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TOPIC:

DESING AND IMPLEMENTATION OF A SISTEM OF HUMIDIFYING AND IRONING IN A PLEATING MASHINE FOR CAYAMBI'S SKIRTS.

AUTHOR: QUIILUMBAQUÍN TABITA

DIRECTOR: ING. COSME MEJÌA

Ibarra – Ecuador.

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DESING AND IMPLEMENTATION OF A SISTEM OF HUMIDIFYING AND IRONING IN A PLEATING MASHINE FOR CAYAMBI'S SKIRTS.

Tabita Quilumbaquín Antamba.

Ingeniería en Mecatrónica.
Universidad Técnica del Norte.
Ibarra, Ecuador.
tquilumbaquina@utn.edu.ec,

SUMMARY

This Project develops the design and implementation of a system of humidifying and ironing in a pleating machine for cayambi's skirts, which focuses on the reduction of production time, reduction of risk of burn in the pleat process and improves the uniformity of the pleat.

It describes an analysis of the process manual of ironing and the parameters that intervenes in the process; In addition to determine the quantities needed of power and endowment of water relevant.; the design of the control system; the implementation of the system, as well as; specify the sizing of the components that comprise it

Finally, is the implementation of systems and their respective performance tests.

Words key: skirt, wetting, temperature of pleated, pleated, iron

1 INTRODUCTION AND BACKGROUND

In the country there are diversity of cultures and nationalities located in different parts of the Ecuador, each a usually use their own attire, this is the case of the nationality Kayambi, whose women tend use skirts with a pleated particular, called Center. He pleated is made form manual by people devoted to this activity

1.1 .PLEATED FABRICS

There are different models of cayambeñas skirts either trimmed or without them; According to the requirements of the final consumer. In the fig.1; will illustrate skirts to give a vision general of them features of pleated.

Fig. 1. Pleated skirts

To give the appearance that characterizes these garments, skirts that are made today, they must go through a process of moistening, pleated and ironing manual. In FiGg.2; It shows the process of ironing. The folds are generally of three types, which are known as: pleated fine between thin and thick, with folds of 1cm, 1.5 cm and 2cm respectively.

Fig. 2. Process of manual pleated skirts.

2 DEVELOPMENT OF CONTENT.

For the design of systems, identified some parameters that govern in the ironing process; This has been conducting a study of the characteristics of the material to pleating; as well as of the elements to form systems.

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2.1 CHARACTERISTICS OF TIS RAW MATERIAL.

The fabric used is the so-called commercially as acrylic cloth the main features presented by acrylic fabric is detailed in the following table [I].

TABLE I. PROPIEDADES TÉRMICAS DEL ACRÍLICO

Thermal behaviour	
Temperatura de transición vítrea	90 °C
Resistencia al calor seco	125 - 135 °C
Temperatura de lavado	40 - 50 °C
Temperatura de planchado	160 - 200 °C
Temperatura máxima de fijado	220 °C
Temperatura de decoloración	235 °C
Temperatura a la que la fibra empieza a ser termoplástica	228 °C
Temperatura de reblandecimiento	215 - 255 °C

Temperatura de descomposición	300 - 320 °C
Temperatura de auto inflamación	560 °C

2.2 PARAMETERS OF DESING ABOUT HUMIDIFICATION SYSTEM

Makes reference to the volume of water used and the time of activation of endowment of water..

2.3 PARAMETERS OF DESING ABOUT TEMPERATURE SYSTEM

Benchmark a: temperature settings higher than 100 ° C; stable temperature and adequate insulation.

3 DISING OF THE CONTOL SYSTEM OF DOISTURE.

The control system is responsible for:

The presence of material.

Provide moisture to the material fold.

Verification of existence of water in the pipe

3.1 AMOUNT OF WATER NEEDED

The moistening system is equipped with a micro spray that must provide at least the following amount of water

$$At = l \times a$$

(1)

Where:

At = Area of the fabric [cm ²]

l = Length of the fabric [cm]

a = Width of fabric [cm]

Then, from the (1) is::

$$At = 150 \times 80$$

$$At = 12000[cm^2]$$

In the humidification system spray for an area of 80 [cm²] has a maximum absorption of water from 2.85 [ml]; by what for a skirt can use is at least:

Área [cm^2] Volumen [ml]

80 -----------------------------2.85

12000 ------------------------- x

$$x = \frac{12000 \times 2.85}{80}$$

x =427.5 [ml]

3.2 DIAGRAM OF FLOW OF THE PROCESS

In the next chart you can see that both moisture system; as the temperature control are correlated.

