Palestine Polytechnic University

College of Engineering

"Design and implementation an Environmental Paper Recycling Machine for Heat Purposes"

Prepared

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إهداء

.إلى معلمنا و قائدنا وحبيبنا وشفيعنا و قدوتنا محمد صلى الله عليه وسلم

إلى من رسموا بدمائهم خارطة الوطن وطريق المستقبل وهندسوا بأجسادهم معاقل العزة والكرامة وإلى من هم أكرم منا جميعا شهداء الوطن الحبيب.

إلى الذين عشقوا الحرية التي تفوح منها رائحة الياسمين وتواروا خلف القضبان ليفسحوا لنا النور أسرانا البواسل.

:إلى أبي الذي لم يبخل علي يوماً بشيء، وأمي التي زودتني بالحنان والمحبة أقول لهم

.أنتم وهبتموني الحياة والأمل والنشأة على شغف الإطلاع والمعرفة

.إلى إخوتي و أسرتي جميعا

.إلى كل من علمني حرفاً أصبح سنا برقه يضيء الطريق أمامي

.إلى من ضاقت السطور لذكرهم فوسعتهم قلوبنا أصدقاءنا الأعزاء

إلي كل من أضاء بعلمه عقل غيره، أو هدى بالجواب الصحيح حيرة سائليه، فأظهر بسماحته تواضع العلماء، وبرحابته سماحة العارفين.

إلى من رسم معنا خطوات هذا النجاح الى من بذل جهده ووقته وكان لنا مرشداً وناصحاً وأخاً مشرفنا الحبيب الدكتور سمير خضر

Abstract

"Design an Environmental Paper Recycling Machine for Heat Purpose"

In this project we designed a machine working on recycling of paper and use it for heating in order to preserve the environment by taking advantage of unused paper quantity which is waste and also to get another source for heating

الملخص

"تصميم ماكنة اعادة تدوير الورق البيئية لاغراض التدفئة "

في هذا المشروع قمنا بتصميم ماكنة تعمل على اعادة تدوير للورق واستخدامه في التدفئة بهدف المحافظة على البيئة من خلال الاستفادة من كمية الورق الغير مستخدمة والتي تعتبر نفايات وكذلك للحصول على مصدر اخر للتدفئة

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1.1 Overview

Modern technology plays a critical role in safeguarding the environment. This is made possible by the development of modern paper recycling machines. Most of these machines make use of waste paper thereby saving the natural trees from being cut down. They convert waste paper into more usable forms. The machines have embraced the digital technology that has made it possible to produce high quality products.

It process of waste paper recycling involves mixing used paper with water and chemicals to break it down It is then chopped up and heated

1.2 Background

About this Issue in the world:

European Union:

Paper recycling in Europe has a long history. The industry self-initiative European Recovered Paper Council(ERPC) was set up in 2000 to monitor progress towards meeting the paper recycling targets set out in the 2000 European Declaration on Paper Recycling. Since then, the commitments in the Declaration have been renewed every five years. In 2011, the ERPC committed itself to meeting and maintaining both a voluntary recycling rate target of 70% in the then E-27 plus Switzerland and Norway by 2015 as well as qualitative targets in areas such as waste prevention, ecodesign and research and development. In 2014 the paper recycling rate in Europe was 71.7%, as stated in the 2014[1].

Japan:

Municipal collections of paper for recycling are in place. However, according to the Yomiuri Shim bun, in 2008, eight paper manufacturers in Japan have admitted to intentionally mislabeling recycled paper products, exaggerating the amount of recycled paper used[1].

United States:

Recycling has long been practiced in the United States. In 2012, paper and paperboard accounted for 68 million tons of municipal solid waste generated in the U.S., down from more than 87 million tons in 2000, according to the U.S. Environmental Protection Agency. While paper is the most commonly recycled material - 64.6 percent was recovered in 2012 — it is being used less overall than at the turn of the century. Paper accounts for more than a half of all recyclables collected in the US, by weight[2].

1.3 Problem

1-collect used paper operation.

2-Paper can not recycle more than three times.

3-Problems in obtaining the required paper

1.4 Importance

1- Recycling paper and used it for heating

2- Preserving the environment

3-Saving a lot of money, water and energy needed by the paper factory for the first time

1.5 Table Time

1.5.1 First semester:

Weak / Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data collection															
Background															
Previous projects on the idea of the project															
Study on raw materials															
Design															
Design Mechanical															
Solid work															
Identification of Mechanical component															
Identification the type of material															
Design Electrical															
Identification of Electrical component															
Load calculation															
Control circuits And power															
Protection circuits															

1.5.2 Second semester:

Weak / Tasks	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Programming															
programmable logic controller (PLC)															
Installation of the machine															
Collection the pieces															
Calibration															
Testing															
feedback															
Close Project															
Identification the final pieces shape															
pricethe final pieces															

1.6 Table coast:

COMPONENT		Quantity	Price(NIS)	Total Price
1	Design Mechanical			
2	Solid work	_	700	700
3	Mechanical component	1	4000	4000
4	Gear	1		300
5	Electrical component			
6	Control circuits And power			
7	PLC	1	800	800
8	Inductive proximity switch	10	35	350
9	Capacitive Proximity sensor	2	75	150
10	Emergency stop	1	35	35
11	Push button (green&red)	2	15	30
12	Cable	10m	2	20
13	Relay	15	25	375
14	contactor	1	50	50
15	Motor	1	250	250
16	Double acting cylinder	3	120	360
17	selctar valve	5	80	420
18	Compressor	1	200	200
19	Protection circuits			
20	3-phase circuit breaker	1	70	70
21	1- phase circuit breaker	2	60	120
22	Over load	1	50	50
23	electrical panel	1	250	250
				8530

