UNIVERSIDAD TÉCNICA DEL NORTE

FACULTAD DE INGENIERIA EN CIENCIAS APLICADAS

CARREA DE INGENIERÍA EN MECATRÓNICA

TEMA:

"SISTEMA DE MOLDEO A INYECCIÓN ESTILO LINEAL PARA UNA EXTRUSORA DE PLÁSTICO RECICLADO".

INFORME TÉCNICO

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2013

INJECTION MOLDING SYSTEM FOR LINEAR STYLE RECYCLED PLASTIC EXTRUSION

(June 2013)

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I. SUMMARY

The detailed work makes three meanings, recycle, reduce and reuse, the need for resolving the problems of environmental pollution, was built by the technology applied to production processes and the proper use of resources, by which will contribute to improving the quality of life of the population and ecosystem conservation.

The objective of this system is reused as recycled plastic by injection molding system for a linear fashion recyclable plastic extruder having optimum cooling by water. To fulfill this objective, it has mainly the selection of more optimal complementary systems requiring production, followed by incorporation of an automatic system for controlling the water level in the cooling system, evaluating and controlling product temperature, taking into account the thickness of the product can be varied by an additional system of controlling the speed inhaler.

To not waste any resources we developed a closed loop system using a cooling tower to recirculate water depending on the level you are in the tub. This will get effectuate the desired production process and in top condition

II. INTRODUCTION

Currently these plastics are widely used as containers or wrappers or substance at discarded food items unchecked, after use, have led to huge landfills thus recycling is one of the alternatives used in reducing the volume of solid waste. This process consists of re-using materials that were discarded and that are still apt to develop other products or remanufacture the same, it is necessary to implement appropriate machinery that is useful to re use recycled plastics transform The goal made recycled plastic hose water to give 400 'of hose for each hour.

III. PROBLEM

Current practices for the management of plastic wastes include incineration, use as landfills and recycling. However:
The incinerator capacity is insufficient.
The emissions generated in their practice is highly polluting

It is developing a health crisis due to the saturation of the deposits.
Recycling, but plays an important role in the handling of waste, will never reach handle all the plastic waste that occur and also requires an additional waste management which increases the cost of a high percentage

IV. OBJECTIVES

General Purpose

Reduce contamination by injection molding system for a linear fashion recyclable plastic extruder having optimum cooling by water.

Specific Objectives

• Provide new tools for theoretical study - involving practical knowledge gained during the race, to implement a system of linear style injection molding.

• design and construct a system for cooling water circulation means that fits the mold which has injected the molten recycled plastic.

• Select a system that prevents agglomeration hauler recycled plastic melted.

• Perform functional tests.

• Perform an economic analysis and feasibility of the construction of the extruder.

V. THEORETICAL

5.1 FUNDAMENTALS OF PLASTICS

In the last 40 years their production volumes has grown a hundred times, and have come to surpass the production of steel and the growth trend is sustained.

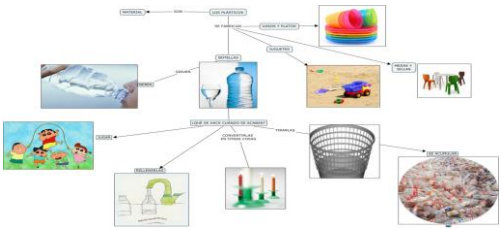


Figure 1. *Application of plastics and various uses*

PROPERTIES OF PLASTICS

a) The Society of the Plastics Industry (SPI) has developed a voluntary basis to identify codes that are used as plastic containers and packages, which are generally located at the base of the containers. These codes are:

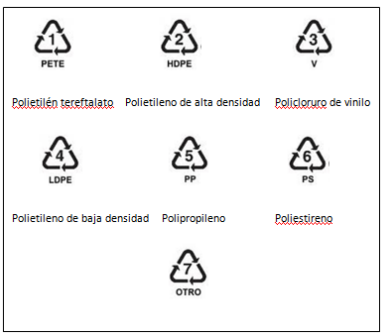


Figure 2. *Plastic identification codes given by the Society of Plastic Industries*

b) According to the trade of products containing or material in question, you can know the type of plastic so for example:
Clear plastic cups more stiff and brittle, are polystyrene (PS), while more flexible polystyrene may "shock" (Reinforced Polymer) or polyethylene (PE).

c) If there are doubts about the type of material you have, or if you specify better the results, you can follow the procedure outlined below, which identifies thermoplastics:
Cut a small piece of material and soak it in distilled water (it is essential that the piece is solid and not adhering air bubbles on the surface). If the piece fleet.

d) In order to accurately identify the plastics, determine its components and the percentage that are present, and hear more about their microstructure and their most important properties are carried out various more specific test, such as :
In trials mechanical tension, bending, hardness and impact.

e) According to the chemical family to which they belong

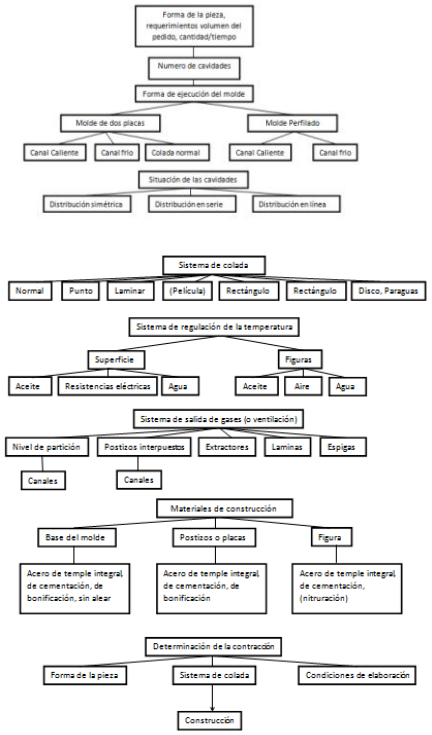
NOMBRES	SIMBOLOS NORMAS ISO
Poliolefinas Polietileno alta densidad Polietileno baja densidad Polipropileno	 HDPE* LDPE* PP
Acrílicas Polimetil metacrilato Polibutil metacrilato	 PMMA PBMA
Celulósicas Acetato de celulosa	 CA
Estirenicas Poliestireno Acrilonitrilo butadieno estireno	 PS ABS
Vinílicas Policloruro de vinilo Poliacetato de vinilo	 PVC PVAC
Poliamidas Poliamida 66 Poliamida 6	 PA 66 PA 6
Poliésteres termoplásticos Polietilen tereftalato Polibutilen tereftalato	 PETP*** PBTP****
Poliacetalicas Polioxido de metileno	 POM
Poliimidas Polimida	 PI
Policetonicas Polieter éter cetona	 PEEK
Policarbonatos	PC
Poliuretanos lineales	PUR
Polisulfona	PSU