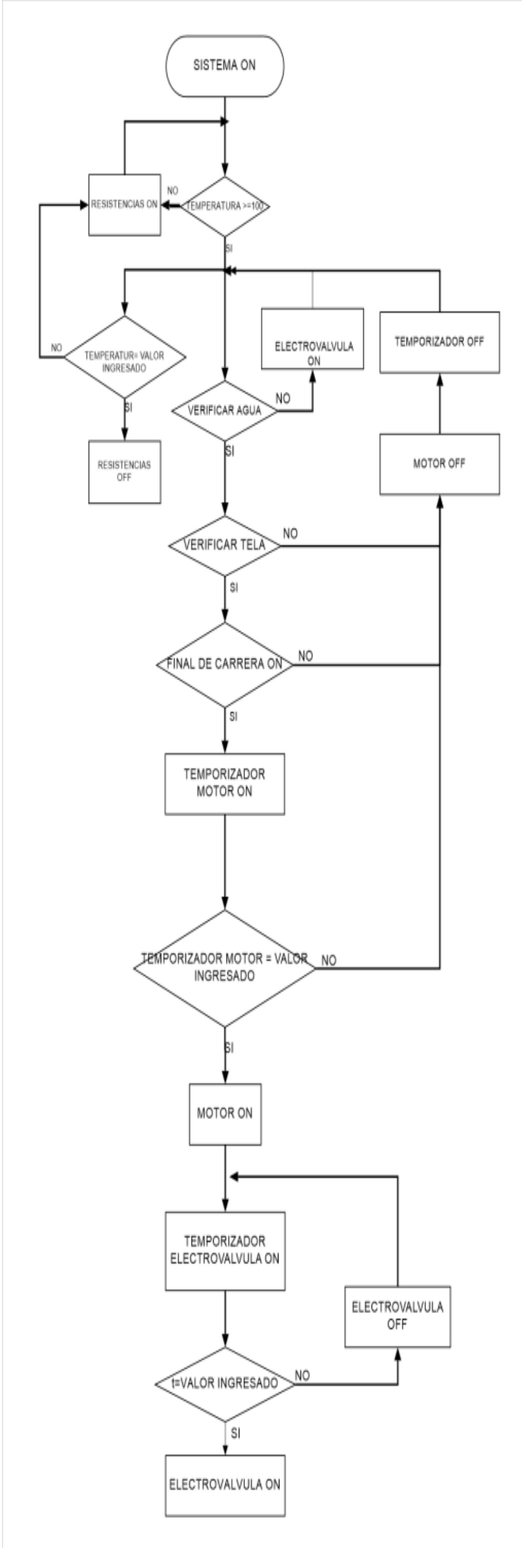


Fig. 3. Flowchart of the humidification and temperature system.

4 HEAT CONSUMED BY THE SYSTM

The heat consumed by the system is governed by (2).

$$Q_{sistema} = Q_{csp} + Q_{perdido}$$

(2)

Where:

Q_{csp} =

HEAT CONSUMED BY THE SYSTEM OF THE IRON

$Q_{perdido} = Head\ losses$[W]

4.1 HEAT CONSUMED BY THE IRON

The configuration of system of ironing is can observe in the fig.4; for analysis has taken into account that driving between metals resistance is negligible

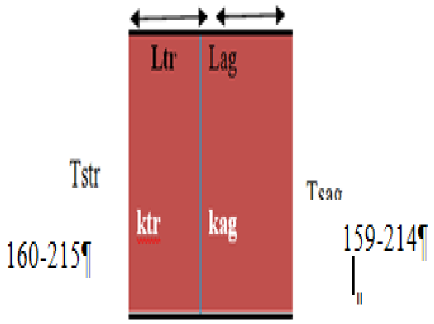


Fig. 4. Conformation of the iron

Based on the Fourier law [8], [9] and [10] and matching the rate of heat flow for rectangular profile with galvanised steel is obtained the rate of flow of heat (3)

$$Q_{cp} = \frac{A(Ttr - Tag)}{(\frac{Lag}{kag} - \frac{Lt}{ktr})}$$

(3)

Where:

Q_{cp} =Flow of heat on the grill

A=Area of the surfaces: 0.044[m^2]

$Tstr$ =Temperature of surface of the tube rectangular: 160[C]

$Tsag$ = Temperature of the surface of the steel galvanized: 159[°C]

Lag=Galvanized steel thickness: 1m[m]

Lt= Rectangular tube thickness: 1.5m [[m]

kag= Thermal conductivity of the galvanized steel: 73[$\frac{W}{m\,°C}$]

ktr= Conductivity thermal of tube rectangular:: 54$\frac{W}{m\,°C}$

Is considered to analyze the configuration of the system; under steady state conditions, which is defined as a problem of thermal conduction in balance; replacing data in (3) is

Q_{cp} = 3125,18[W]

4.2 HEAT LOSSES

For the calculation of the loss of heat from the system, the following process is enhanced: heat losses were analyzed both by natural convection; as for driving [8], [9]; Like this

4.2.1 LOSS OF HEAT BY CONVECTION OF THE IRON

An approximate value of coefficient of heat transfer by convection 30° c for plates in contact with air at ambient temperature mentioned by [8] corresponds to 4.5 [W /(m^2×°C)]; In addition, the cross-sectional area of transfer of heat (loss) is previously known convection to = 0, 04 [m ^ 2]. So the dissipated power is obtained using the law of Newton cooling

$$q = h \times \frac{Tmat - T\ amb}{A}$$

(4)

Where:
h= Coefficient of transfer of heat by convection
Tmat= Temperature of the surface of the material
Tamb= Ambient temperature.
A= Area of the surface in contact

Replacing data in (4), it has

$$q = 23{,}2[\text{W}]$$

4.2.2 SYSTEM HEAT LOSSES

System heat losses are analyzed with the thermal resistances of the system, thus:

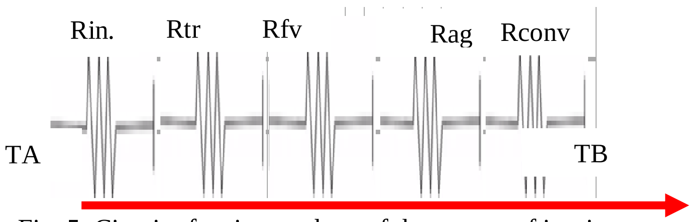


Fig. 5. Circuit of resistance heat of the system of ironing

$$R_{Total} = \frac{1}{hint \times Aint} + \frac{xtr}{ktr \times Atr} + \frac{xfv}{kfv \times Afv} + \frac{xag}{kag \times Aag} + \frac{1}{h \times Aanb.}$$

(5)

Where:

hint= Coefficient of convection in the interior: 5[$\frac{w}{°Cm^2}$]

Aint= Area of the surface in contact with the hot air: 0,189[m^2]

xtr= Thickness of the tube rectangular:1,5m[m]

Ktr= Conductivity thermal of tube rectangular

Atr= Area cross of the tube rectangular: 0,144[m^2]

xfv= Thickness of glass fiber:0,0254[m]

kfv= Coefficient of thermal conductivity of glass fiber: 0.046[$\frac{w}{°Cm^2}$]

Afv= Area of the section cross of the fiber of glass:0,2493[m^2]

xag= Thickness of galvanized steel: 1m[m]

kag= Coefficient of thermal conductivity of galvanized steeL.

Aag= Area of cross section of galvanized steel: 0,2493[m^2]

Aamb= Area of the surface in contact with the environment: 0,2493[m^2]

Replacing data in the equation will have

R_{Total} =4,15$\frac{°C}{W}$

By what the heat lost is obtained to the divide the variation of the temperature with the resistance total, thus:

$$q = \frac{\mathrm{TA} - \mathrm{TB}}{4{,}15}$$

$$q = 30{,}32[\mathrm{W}]$$

$$Q_{perdido} = 23{,}2 + 30{,}32$$

$$Q_{perdido} = 53.52\mathrm{W}]$$

Replacing heat loss is the value of the amount of power needed to keep the surface of galvanized steel to desired temperatures, thus

$$Q_{sistema} = 3125{,}18 + 53{,}52$$

$$Q_{sistema} = 3178{,}1[W]$$

4.3 DESCRIPTION OF THE TEMPERATURE CONTROL SYSTEM

The system of control of temperature is the responsible of::

Take the control of the process of on and off of the niquelinas.