2

General description about project

2.1 Block diagram

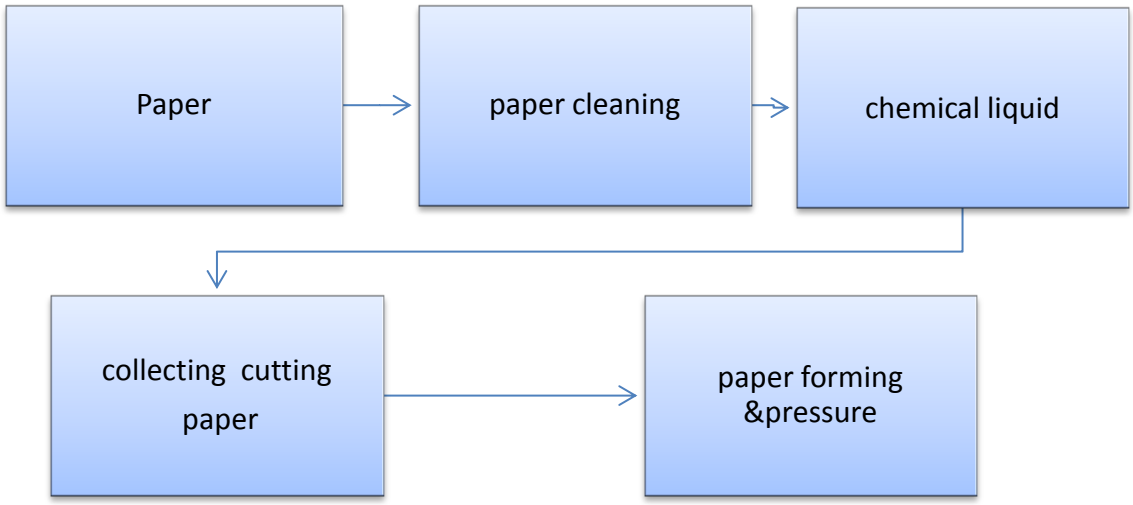
2.2 Component table

2.3 PLC controller

2.4 Compressor

2.1 Block diagram

In this chapter description of the project in terms of block diagram and the main component used in addition to talking about the programmable logic control and air compressor



Block 1: Paper

Collect paper waste and cut it manually

Block 2: Clean

In this stage add the water and chemicals and move the mix become homogenous, and then passed through sieves to liquidation of metals.

Remove ink: two stages, first by washing with water, and the second by passing a stream of air bubbles into the container, then scrape the ink accumulated on its surface.

The primary goal of this process, Avoid emissions resulting from the burning of paper when there is ink‹to avoid risks.

Block 3: Forming by pressure

Use Pneumatic systems: In manufacturing facilities, compressed air is so widely used that it is often regarded as the fourth utility after electricity, natural gas and waterbus compared to electricity. The pressure process by cylinder to make it pierced cube from the inside.

2.2 Component table

Name of block	Photo	component	Function
Block (2)		3 phase motor	Connect to mixer
		Contactor	Connecting the power between network and motor
Block (3)		Double acting cylinder1	For forming process
		Proximity sensor	know about the situation of the cylinder
		selector	Control the valve

2.3 PLC controller:

Using of relay-based switches to implement basic logical expressions and some examples of logic-based industrial system control. This type of control system detects the status of inputs like switches and other on-off logical devices(e.g. position directors, liquid level detectors, etc.) and then uses relays, timers and counters to implement logic and drive outputs by energizing the output coil of some sort of valve or other actuator.

2.3.1 Introduction to PLC:

- A programmable logic controller (PLC) is a microprocessor-based piece of hardware that is specifically designed to operate in industrial environment.
- Generally PLCs (as the name suggests) implement logic, determining outputs based on some logical combination of inputs. PLCs are programmable devices that are capable of taking inputs from sensors and activating actuators in order to control industrial equipment.

Fig (2.1): PLC Delta

- The lack of a keyboard and other input-output devices is immediately apparent. On the front of a PLC the indications are normally limited to status lights used to indicate operating status and others that can be used for system debugging.

2.3.2 Common LED indicators include:

1. Power on - indicating that power to PLC switched on.
2. Program running - (yes), it means a program is running in the PLC.
3. Software Fault – PLC code often has self testing code designed into it.
4. Module Fault – used by installed modules to show that HW self-test has failed.
5. Link Status – modern PLCs often from part of a distributed control.

system and this indicator is used to show whether the local area network is ok.
A number of pushbuttons/switches can also be provided as part of the PLC
hardware:

2.3.3 Input Output controller and Devices:

The input/output controller provides the interface between the PLC processor and the outside world. It allows connections to be made via input/output channels to sensor actuators.

In PLC, the input/output controller and its interfaces provide important buffering, isolation and signal conditioning to enable direct connection of sensors and actuators Typically the PLC will be designed to accept standard modules which plug directly into the I/O Bus and which provide appropriate levels of protection and conditioning.

Run/Program Switch used to switch between program mode usually used during maintenance activities and run mode when the unit is operating in its usual autonomous mode.

PLCs are often protected by a mechanical KEY that stops unauthorized personnel altering a PLC program or stopping its execution. A PLC will usually not have an on-off switch or reset button on the front panel. This needs to be considered when designing/configuring systems.