Table 1. *Thermoplastics chemical family.*

5.2 METHOD OF MOLDING

FUNDAMENTAL ASPECTS OF MOULDS CONSTRUCTION.

If critically observes a large number of injection molds, are certain groups and classes differ from one another by construction completely different. Such a classification, if it is to be understood, it cannot contain all the possible combinations between different groups and classes. It is possible that new experiences and results require an extension of it.



Flowchart 1. *Construction the Mould*

The flow chart. Represents a method methodical and planned development of injection molds

Classification of injection molds logically governed by the main features of construction and function. These are:

- The type of casting and their separation.
- The rate of removal of the molded parts.
- The existence of external undercuts in the part to be injected.
- The type of release.

A CLASSIFICATION OF INJECTION MOULDS

DIN 16750 E injection molds for plastics containing a division of the molds according to the following scheme:

- Standard Mold (mold two plates),
- Jaws mold (mold sliding)
- Segment extraction Molde.
- Three plate mold,
- Floors mold (mold sandwich),
- Hot runner mold.

CLASSIFICATION OF CAST AND TICKETS

- Cold Wash Systems.
- According to DIN 24 450 difference between:
- Colada, as a component of the pressed, but that is not part of the piece v itself,
- pouring channel defined from the point of introduction of the plasticized mass in the mold to the entrance.
- Hall, as the runner section at the point where it meets the mold cavity.

SIMPLE INJECTION MOULDS.

Pipes:

- Piping for driving, drainage and chemicals.
- Garden hose.
- Hose for medical and automotive.
- Straws.

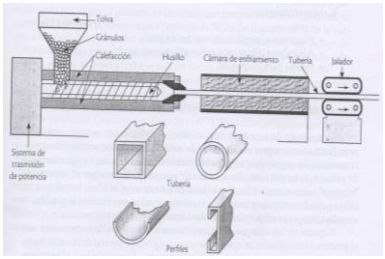


Figure 3. *Equipment for extrusion profiles*.

DESCRIPTION OF PRINT ONLINE

When a material fed to the extruder through the hopper, is caught by the screw and forced through the barrel where the heat generated by friction and the electrical resistance provided by such straps placed on the outside of the barrel, it is plasticized enough to continue their journey to the nozzle.
In this way, the energy to plasticize the material is mostly from the motor, which rotates the spindle. In most cases, cover the outside of the barrel to maintain the temperature constant.

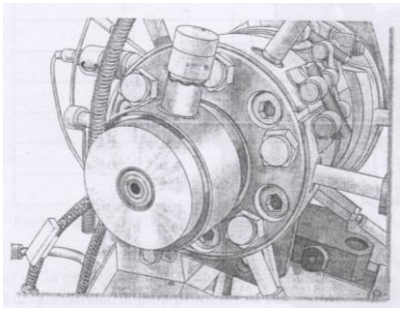


Figure 4 *Head with circular die extrusion.*

HEAD

The head is the end of the extruder, the plate is coupled to the barrel, and is formed by two plates: one attached to the barrel and a mobile, in which position the breaker plate, a support plate or converging given the die or die and the clamping ring.

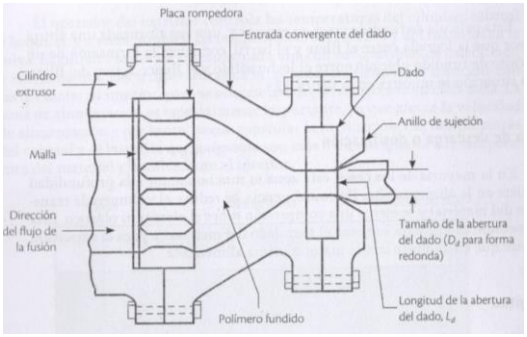


Figure 5. *Extruder head*

As stated, the goal of extrusion is the production of a continuous and specifically formed within very strict dimensional tolerance, and this is done using a matrix except in special cases, has a section that varies considerably from the finished part.

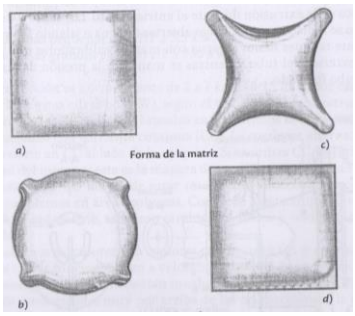


Figure 6. *Extruder head*

5.3 SYSTEMS THAT MAKE THE INJECTION MOLDS

The feed system takes care of transferring the polymer melt from the injection unit to a mold cavity.

The system consists of:

Drinker
Channels
Entrance

DRINKER

It is the connecting element between the mold and the injection nozzle of the machine. Mass leads from the nozzle to the mold where the channels. Should take into account thermal behavior and its expulsion.

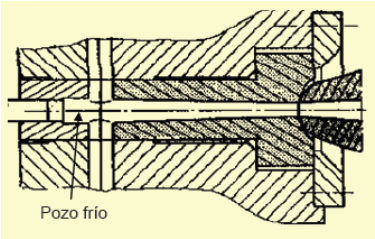


Figure 7. *Mold temperature behavior*

CHANNEL POWER

Leading the material from the spruce to the cavity entrance

• appropriate Section
• Cooling.
• Maintaining the flow until after the holding pressure.