The required information from the sensor.

Process the information in the control unit.

Run actions on the actuators to correct any failure.

4.3.1 MATHEMATICAL SYSTEM OF TEMPERATURE MODELING

For the modeling mathematical of the system of temperature is raises that the heat flows from the inside of the container of resistances heating toward the outside, by what is has:

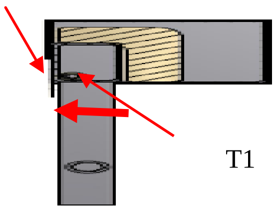


Fig. 6. Flujo de calor del sistema

$$R\,C\frac{dT}{dt} + T_1 - T_2 = 0$$

(6)

Where:

T1: Temperature inside.

T2: Temperature outside.

R: Heat resistance: 0,000488 [$^{\circ}\mathrm{C}/_W$]

C: Thermal capacitance: 3751,355 [$J/°\mathrm{C}$]

Applying the transformed of laplace; with conditions start them equal to zero and developed the equation in a function of transfer [11], [3]; is obtained the following

$$\frac{T_2}{T_1} = \frac{\frac{1}{RC}}{s + \frac{1}{RC}}$$

$$\frac{T_2}{T_1} = \frac{0{,}55535}{s + 0{,}55535}$$

4.4 CALCULATION OF PARAMETERS OF STABILITY

TABLE II
PARAMETERS OF THE SYSTEM'S TEMPERATURE

Parámetro	**Valor**
Tiempo de establecimiento(t_s)	$\mathbf{7{,}32}$ [s]
Error de posición(e)	**1** [%]
Máximo sobre impulso(Mp)	–

4.5 COMPENSADORES PI

To the treat is of a function of first order, is advisable use a driver PI, the method for find them values of KP and KI, is presented below[11].

$$G_s = \frac{M_{(s)}}{E_{(s)}} = K_P + \frac{K_I}{s}$$

(7)

Donde:

M (s): Variable to check.

E (s): Sign in error.

The PI system of temperature compensator can be seen in (8)..

$$G_{(s)} = \left(K_P + \frac{K_I}{s}\right)\left(\frac{0.5535}{s + 0.5535}\right)$$

(8)

Where:

Kp= Proportional gain..

Ki= Gain comprehensive..

Performing the corresponding mathematical arrangement to match the factor $\left(K_P + \frac{K_I}{s}\right)$ the denominator representing plant $\left(\frac{0,5535}{s+0,5535}\right)$ of (8) ; and simplifying the function has the following:

$$G_{(s)} = \frac{K_P}{s}\left(s + \frac{K_I}{K_P}\right)\left(\frac{0.5535}{s+0,5535}\right)$$

To cancel those factors $\left(s + \frac{K_I}{K_P}\right)$ y $\left(\frac{1}{s+0,5535}\right)$; You must comply with the condition of (9 factor).

$$\frac{K_I}{K_P} = 0.5535$$

(9)

TABLE III

PARAMETERS OF COMPENSATOR PI.

Parámetro	**Valor**
K_P	3,61
K_I	2

With that the Compensator is in the following way:

$$G_{(s)} = \left(3,61 + \frac{2}{s}\right)$$

(10)

Simulating in the simulink environment the following graphs are obtained.

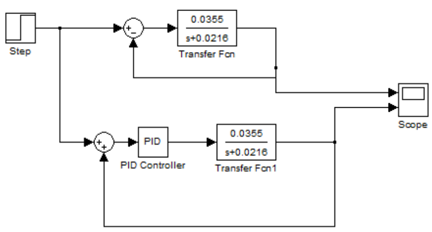


Fig. 7. System without driver and with driver PI..

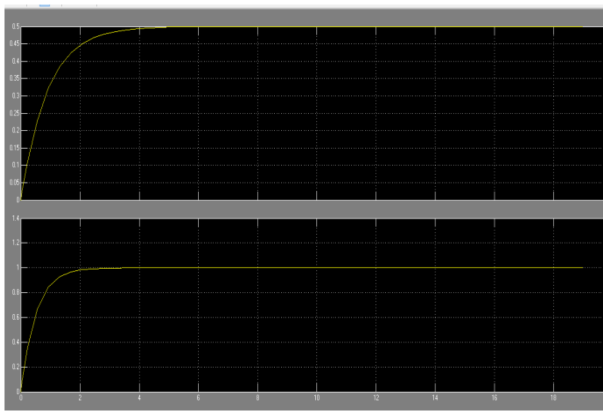


Fig. 8. Response of the system without a controller and PI controller

In Fig. 8. You can appreciate that the error tends to zero, while the time of establishment is reduced to 2 [s]