3

Component and design Mechanical

3.1 Introduction.

3.2 Collection paper and cutting.

3.3 Clean process.

3.4 Paper forming.

3.1 Introduction

The described forming process can be completed throughout pressure and collection

The figure show Machine dimensions

Length equal 146.36 cm

Width equal 148.4 cm

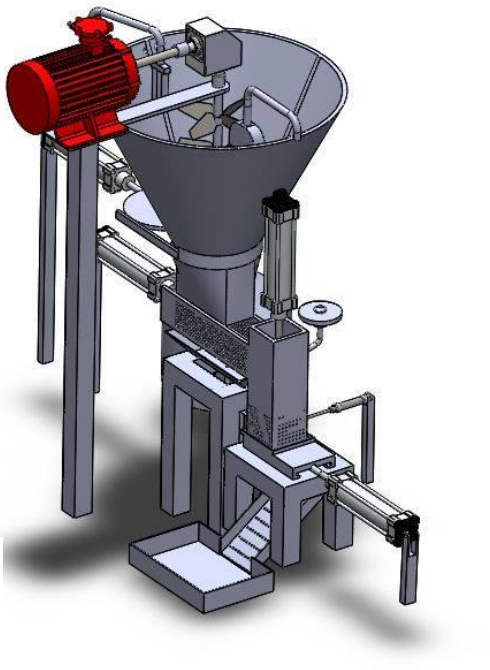


Figure (3.1): Machine dimensions

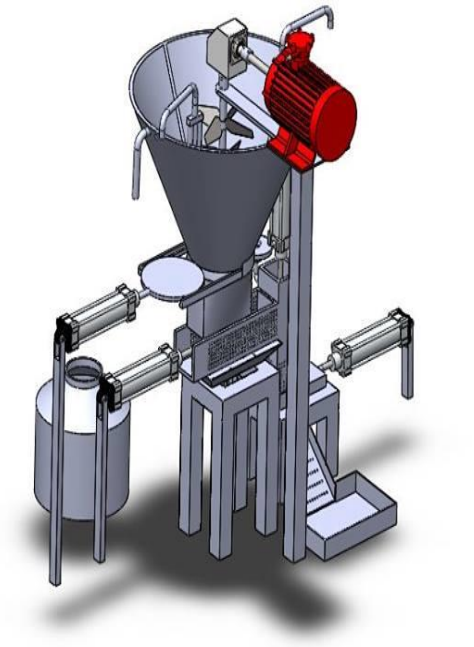


Figure (3.1.1): Vertical section

3.2 Clean process:

3.2.1 Main basin clean process

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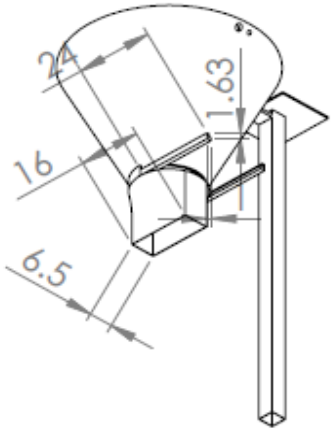
Figure (3.2): cone.



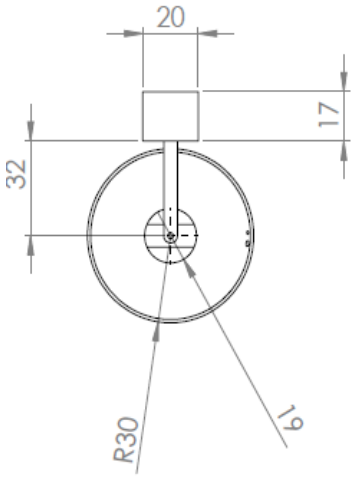


Figure (3.2.a): cone dimension Figure (3.2.b):Vertical section

In this figure this basin use to clean paper it former cone Because Facilitate the exit of the mixture. Show position mixer and motor, gear box

Calculation volume cone

$$v = \frac{\left(\square * \pi \left(R^2 + R * r + r^2\right)\right)}{3} = 0.07 m^3 \qquad (3.1)$$

V: volume of cone

H: height

R: radius of upper baser: radius of the lower base

3.2.2 Mixer blades:

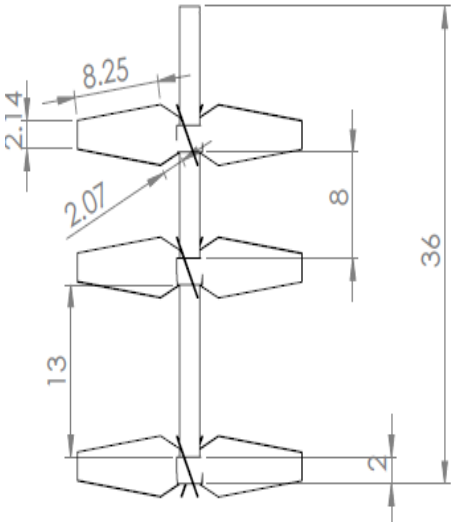


Figure (3.3.a): mixer blades dimension

Figure (3.3): mixer blades

Type Impeller: A310

Pitched blade turbine

The size of the basin from above is greater than down, so the distance between the first blades and second blades Equal (8cm) and distance between the second blades and third Blades equal (13cm).

3.2.3 Gear box

Gearboxes are used to increase torque while reducing the speed of a prime mover output shaft. This means that the output shaft of a gearbox rotates at a slower rate than the input shaft, and this reduction in speed .