5.4 DESIGN AND CONSTRUCTION "LINEAR STYLE MOLDING SYSTEM"

ALTERNATIVE SELECTION OF DIFFERENT SYSTEMS THAT MAKE THIS MOULDING SYSTEM.

EXTRUSION FACILITY FOR THE MANUFACTURE OF GRANULES AND ARTICLES PERFILADOS.

Generally the use of granular material to charge injection and extrusion machines significantly stabilizes the power, increases the production and quality of the manufactured articles. Granulation is recommended to combine with the plasticizing, stabilizing and coloring thermoplastic material.

For granular thermoplastic extrusion machines are typically used for one or more spindles and special machines, known granulators. Spindle machines in the material is injected through a grid-shaped wire pelletizer and cut into pellets with a cutter installed in the rack directly or after cooling in a water bath.

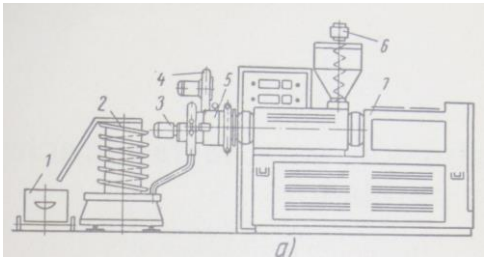


Figure 8 (a) *Installation for granulating extruded thermoplastic materials: the wire or rod is cut into pellets directly into the grid.*

MANUFACTURING FACILITIES SHEETS.

Usually extruded sheets obtainable from 0.5 to 6 mm thick and up to 3 meters wide The sheets can be smooth, with or without lining, corrugated (longitudinal and transverse), filling boards with special fiber reinforced, mesh, fabrics, etc..

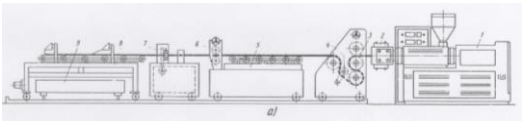


Figure 9 (a) *An installation for manufacturing sheets of thermoplastic material (a) - smooth*.

FACILITIES FOR PIPE EXTRUSION, ARTICLES AND APPLICATION PROFILES A WRAP INSULATION WIRE AND CABLES.

In principle, a plant for manufacturing pipes, rods, hoses, and other shaped articles consisting of a spindle estrusionadora 1 annular head 2 with its corresponding sorter row 3 devices 4, 5, 6 and 7 to cool, measuring, stretch and cut tube 8 pieces of predetermined length; also carries a special collector sorts the finished tubes (the figure not shown). Small diameter tubes and hoses usually are collected in coils.

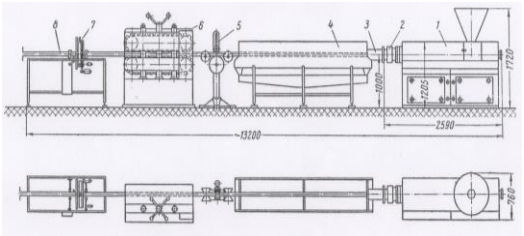


Figure 10. *Installation for extruding tubes of thermoplastic material with a 60mm diameter screw.*

SELECTION OF STARTING EXTRUSION MODELING FOR PRODUCTION

Several options are opto the facilities for extruding profiled articulated pipe which have a row of calibration tube extrusion found inside mold performs a weighting table to see its benefits and from there to with the project.

Instalaciones tuberías	País	Husillo			Producción Kg/h	Potencia en Kw	
		Diámetro mm	L:D	Velocidad rpm		Calefacción	motor
Instalación de extrusión para la granulación de materiales termoplásticos alambre o varilla	BELGICA JUMEX	48	10:01	9.0 -60	60	4.8	3
		62	11:01	9.0 -60	100	6	5.2
		82	10:01	9.0 -60	160	12.5	9
		100	10:01	9.0 -60	350	18	12
		125	10:01	9.0 -60	630	24	17.5
Instalación de extrusión para la granulación de materiales termoplásticos	REPUBLICA FEDERAL DE ALEMANIA	30	18:1 Y 24:1	13-48	10	4	3.5
		45	18:1 Y 24:1	7.0-41	25	5.5	6.5
		60	18:1 Y 24:1	6.0-39	55	10	9
		90	18:1 Y 24:1	9.0-33	140	17	22
		120	14:1 Y 20:1	8.0-29	320	24	28
		150	14:1 Y 19:1	6.0-23	470	30	35
Instalación para fabricar laminas de material termoplásticos lisa	INGLATERRA WINDSOR	80 - 85 Y 90	(16-32):1	4.0-13	30	6	3.7
		104 Y 98	(17-34):1	6.0 - 18	45	7.0 - 8	7.5
		111.5	(18-36):1	0 - 40	180	30	37
Instalación para fabricar laminas de materiales termoplásticos con ondulación longitudinal	ITALIA BAUSANO	25	10:01	10.0-90	6	0.4	0.7
		35	10:01	6.0-54	20	0.8	2.2
		60	10:01	18-32	50	2.2	3
		80	12:01	10.0 -32	100	4	6
		100	12:01	7.0-25	150	6	9
		140	12:01	6.0-20	300	6.0 - 8.0	18
Instalación para fabricar laminas de material con ondulación transversal	LUXEMBURGO MAPRE	64	12:01	0-50	100	7	12
		92	10:01	0-48	150	8	15
		102	10:01	0-50	250	14	18
		160	10:01	0-33	800	28	37
Instalación para fabricar laminas de material termoplástico con ondulación transversal	CHINA	30	18:1 Y 24:1	13-48	10	4	3.5
		45	18:1 Y 24:1	7.0-41	25	5.5	6.5
		60	18:1 Y 24:1	9.0-33	140	17	22
		100	12:01	7.0-25	150	6	9

Table 2 *Weighting benefits of installing systems.*

5.5 COOLING RESERVOIR AND TINA

One proceeds to fill the container with water (1), which is pumped into the container (2) in this container is produced momentum and heat transfer to cool the product simultaneously. The water is recirculated.