4.6 DISCRETIZATION OF THE DRIVER

Discrete in the controller signal is acquired through (11)

$$\frac{m_{(z)}}{e_{(z)}} = K_P + K_I \frac{z}{(z-1)} * T_m$$

(11)

Where:

T_m: Is the time of sampling: 20m¨ [s]

Reducing the expression above is observed:

$$\frac{m_{(z)}}{e_{(z)}} = \frac{K_P + (-K_P + K_I * T_m)\, z}{z - 1}$$

(12)

Replacing values of K_P, K_I y T_m in (11); the system of temperature controller is determined in the following manner

$$\frac{m_{(z)}}{e_{(z)}} = \frac{3,61z - 3,57}{z - 1}$$

In Fig. 9, you can see the simulation in the surroundings of simulink from the system with the driver implemented; showing his response in Fig 10..

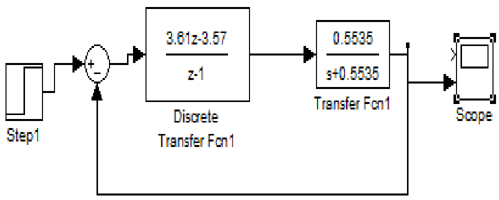


Fig. 9. System with digital controller

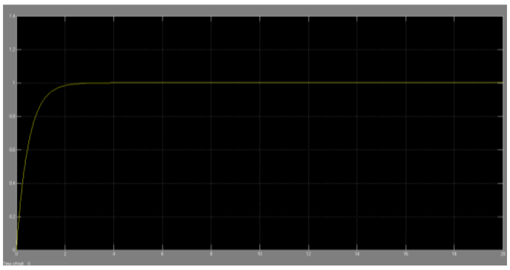


Fig. 10. Response of the system with digital PI controller,

To implement this equation in the microcontroller, the expression is the equivalent difference equation; represented by the

$$m_{(k)} = K_P e_{(k)} + (-K_P + K_I * T_m)\, e_{(k-1)} - m_{(k-1)}$$

(13)

Where the values of KP and KI are the same of the driver analog that is designed previously, the time of sampling is chose a value of *twenty* [ms] milliseconds. Replacing those values is has the equation that is implemented in the microcontroller [11]

$$m_{(k)} = 3{,}61\, e_{(k)} - 3{,}57 e_{(k-1)} + m_{(k-1)}$$

5 *IMPLEMENTATION*

In the Fig. 11 and fig. 12, the implemented systems can be seen

5.1 *IMPLEMENTATION OF THE SYSTEM OF HUMIDIFICATION*

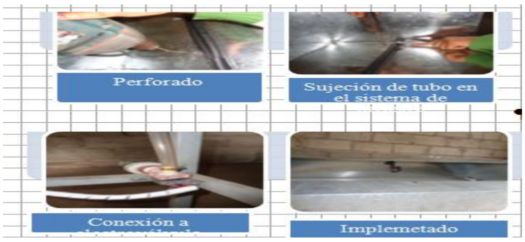


Fig. 11. Implemented system

5.2 *IMPLEMENTATION OF THE SYSTEM OF IRONING*

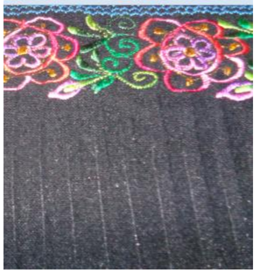
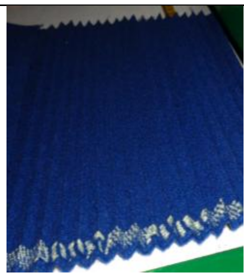
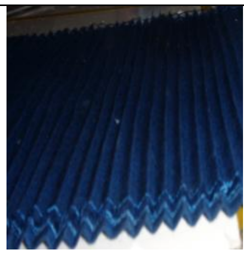
Fig. 12. System implements

6 *TESTS*

Is have made tests both of the sensors and actuators implemented in those two systems; having a satisfactory response to the needs of the machine with an error of zero.