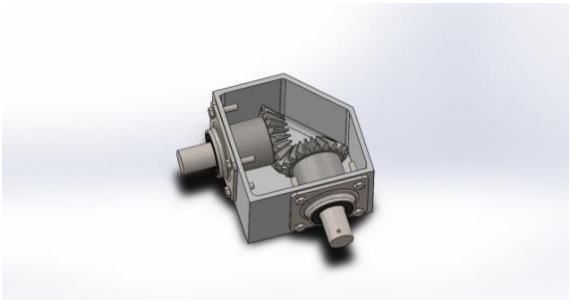


Figure (3.4): gear box

3.2.4 Metallic air pump

This figure show dimension metallic air pump where design in the form of cylinders to produce bubbles of air.

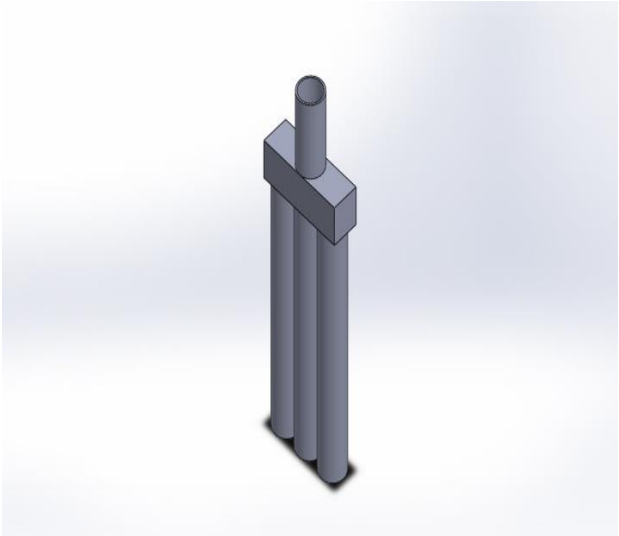


Figure (3.5): Metallic air pump

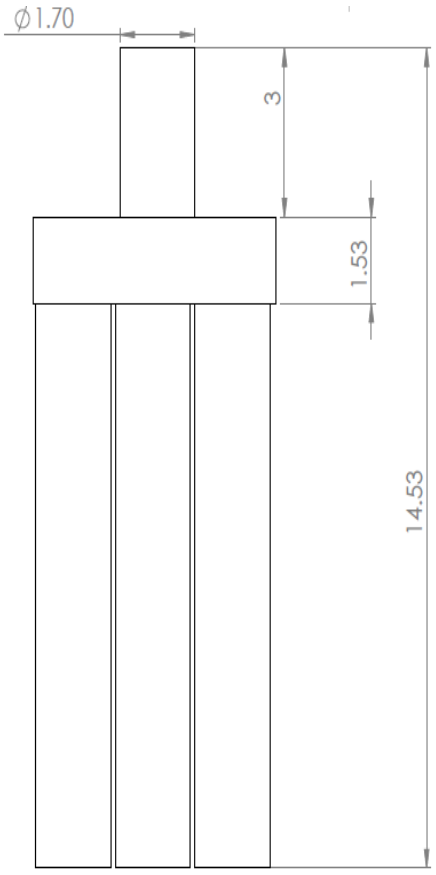


Figure (3.5.a): Metallic air pump diminution

3.2.5 Suction:

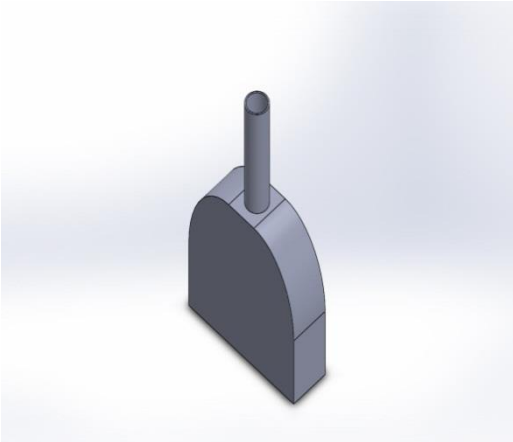


Figure (3.6): suction

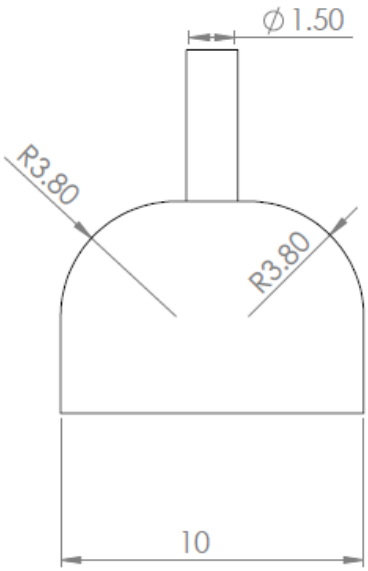


Figure (3.6.b): suction diminution

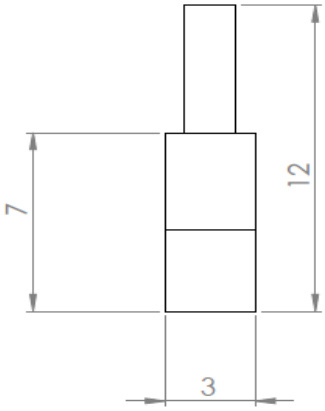


Figure (3.6.a): left side

Corner designed a circular shape to match the shape main basin.

3.2.6 Basin slot cover:

Designed a circular shape to close the main basin from the bottom and is controlled through the cylinder open and close Main basin.