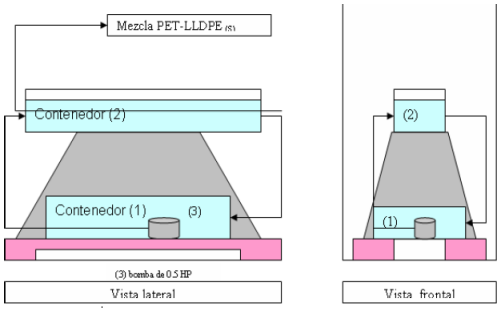


Figure 11 *Tina cooling recirculation system is manipulated flow with a valve to keep this constant.*

Heat balance in the cooling bath.

In the extruder the mixture leaves PET - LLDPE (90-100)% totally melted at a temperature of 130 - 160 ° C, which is cooled in a bath of cooling which must be kept at 5 ° C by means of a engine pump that recirculates the water where there is a heat exchanger which lowers the temperature.

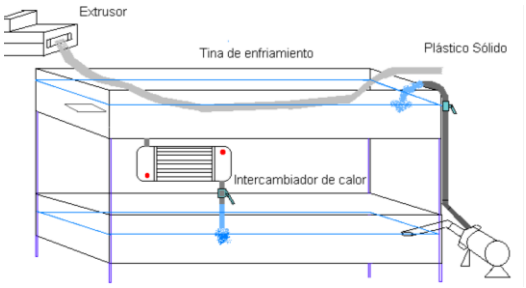


Figure 12 *Cooling System Water recirculation.*

Conditions.

Steady state, the heat conductivity varies with temperature. The highest temperature is in the center of the plastic pallet, T2 = Tw is the wall temperature of the plastic, which is hypothetically 130 - 160 ° C.

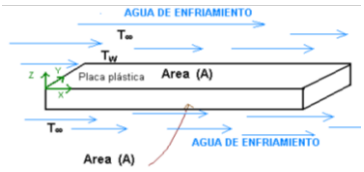


Figure 13 *plastic pallet where the face is in Z which emits more heat, because there is greater area*

These conditions can be determined by resorting to temperatures in the middle and the surface of the plate.

T = T1 in z=0

Boundary Conditions

T = T2 = Tw in z=L

In equation (2.21) we apply the boundary conditions.

$$T = -\frac{c1}{k}z + c2$$

Then C2 = T1

And

$$C1 = \frac{k}{L}(T1 - T2)$$

Substituting in the equations

$$T = T1 - \frac{(T1-T2)}{L}z$$

Heat transferred by the plastic plate (convection).

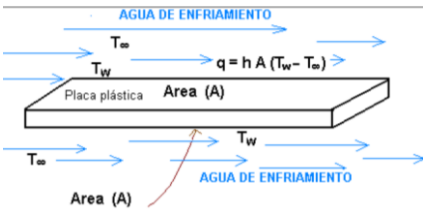


Figure 13 *plastic pallet where the face is in Z which emits more heat, because there is greater area*

A = is the area of the plate, showing that it is the part that emits heat, the area of the sides is very little heat emitted therefore was discarded. It is considered that the heat goes in one direction.

T ∞ = Temperature of cooling water.
TW = Temperature on the surface of the plastic plate.
h = Coefficient heat transfer by convection.
The transfer area is 2A.

Assumptions:

Steady state.
The water takes the heat from the plastic.
Water constant properties for each of the set temperatures.
The Reynolds system is subject to each of the set temperatures, which is performed every run.

Correlation (Pohlhausen) heat transfer by convection external flow, that for a board.

h= 0.664 (Re)1/2(Pr)1/3(k/L)

NVL = 0.664 (Re)1/2(Pr)1/3

$$h = \frac{NVL\ k}{L}$$

Properties of water at 1 atm

T(°C)	$\rho\ (\frac{kg}{m^3})$	$\mu\ (\frac{kg}{m.s})$	$k(\frac{w}{m.°C})$	$Cp(\frac{kJ}{Kg.°C})$	Pr
5	999.75	0.0015	0.576	4.2069	11.167
11	999.55	0.00137	0.5868	4.1936	9.2166
35	993.6	0.00084	0.6256	4.174	4.7194
36.08	963.85	0.000814	0.6068	4.049	4.5781

Table 3. *Properties of water at different temperatures.*

The rules and calculations detailed above we obtain that the most optimal cooling tub to build detailed in the following table of weights.

TINA DE ENFRIAMIENTO		
Características		Dimensionamiento
Estructura	Diámetro (mm)	1500 - 2000
	Base (mm)	395 mm
	Altura (mm)	292,280 mm
	Boquillas de entrada manguera (in)	1/2" - 2"
	Boquillas de salida manguera (in)	1/2" - 2"
	Temperatura promedio de estándar °C	5°,11°,35°
	Riel de desplazamiento horizontal (mm)	300mm
	Desplazamiento de calibración (mm)	150 mm
	Forma	Rectangular
	Volumen de agua	307098.596

Table 4. *Feature Weighting cooling tub*

Hauler tube and cutter.

The stretching device has four pairs of roller bearings 1 rubber coated. Drawing the minimum speed are usually 0.5 to 1.1 m / min. A suitably designed drive ensures smooth change of the speed covering a range of 1:9. Engine power is 0.5 kW. To form the necessary vacuum-stepped pump is used 4 to 5 m³ / h, an electric motor powered by 0.5 to 3kW. When calibration is required through pump compressed air can be easily replaced by a compressor.