To others; is have carried out tests of temperature optimum of pleated, whose results can appreciate is in the following table:

TABLE IV
PRUEBAS DE TEMPERATURA ÓPTIMA

Temperature of test: 100 ° C **Appreciation:** Retrieved pleat is weak; be made recordings of fold subtle; so for the final pleat folds handling is difficult; It tends to lose the set in the decorated part	
Temperature of test 115ªC: **Appreciatión**: Retrieved pleat is weak; be made recordings of fold subtle; so for the final pleat folds handling is difficult; It tends to lose the set of crease in the embroidered part.	
Test temperature: 130° C **Appreciation:** The pleated retrieved lowly strong; be made recordings of fold moderate; so for the final pleat folds handling tends to be more manipulable	
Temperature of test: 145 ° C **Appreciation:** the pleated retrieved is fairly strong; will perform lines well marked on the fabric; so for the final pleat folds handling becomes easier	
Temperature of test: 150 ° C **Appreciation:** Strong retrieved pleat; are moderately strong crease markings; by what the manipulation of the folds for the pleated end is easy.	

7 *CONCLUSIONS AND RECOMMENDATIONS.*

7.1 *CONCLUSIONS.*

By means of interviews and the properties thermal of the material; have been to determine the parameters influencing appropriate pleat fabric, these are: the temperature of iron; moisture from the fabric and ironing time. is determines a temperature of set of fold satisfactory 150 ° C with a time of depressed for 15 seconds and humidity moderate

With *three* KW of heating elements, we have managed to obtain an adequate formation of folds; without Burns total or partial of the material; exploiting to the maximum the moisture supplied on the fabric.

The selection of them materials to implement in the machine plisadora of fabric, is made based on them calculations of design and to the dimensions of the machine. For the proper wetting of the fabric; the micro pulverizer was selected based on the little absorbing properties of the material; that is, that pressure is required to make the fabric to absorb water. Given that the iron is in contact with water, it has opted for a galvanized steel material. It has as unit of control a micro controller atmega; the actuators and sensors are selected according to the requirements of the machine

The implementation of components was carried out based on the selection of elements and the relevant calculations for the iron should be: to reach the temperature required by the system was implemented 3 resistances heating in parallel; While the mounting of the moistening system took into consideration the dimensions of the machine

The tests start them made with temperature of 100 ° C observed that the pleated is weak and little manageable; These characteristics are changing the pleated temperature increases up to 150 ° C; the increase of temperature and time of ironing make that the folds are marked of best way in the fabric. The Endowment moderate of water allows that the step of the material by the iron and eliminates the accession of the material to the table with a time of activation of the solenoid valve of 1 [s] each 4 [min].

The development of the user manual and troubleshooting guide, allows the operator to become familiar with all control system and with it; provides the facilities to correct any mishap during the process of pleated in a way more ajil; It also helps to keep in perfect working condition quickly

7.2 RECOMMENDATIONS.

To make the design and implementation of the system is important have in clear the variables to control; as well as physical phenomena present in the system, so for the pleat from another type of different acrylic cloth fabric, is important to perform the relevant tests (trawling fabric, fabric, etc. melting facility) new material in order to obtain the new values of the parameters temperature and humidity, suitable design.

To have a greater accuracy in the time of response of sensor of temperature, is recommended, the use of a sensor of temperature more exact, this since the sensor LM 35 presented in them tests a slight delay in the reading of the temperature.

In tests was determined at the start of the activity of ironing is presenting an average time of 2, 94minutos [min] in which the iron starts its heating from ambient temperature to working temperature; so for faster heating of the iron is recommended the addition of a larger number of heating elements; with what is change the time of transfer of heat by conduction.

Maintenance of the electrical part is lower as compared to the mechanical part, however it is recommended to have a log of errors that arise, in order to assess the performance of the machine.

Because there is a warming in some of the components of the control system; is recommended to install a proper ventilation; taking into account the environment the environment in which work the machine.

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About the author.

Tabitha. Quilumbaquin A., was born in Ibarra - Ecuador, 03 October 1988. I make his secondary education at the Colegio Nacional San pablo, culminated his studies in Northern technical college in the

career of engineering in Mechatronics in 2015
Areas of interest: automation and control of industrial processes, electronics, micro controllers, robotics, CNC, alternative energy

(tquilumbaquina@utn.edu.ec