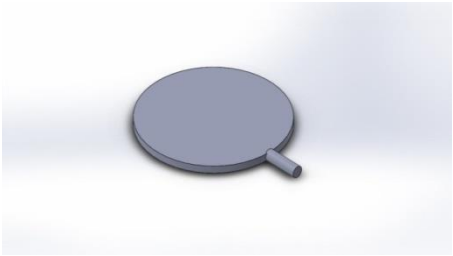


Figure (3.7): Basin slot cover

3.3 paper Forming:

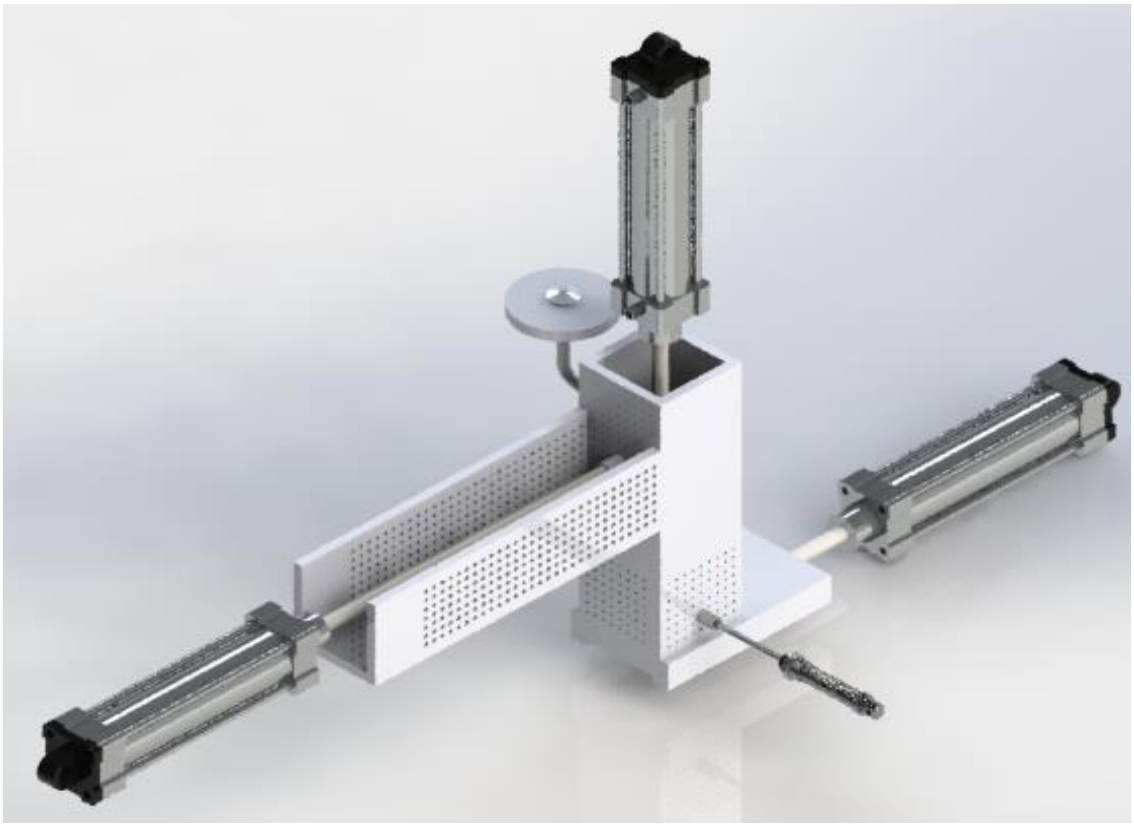


Figure (3.8): Collection cutting paper and Forming by pressure

3.3.1 Basin Water Filter

The process filter two stage:
One: collection the mixture with water in the first basin after coming off of the wash basin and a basin-shaped grille. It is pushed to the second basin.
Two: in this stage, filter mixture from water by pressure, it shape grille From under.

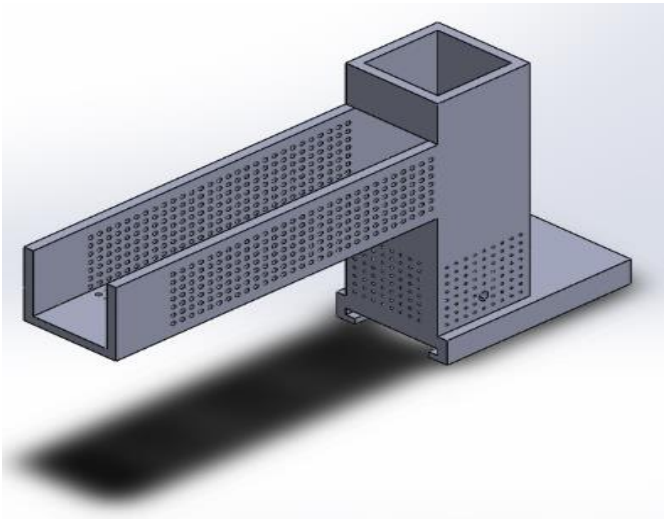


Figure (3.8.a): water filter and pressure

$$Volume = H * L * W$$

Where:

H: high

L: length

W: width

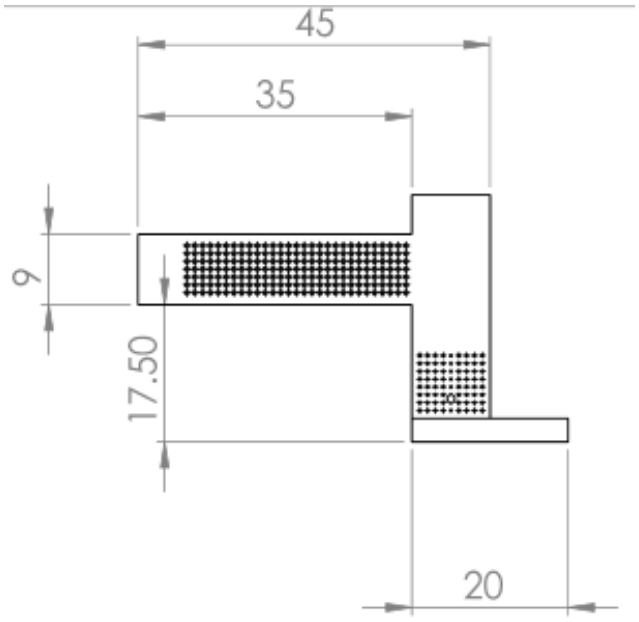


Figure (3.8.b):Lateral section and dimintion

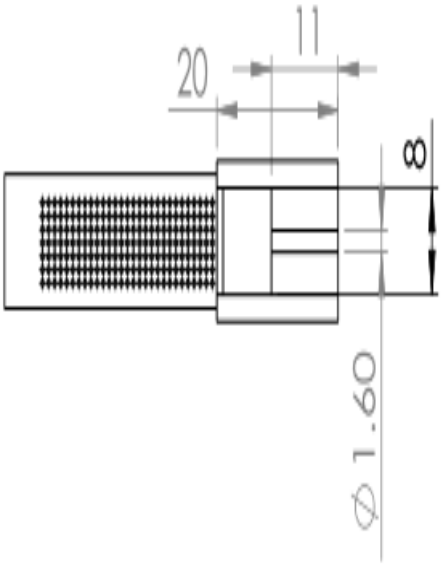


Figure (3.8.c):Horizontal section

3.3.2 Basin to collection water

This basin use to collect water
After it down from clean basin.
This basin place under basin water
Filter.

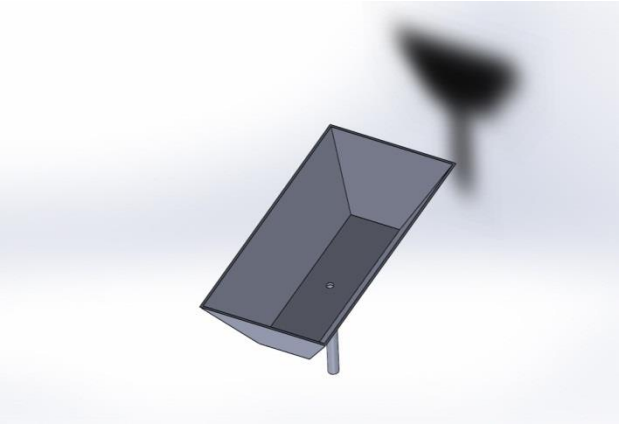


Figure (3.9): basin to collect water

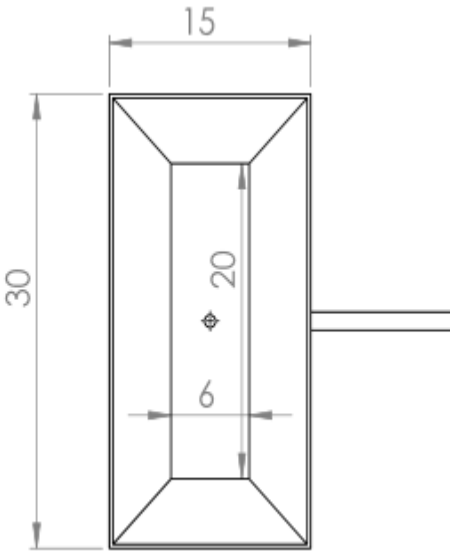


Figure (3.9.1) Vertical section

3.3.3 Drawer move by cylinder:

This piece place under basin forming Thickness at 8 mm in order to against withstand.

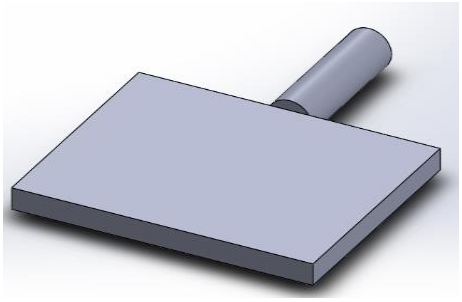


Figure (3.10): piece metal

3.3.4 Basin to collect final piece paper

This basin place under basin forming use to collect final pike paper Diagonal form to facilitate down piece