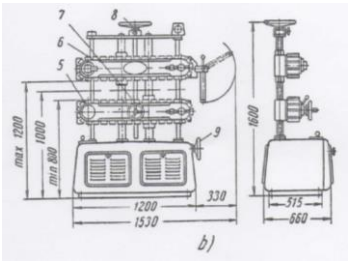


Figure 15. *Auxiliary devices for the manufacture of tubes, (b) - From caterpillar to the tube drawing*

Main features several facilities Soviet one and two spindles for the manufacture of pipes, hoses and shaped articles.

TABLA 2.3	Características técnicas de las instalaciones soviéticas para la fabricación de tubos, mangueras y artículos perfilados						
Parámetros	591681	591856	591670	AT-2-90-32110	591673	591627	513568
Diámetro del husillo, mm.	20	45	65	2 x 90	125	2 x 125	45 y 20
Relación L:D	25	25	20	12	30	12	25
Velocidad de giro del husillo, rpm	26-260	hasta 300	hasta 180		hasta 125	3.75 -15	
Producción máxima, kg/h	9	80	80	83	270	160	45
Velocidad de estirado, m/min	0.5 -14	0.5 - 10	0.5 -10		3		0.5 - 8
Dimensiones de los artículos:							
diámetro exterior, mm	10	6.0 - 50	10.0 - 50	32 - 110	110 - 160	125 - 400	
longitud, m		hasta 12		6	6.0 - 12	6.0 - 8	
sección de perfil, mm	20 x 15						
Números de motores:							
de corriente continua	3	3	3		2		3
de corriente alterna	1	6	4		8		2
Potencia de los motores , kw	5	25,9	28,5	54	155	70	22
Potencia de calefacción, kw	3	32,7	33,3		110		15.6
Consumo, m³/h:							
de agua	0,1	3	0,6	1	4	1,5	0,55
de aire comprimido	1,5	4		0,5	4,5	1	
Dimensiones (superficie de base x altura), m	10,2 x 0,74 x1,6	23,3 x 2,3 x 3,3	31,2 x 2 x 2,3	20 x 3,1 x 2,2	39,4 x 2,6 x 4,6	24,7 x 1,3 x 2,6	4,3 x 3,5 x 2,1
Peso de la maquina, KN (t)	15	55	54	69	158	178	35
	1,56	5,5	5,43	6,97	15,8	17,8	3,5

Table 5. *Main characteristics of several Soviet facilities.*

Selecting based on the production inhaler.

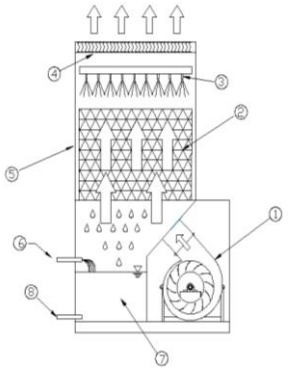
It took several alternatives haulers to find the best option for this system to optimize production.

Características de haladoras de rodillos						
Parámetros	HPIII, Fette	RS21,Manesty	DPIII5, Stokes	DDS-2, Stokes	280-47, Colton	APP - 20 - 200
País	Inglaterra windsor	Bélgica	Italiana Bausano	China	Republica federal Alemana	Italiana Macris
Diámetro de husillo, mm	20	32	45	83	90	20
Relación L/D	25	25	25	20	20	25
Velocidad de giro del husillo r.p.m.	12,5-125	11-160	9,0 - 90	7,5-75	11,0-72	12,5 - 125
	18-180	14-140	12-118	10-100		18-180
	26-260	21-212	18-180	15-150		26-260
Resistencia total de cabeza perfiladora mm²	0.035	0,075	0,1	0,105	3,05	0,045
Formado por rodillos		ok	ok	ok		
Formado por orugas	ok				ok	ok
Velocidad mínima m/min	0,10	0,12	0,13	0,14	0,18	0,1
Velocidad máxima m/min	30	45	60	70	95	32
Esfuerzo máximo (KN o Kg)	1 o 100	1,5 o 150	2 o 200	3 o 300	4 o 450	1,2 o 120
Adecuado para tubos hasta (pulgadas)	1/2"	1"	3/2"	2"	4"	1"
Motor eléctrico (hp)	1/4hp	1/4 hp	1/2 hp	1hp	2hp	1/4hp
Voltaje (v)	110/220	110/220	220-240	220-240	360/480	110/220
Frecuencia (hz)	60 hz	50hz	60hz	60hz	60hz	50hz
Factor de frecuencia fp	0.83	0.83	0.83	0.83	0.83	0.83
Amperios	0,7/1	0,75/1,2	1,72/2,96	1,72/2,96	2,76/3	0,7/1
Variador de frecuencia	ok	ok	ok	ok	ok	ok

Table 6. *Ponderación of characteristic of halador*

5.6 COOLING SYSTEM

Torres natural circulation. - Natural circulation towers fall, in turn, atmospheric towers and natural draft towers.



Figures 16. *Parts of a cooling tower.*

1. Fan: is a mechanical element that directs air into the landfill, this element can be centrifugal or axial type depend on the design application and the type of cooling tower.

2. Filling: is a structure that is located within the tower and can be metal, plastic or wood, its function is that the water crosses inside can be split into smaller droplets and the droplets remain as amount of time within the body of the tower to ensure optimal heat transfer. Likewise helps the airflow is evenly distributed within the body.

3. And sprinkler distribution system: They are in the top of the tower and allowing the hot water enters the tower in drops to increase its contact surface.

4. Hauling scavengers: carries scavengers or cortadotas are structures located on top of the tower and are intended that droplets are not entrained in the air stream out of the system.

5. Body: This part is the structure that gives shape to the tower, the materials with which it can be constructed can be metal, concrete, wood, fiberglass or a combination of them.

6. Liquid return pipe: As the evaporation of water is necessary to go restoring it, for this purpose there is a pressure line that maintains constant reservoir level.

7. Reservoir: Located at the bottom of the tower and is a tank in which cold water is collected for her to return to the system (thermal load).

8. iquid outlet pipe: This pipe is located in the lower level of the reservoir and is intended to remove water that has been cooled and sent to the thermal load.

