
Velocidad angular del eje máxima	54 rpm.	54 rpm.
Velocidad angular del eje mínima	13 rpm.	13 rpm.

3.10. Control De Temperatura.

Esta prueba se realiza en la cámara de calor de la fusionadora con la ayuda de un termómetro tomando la lectura cada cinco minutos desde el momento de encendido de la Fusionadora Textil como se indica en la tabla.

Tabla 12: Control de temperatura.

PROOF	RESULT REQUIRED	OBTAINED RESULT
Maximum shaft angular velocity	54 rpm.	54 rpm.
Minimum axle angular speed	13 rpm.	13 rpm.

3.11. Control uptime.

Once the temperature reaches 140 ° C and the hairless fabric is inserted and proceeds to take the time for joining the fabric with the hairless as indicated in the table.

Table 13: Control of operating time.

PROOF	RESULT REQUIRED		OBTAINED RESULT	
Operating time	maximum amount (U)	8000	maximum amount (U)	18000
	Time (h)	24	Time (h)	1
	Minimum amount (U)	500	Minimum amount (U)	4500
	Time (h)	1	Time (h)	1

3.12. Testing motor operation Nominal amperage.

Once assembled and commissioning the machine, the test is performed on the engine consumed and compared with the rated motor current, as indicated in the table.

Table 14: Operation of the engine.

PROOF	RESULT REQUIRED		OBTAINED RESULT	
Rated motor current	Vacuum (A)	1	Vacuum (A)	0,98
	Loaded (A)	1,5	Loaded (A)	1,44

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions.

- The main objective has been achieved by designing a textile splicer, the same that meets the required parameters of time, temperature and pressure required for fusion fabric with interlining.

- Project development titration gives a solution to the current problem of business, implementing the splicer with band being a semi automated process reduces labor, time spent and operating costs of such activity.

- fusing productivity has increased to 10 times, as the fused fabric used to take 60 seconds, now it takes about 5 seconds.

- recycled copier rollers are used in the selected construction materials machine, mechanical and other tools used in the construction of the textile splicer elements are selected according to the availability you have in the market.

- With the selected elements of the mechanical system design is done, based on the measures of the fabric and interlining to merge, time and pressure.

- The implementation of the control system is performed based on the parameters of the machine to be controlled, such as temperature, time and pressure.

- Construction of the textile factory splicer for MAQUILA MANUFACTURE, it done by conveyor bands Teflon material resistant to high temperatures above 170 ° C, using tubular heaters and copper as the heating element.

- For operation of the machine and helps in both preventive and corrective maintenance, operating manual and a practical guide to the textile splicer, since it consists of elements that can be easily found in the local market without performed use specialized equipment or technology workshops.

- In the design and construction of the machine have been used knowledge that were taught during the student stage, also taking into account recommendations by the staff working at the plant.

5.2. Recommendations.

- Personnel are advised to read the manual before operating the machine.
- Perform preventive maintenance often all systems that form the fusion splicer to avoid long-term problems and also extends the life of the same.
- For best results we recommend splicer adjust the parameters established in the design variables such as web speed, operating temperature etc.
- To operate the machine is recommended to verify that the components are in compliance job characteristics, lubricated bearings, motor resistance and smooth operation.
- There must be a pre-heat resistance before starting to operate the splicer.

6. BIBLIOGRAPHY

Budynas, R., & Keith, N. (2008). *Diseño en ingeniería mecánica de Shigley.* México, D.F.: McGraw-Hill.

Castellanos, S. (2013, 02 22). *Poliester*. Retrieved from Poliester: www.consultar.com

Cengel, Y., & Ghajar, A. (2011). *TRANSFERENCIA DE CALOR Y MASA FUNDAMENTOS Y APLICACIONES.* México. D.F.: Mc Graw Hill.

Collaguazo, G. (2006). *Sistemas Microprocesados.* Ecuador.

DIPAC. (2014). DIPAC PRODUCTOS DE CERO. Quito, Pichincha, Ecuador.

Ferritodo. (n.d.).

FOTOLOG. (2010, Mayo 17). *FOTOLOG*. Retrieved from FOTOLOG: http://www.fotolog.com/hornosdecurado/23707391/#profile_start

Gaboto., M. 1. (n.d.). *IJASA DIVISION INDUSTRIAL.* Retrieved from IJASA DIVISION INDUSTRIAL: www.ijasa.com

Gencel, Y., & Boles, M. (2009). *TERMODINÁMICA* (Sexta edición ed.). México, D.F.: McGraw-Hill/INTERAMERICANA EDITORES, S.A. DE C.V.

HASHIMA. (n.d.). *fusionadora%20textil*. Retrieved from fusionadora%20textil: file:///D:/Documents/proyecto%20de%20gradol/maquina/mas%20informacion.htm.

Hufnagel, W. (1992). *Manual del aluminio.* BARCELONA: REVERTÉ, S.A.

IDMACOM. (n.d.).

Ingelcom. (n.d.).

J., S. (n.d.). *Diseño en ingeniería mecánica.* (Vol. Octava edición). México: Mc Graw Hill.

JORESA. (n.d.). *CATALOGO GENERAL CADENAS DE RODILLOS.*

Kauman. (n.d.). *Manual de bandas transportadoras.*

Link-Belt. (n.d.). *Link-Belt*. Retrieved from Tecnología de cadenas de rodillos. .

McCormac, J. (n.d.). *Diseño de estructuraras metálicas.*

Millán, A. (2014). *Preparación del sistema de entintado, humectador y de los dispositivos de salida y acabado en máquinas de impresión offset.* México: IC, Editorial.

Mott, R. (2006). *Diseño de elementos de máquinas.* EE.UU: Pearson Prentice Hall. Retrieved from CADENASMOBLAT: WWW.CADENASMOBLAT.COM.

Mott, R. L. (1995). *Diseño de elementos de máquinas.* México: PRENTICE HALL HISPANOAMERICANO, S.A.

Prieto, A. (2015). Especificaciones de Produsto Estructurales. Vemacero, España.

Riba, C. (2002). *Diseño concurrente.* Barcelona: illustrated.

Saráuz, J., & Tirira, A. (2011). *Diseño y Construccion de una Máquina para la Elaboración de Tortillas de Arina de Trigo.* . Quito.

Shigley, & Mischke. (1996). *Standard handbook of machine designe.* EE.UU: MacGrawHill.

Shigley, J. (1989). *MANUAL DE DISEÑO MECÁNICO* (Cuarta edición ed.). Mc Graw Hill.

TIMOSHENKO. (1977). *Elementos de resistencia de materiales* (Segunda Edición ed.).

Vallejo, P., & Zambrano, J. (2009). *FISICA VECTORIAL I.* Ecuador: RODIN.

Vallejo, P., & Zambrano, J. (2009). *FISICA VECTORIAL I.* Ecuador: RODIN.