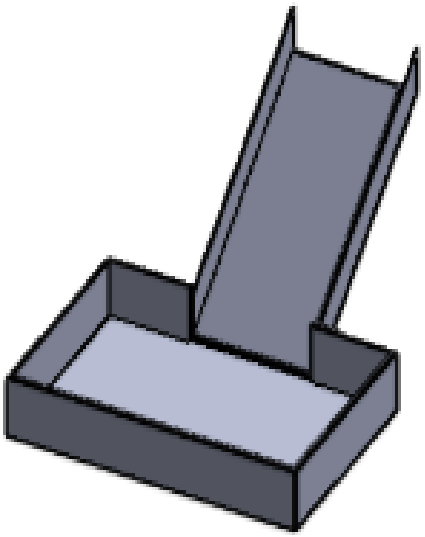


Figure (3.11): basin to collect final piece

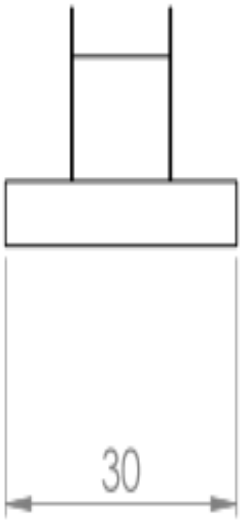


Figure (3.11.a): Lateral section

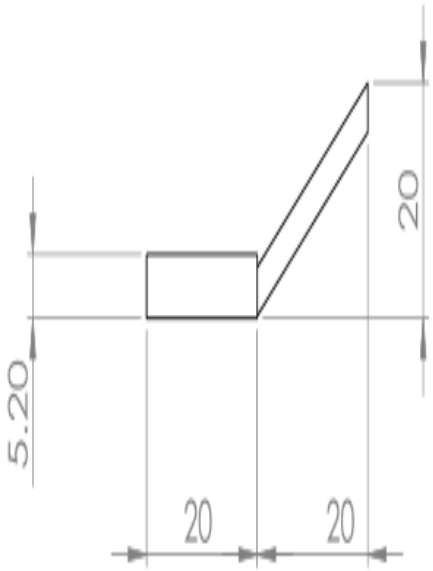


Figure (3.11.b): front suction

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4

Electrical Design

4.1 Introduction

4.2 Power circuit of motor.

4.3 Load calculation of mixer motor.

4.4 Power circuit of all cylinders

4.5 Input and output table

4.1 Introduction

In order to realize moving mixer and low speed induction motor should be selected 8-pole

.

$$ns = \frac{120 * F}{P} = 1500rpm \tag{4.1}$$

Where:

ns: speed of motor

F=Frequency= 50 Hz

P=pole = 8

$$nn = ns(1 - S) = 1400\ rpm \tag{4.2}$$

Where:

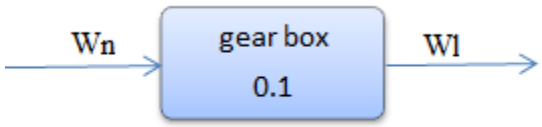
n_h: high speed

S: slip ring= 0.05

$$Wn = \frac{2\pi * Nh}{60} = 146.5rad/s \tag{4.3}$$

$$Wl = \frac{2\pi * Nl}{60} = 14.5\ rad/s \tag{4.4}$$

4.1.1Gear tooth ratio



4.1.2The main equation of tooth ratio

$$\frac{Wl}{Wh} = \frac{14.5}{146.5} = 0.\mathbf{1} \qquad (4.5)$$

Table (4.1): data sheet of motors

type	hp	Voltage v	Nrpm	Current A	Frequency Hz	phase
Mixer motor	2	380	1000	3.5	50	3 phase way connect

4.3 Load calculation of mixer motor

4.3.1 Moment total inertia

$$Jeq = Jm + Jp + Jg * a^2 + Jb * a^2 = 0.10054 \text{ kg}.m^2 \qquad (4.6)$$

Where:

Jeq: total of moment inertia

Jm :moment inertia of motor

Jp: moment inertia of small Gears

Jg :moment inertia of large Gears

Jb:moment inertia of blades

a:gear tooth ratio calculated from equation =0.1

$$Jm = 0.5 * m * r^2 = 0.1\text{kg}.m^2 \qquad (4.6.1)$$

Where:

m: mas of motor = 30(kg)

r: radius motor = 0.09(m)

$$Jp = 0.5 * m * r^2 = 0.0468 * 10^{-3} \text{kg}.m^2 \quad (4.6.2)$$

Where:

m: mas of small Gears = 0.15(kg)

r:radius small Gears =0.025(m)

$$Jg = 0.5 * m * r^2 = 0.375 * 10^{-3} \text{kg}.m^2 \quad (4.6.3)$$

Where:

M: mas of large Gears = 0.3kg

r: radius small Gears =0.0.05m

$$Js = Jr + Jb = 0.117 * 10^{-3} kg.m^2 \quad (4.6.4)$$

Prime equation

$$Jr = 0.5 * m * r^2 = 0.025 * 10^{-3} \text{kg}.m^2 \quad (4.6.5)$$

Where:

m: mas of rod= 0.5(kg)

r: radius rod=0.0.05(m)

$$Jb = 12 * m * r^2 = 0.092 * 10^{-3} \text{kg}.m^2 \quad (4.6.6)$$

Where:

m: mass blade = 0.03(kg)

r: radius rod = 0.0.0525(m)

4.3.2The toque motor

$$Tm = Jeq * \frac{dw}{dt} + + b * w = 2.7(\text{N. m}) \quad (4.7)$$

Where:

T_m**:** toque of motor

Jeq: total of moment inertia

b:Kinematic Viscosity of water equal 0.801(m^2/s)

w_l: speed out of motor

$\frac{dw}{dt}$=accelerating of torque and time equal 2sec

Calculate of power requirements

For mixing described in[Stark, 1971; Sulk, 2004].

$$P = Np * P * Ni^3 * Di^5 = 0.3\text{kW} \quad (4.8)$$

Where:

P:power requirements for mixing

Np: turbulent power number= 0.3

Ni: rotational speed = $2S^{-1}$

P=liquid density water and paper =1720(kg/m^3)

Di: diameter of the impeller= 0.16(m)