5.7 SIZING OF DIFFERENT SYSTEMS THAT MAKE THE LINE MOLDING SYSTEM SELECTED.

MOULDING SYSTEM SELECTION

Moulding begins with the placement of the mold in the machine and ends when all systems are connected in operation of the mold. The difference is that prior to assembly analysis sometimes started with the placement of the machine you replace. After the analysis has defined a list of molds with their respective priorities machine so that this operation was removed. Priority is established according to the best fit mold-machine while working with the cast, the latter was established considering efficiency of the machine.

The assembly begins with placing the mold in the machine. The mold must be located at one end of the machine with their respective components.

Molde	
Características	Parámetros
Ref. molde	23.99
Descripción	molde macho
Maquina china	VD 1000-B
Para rev.	95
Zona de Salida de Extrusión	A
Cavidades	1
Opción	4
Descripción	molde hembra
Maquina plasgo	R100B
Para Rev.	30-95
Zona de Salida de Extrusión	B
Cavidades	1
Opción	3
Modificaciones	4
Moldes plasgo (pule)	1/2" hasta 2"

Table 7. *Selection of the shaping system*

TUB SIZING COOLING.

For sizing the cooling bath should take into account the parameters of production in order to meet production requirements by which a system has been developed as a shirt in order to get efficient cooling using a level control for water filling for cooling whereby either taken the following characteristics for construction of the vat cooling.

TINA DE ENFRIAMIENTO		
Características		Parámetros
Estructura	Diámetro (mm)	1500 - 2000
	Boquillas de entrada manguera (in)	1/2" - 2"
	Boquillas de salida manguera (in)	1/2" - 2"
	Temperatura promedio de estándar °C	5°,11°,35°
	Riel de desplazamiento horizontal (mm)	300mm
	Desplazamiento de calibración (mm)	150 mm
Control de nivel	Voltaje (v)	220/240
	Código	B,F,M
	Sondas para detección de nivel de líquidos	LA9-RM201
Re alimentación	Bomba (hp)	1hp
	Velocidad (rpm)	1400 rpm
	Corriente (A)	1.2 A
	Reservorio de agua (lt)	500 lt

Table 8. *Dimensions of cooling tub.*

SELECTION OF PIPE HAULER.

Para la selección hay que cumplir los siguientes parámetros por medio de tablas mediante el cual se toma en cuenta la producción que entrega la maquina. Para el estirado de tubo se empleo un sistema de dispositivos de rodillos de sujeción mecánica estos dispositivos de rodillos cubierta de goma porosa con un variador que permite cambiar las velocidades para distintos espesores.

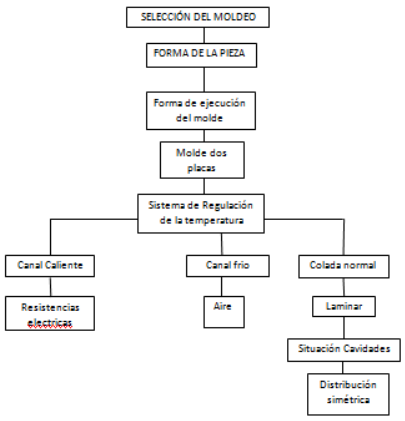
Características de haladores de rodillos	
Parámetros	DDS-2, Stokes
País	China
Diámetro de husillo, mm	63
Relación L:D	20
Velocidad de giro del husillo r.p.m	7,5-75
	10-100
	15-150
Resistencia total de cabeza perfiladora mm³	0,105
Formado por rodillos	ok
Formado por orugas	
Velocidad mínima m/min	0,14
Velocidad máxima m/min	70
Esfuerzo máximo (KN o Kg)	3 o 300
Adecuado para tubos hasta (pulgadas)	2"
Motor eléctrico (hp)	1hp
Voltaje (v)	220-240
Frecuencia (hz)	60hz
Factor de potencia fp	0.83
Amperios	1,72/2,96
Variador de frecuencia	ok

Table 9. *Selection of pipe halador*

CONSTRUCTION AND INSTALLATION

Installing molding system.

For the selection and construction of injection parts and associated molds are used with increasing frequency fine element method profiling, this method reduces development time and costs, and to optimize the functionality of the parts. Only when the parts are determined and all demands that influence the design of a mold can run this final construction. Thus is selected to DIN E 16750 1/2 "to 2" hose profilers molds whose standard Molde division (two-plate mold).



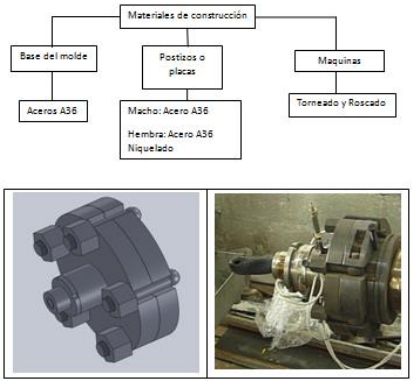
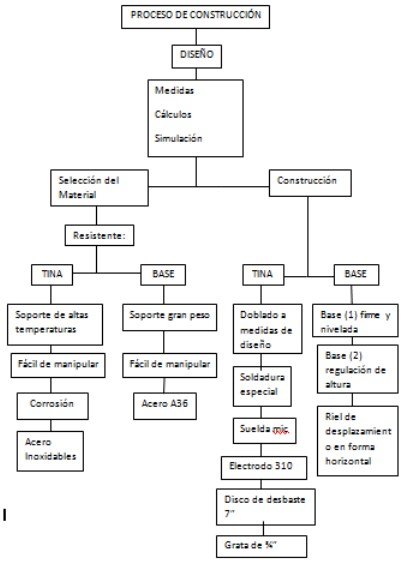
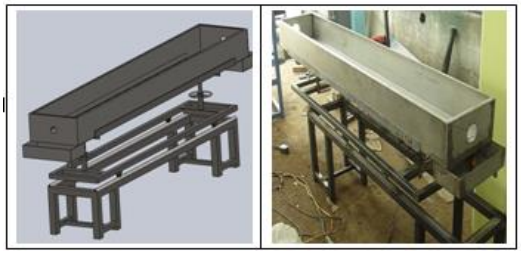


Figura 16. *Diseño de la selección del molde*

Construction of the cooling bath.
Is intended to remove the heat surplus that retains the pipe at the exit of the calibration tank. The importance lies in the stability acquires plastic to deform to pass through a shooting unit, from which the tube is subjected to pressures that could cause alterations in the circular shape required. Which is dimensioned for the immersion cooling, the tube passes through a cooling bath, and is carried out by heat exchange also constant immersion diameter pipe where the high speed extrusion requires a intense cooling.

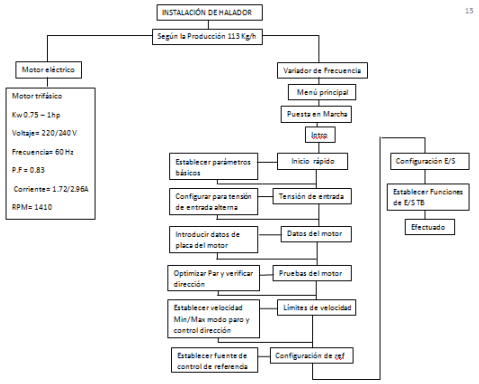


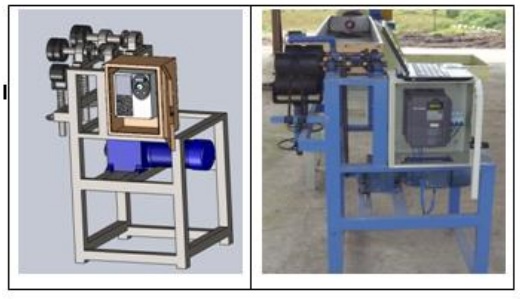


Figures 17. *I design and construction of cooling tub.*

SYSTEM INSTALLATION PIPE HAULER.

Once you leave the tube completely rigid cooling tub goes through a circulation system for which you use a squeegee or puller which function will pull the tube. This transport squeegee also has the function of controlling the thickness of the pipe by regulating the speed obtainable walled tubes of different thickness.



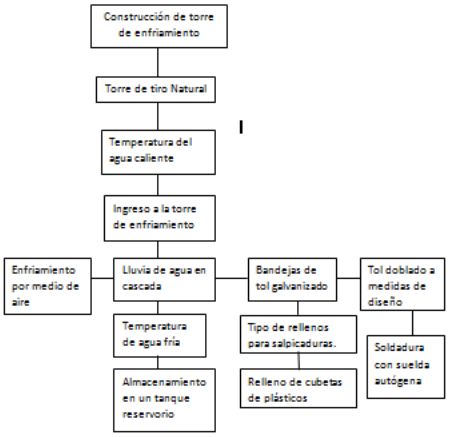


Figures 18. *Installation of the halador*

SIZING OF COOLING TOWER.

This design is intended to cool a flow of water by partial vaporization of this with a consequent exchange of sensible and latent heat from a stream of cold, dry air flowing in the same pipe circuit towers can be of many types but nevertheless the

focus is on the following draft cooling tower naturally.



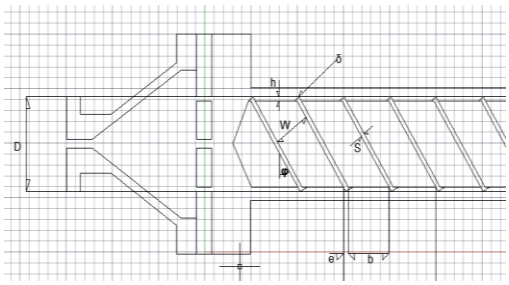
Figures 19. *Dimensionamiento of cooling tower.*

VI. CALCULATIONS, SIMULATION AND TESTING

PRODUCTION CALCULATIONS. Madder Flow

To find the temperature of the mold need to know the output of the extruder.
We need to determine the production of an extruder, which produces tubes of low density polyethylene, with constant width and depth of the channel, the screw is a single thread or channel (m = 1).

The technical characteristics of the extruder were: screw diameter D = 63mm, L = 1512mm length, radial clearance between the tip of the spindle and the cylinder δ = 0.0064mm, apex width e = 6.3 mm, helical channel step t = 63mm , channel depth h = 3 mm, and the total head resistance profiling ³ k = 0.105 mm by rotating the spindle n = 90 rpm.



Figures 20. *Section of the screw and mold general data.*

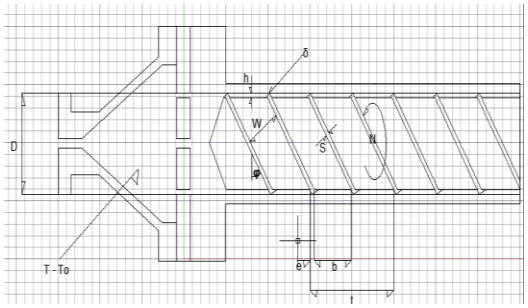
Producing a pipe extruder.

$$Q = \left(\frac{\alpha\, k}{k+\beta+\gamma}\right).n \quad (4.5)$$

$$Q = \left(\frac{(23{,}43)\,(0{,}105)}{0{,}105 + 8{,}78\,x\,10^{-5} + 3{,}43\,x\,10^{-8}}\right).90$$

$$Q = 2108.56\ \text{cm}^3/\text{min}$$

TEMPERATURE CALCULATION OF MELTED GRANSA



Figures 21. *relationship of temperature and variables*

$$T - To = \frac{n}{b}\ln\left(\frac{bl}{nch}\left(\frac{\pi Dh}{mo\ h}\right)^{\frac{1}{n}}\ S + 1\right)$$

$$T - To = \frac{6}{1}\ln\left(\frac{1(1512)}{3(1,98)(0{,}46)}\left(\frac{\pi(63)(0{,}46)}{1\ (0.46)}\right)^{\frac{1}{6}}\ 4538195,25 + 1\right)$$

$$T - To = \frac{6}{1}\ln(\ 3{,}950538751\text{x}10^{13})$$

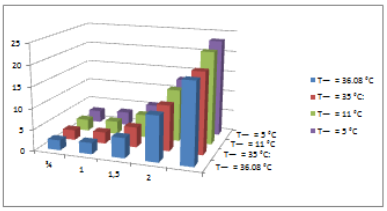
$$T - To = 140.736\ ^{\circ}\text{C}$$

CALCULATIONS OF COOLING JACKET.

It is noteworthy here is not needed between taking an average wall temperature of the plastic and the water temperature, because this value T remains fixed by means of the recirculation of water and a heat exchanger.

	Q	Q	Q	Q
Diámetros de tubos (pulgadas)	T_∞ = 5 ºC	T_∞ = 11 ºC	T_∞ = 35 ºC	T_∞ = 36.08 ºC
½	2.90 W	2.75 W	2.39 W	2.27 W
¾	3.27 W	3.09 W	2.69 W	2.56 W
1	5.814 W	5.50 W	4.79 W	4.55 W
1 ½	13.08w	12.39 W	10.79W	10.17W
2	23.24 W	22.03 W	19.18 W	18.22 W

Table 10. *Heat table transferring the plastic tube into the water.*



Figures 22. Representation of the heat that transfers the tube of plastic toward the water.

Water cooling is desired from an estimated temperature TL2= 43,3 ºC (110 ºF) to TL1= 29,4 ºC (85 ºF) in a water cooling tower packed countercurrent working with airflow G = 1.356 kg de aire seco/s´m² and a water flow rate of water L= 1.356kg the agua/s´m². Incoming air is 29,4 ºC and a wet bulb temperature of de 23,9 ºC. The mass transfer coefficient kGa is an estimated value of 1,207 x 10^{-7} kg mol/s´m³ . Pa y hLa/kGaMBP is 4.187 x 10^{4} J/kg´K (10.0 btu/ lbm ´ºF). Calculate the z height of the packed tower. The tower is operated at a pressure of 1.013 x 10^{5} Pa.

SOCIO ECONOMIC ANALYSIS

Considering the budgets established in the proceedings of decentralized autonomous Government of Otavalo. Can plan application possibilities maturing periods and update process.

COST BENEFIT

It takes the income and expenses net present income statement, to determine what are the benefits for every dollar that is sacrificed in the project.

Año de operación	costos totales (usd)	Beneficios totales (usd)	Factor de actualización 10,7%	Costos actualizados (USD)	Beneficios actualizados (USD)	Flujo neto de efectivo actual (USD)
0	0	-16000	1	0	-16000	-16000
1	77880	288000	0,903	70355,15	260173,15	189817,99
2	82093,30	303580,8	0,816	74925,57	277074,55	202148,97
3	86534,55	320004,52	0,737	79710,52	294769,28	215058,75
4	91216,07	337316,76	0,666	84715,83	313278,89	228563,06
5	96150,86	355565,60	0,602	89957,40	332662,20	242704,79
6	101352,6	374801,70	0,543	95463,93	353025,34	257561,41
7	106835,8	395078,47	0,491	101222,971	374322,23	273099,26
8	112615,6	416452,22	0,443	107277,52	396711,96	289434,44
9	118708,1	438982,28	0,401	113614,716	420146,87	306532,15
10	125130,2	462731,22	0,362	120283,44	444807,79	324524,33
11	131899,7	487764,98	0,327	127284,74	470698,57	343413,836
12	139035,5	514153,07	0,295	134646,90	497923,82	363276,92
13	146557,3	541968,75	0,267	142370,38	526485,24	384114,86
14	154486,1	571289,26	0,241	150502,40	556557,42	406055,02
15	162843,8	602196,01	0,218	159045,34	588149,18	429103,84
total	1733339	6393885,6		1651376,87	6090786,57	4439409,7

Table 11. *Indicators of financial profitability.*

VII. CONCLUSIONS RECOMMENDATIONS.

CONCLUSIONS

When designing a mold for one piece plastic pipe profiling, it is important to consider that the objective is to produce pipe with the best possible quality and in an injection cycle as short as possible, because it takes a lot of skill and speed of the operator to get to start shaping the hose.

Initial production is always flawed because the system requires a stabilization in the air flow, working temperature and guiding the hose through the inhaler until a good conformation.

The materials selection for the mold plates is important, since their function is to allow the molten plastic flow as smoothly as possible and provide a better surface finish, avoiding imperfections such as porosity and surface roughness in the product.

We designed and built a cooling tub that if meets the requirements of cooling the extruded product and to solidify for better consistency and rigidity.

Through an inhaler it was found that by changing the speed can get larger pipe thickness.

The optimal process for extruding waste HDPE was obtained at an average temperature of 140 across the barrel °C and a rotation speed of 90 rpm of the screw getting a flow of 113 kg / h.

The extrusion system is designed independently of the finished product, this means that different products can be obtained only by changing the profile of the nozzle.

The final product is of good quality and meet consumer requirements, allowing proper placement in drinking water pipes without presenting ruptures.

RECOMMENDATIONS

We must take into account the characteristics of the polymer which is thought to work as temperatures and pressures vary with the polymer, even more so when working with recycled material.

Taking into account the appropriate safety standards using PPE, personal protective equipment in the case of people who are going to manipulate the machines.

Perform a head cleaning and mold before starting production. one way to clean PVC pieces is put in the hopper of the machine to be cast since this plastic is clean, and is able to drag the impurities inside the mold.

Always check that the control electrodes of the tub level cooling signal to the relay send level to turn on the LED's.

Clean trays cooling tower of impurities that are within these as they could cause clogging strainer holes to be exposed to the open field.

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