4.3.3Total power

$$Pt = Pm + Pl = 0.736\text{kW} \tag{4.9}$$

Where:

Pt : total power

Pm: power of motor

Pl : power load

$$Pm = Tm * Wm = 0.4\ \text{kW} \tag{4.9.1}$$

4.3.4 Horse power

$$Hp = \frac{0.7\ kw}{0.746\ kw} = 1 \tag{4.10}$$

4.3.5 Power in watt (Pin)

$$P\ in = 1.73 * V * I * PF = 1.18\ \text{kW} \tag{4.11}$$

Where:

Pin = Three-phase power in kW

V = voltage= 380V

I = current= 2.4A

PF = Power factor as = 0.75

4.3.6 Efficiency (%)

$$\eta = \frac{Pout}{Pin} x\ 100\% = 0.75 \tag{4.12}$$

Table (4.2) protection

Mixer motor	**number**	**Serial number**	**hp**	**Voltage**
Contactors	1	LC1D09	1	220VAC
Over load	1	LRD08	1	Current 1.5-3A
MCB	2	type aM	current rating 6A	

4.4.1 Power circuit of all cylinders

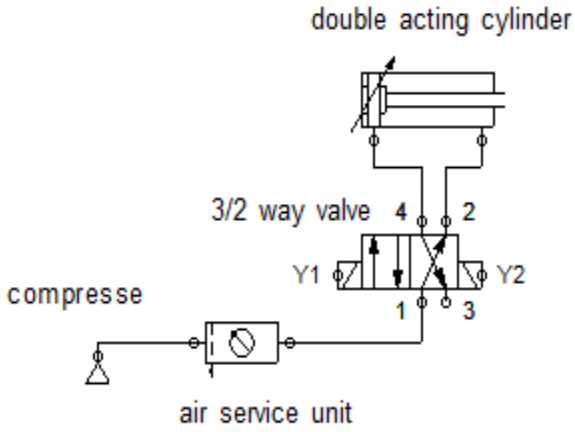
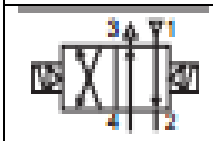


Figure (4.2): power circuit of cylinder

Table (4.3) Data sheet

	Solenoid	Part Number	number	voltage
	**Double Solenoid (Bitable)**	**P2M1S4EE2C**	**5**	**24VDC**

4.4.2 Load calculation of actuator cylinder

Cylinder pull slot cover and Cylinder use to push small cylinder inside basin

$$F = \frac{\pi(D1^2 - D2^2)}{4} * P = 12.56kg \quad (4.13)$$

F=force (Kg)

D1=inner diameter equal 1.5(cm)

D2=Rod diameter equal 0.5 (cm)

P=air pressure equal 8 (bar)

Cylinder pull piece metal and Cylinder use push mixture

$$F = \frac{\pi(D1^2 - D2^2)}{4} * P = 37.68kg \quad (4.13.1)$$

F=force (Kg)

D1=inner diameter equal 2.5 (cm)

D2=Rod diameter equal 1 (cm)

P=air pressure 8 (bar)

Cylinder use pressure mixture

$$F = \frac{\pi(D1^2 - D2^2)}{4} * P = 362kg \quad (4.13.2)$$

F=force (Kg)

D1=inner diameter equal 8 (cm)

D2=Rod diameter equal 2.5 (cm)

P=air pressure 8 (bar)

Table (4.5): Input and Output

address	description
	input
X0	Push-bottom stop
X1	Push-bottom start
X2	Emergency switch Electrical panel
X3	Capacitive sensor clean basin
X4	Capacitive sensor collection basin
X5	Proximity sensor for Cylinder use pressure mixture(out)
X6	Proximity sensor for Cylinder use pressure mixture(in)
X7	Proximity sensor for Cylinder use push mixture(out)
X10	Proximity sensor for Cylinder use push mixture(in)
X11	Proximity sensor for Cylinder pull slot cover clean basin (out)
X12	Proximity sensor for Cylinder pull slot cover clean basin (in)
X13	Proximity sensor for Cylinder pull piece metal(out)
X14	Proximity sensor for Cylinder pull piece metal(in)
X15	Proximity sensor for Cylinder use to push small cylinder inside basin(out)
X16	Proximity sensor for Cylinder use to push small cylinder inside basin(in)
X17	Over load
	Out put
Y0	Mixer motor
Y1	Suction
Y2	Air pump
Y3	Solenoid valve for Cylinder use pressure mixture(out)
Y4	Solenoid valve for Cylinder use pressure mixture(in)
Y5	Solenoid valve for Cylinder use push mixture(out)
Y6	Solenoid valve for Cylinder use push mixture(in)
Y7	Solenoid valve for Cylinder pull slot cover clean basin (out)
Y10	Solenoid valve for Cylinder pull slot cover clean basin (in)
Y11	Solenoid valve for Cylinder pull piece metal(out
Y12	Solenoid valve for Cylinder pull piece metal(in)
Y13	Solenoid valve for Cylinder use to push small cylinder inside basin(out)
Y14	Solenoid valve for Cylinder use to push small cylinder inside basin(in)

5

Chapter Five

Implementation

5.1 Introduction

5.2 Flow chart

5.3 PLC Code

5.4 Electrical Board

5.5 Result and Recommendation

5.1 Introduction:

In this chapter we show Implementation in this project through draw the flow chart of project and write the PLC code, after that we design the electrical board and final write the result and recommendation.

5.2 General Flow chart

In this diagram the principle of the work project at all stage in the form of an algorithm

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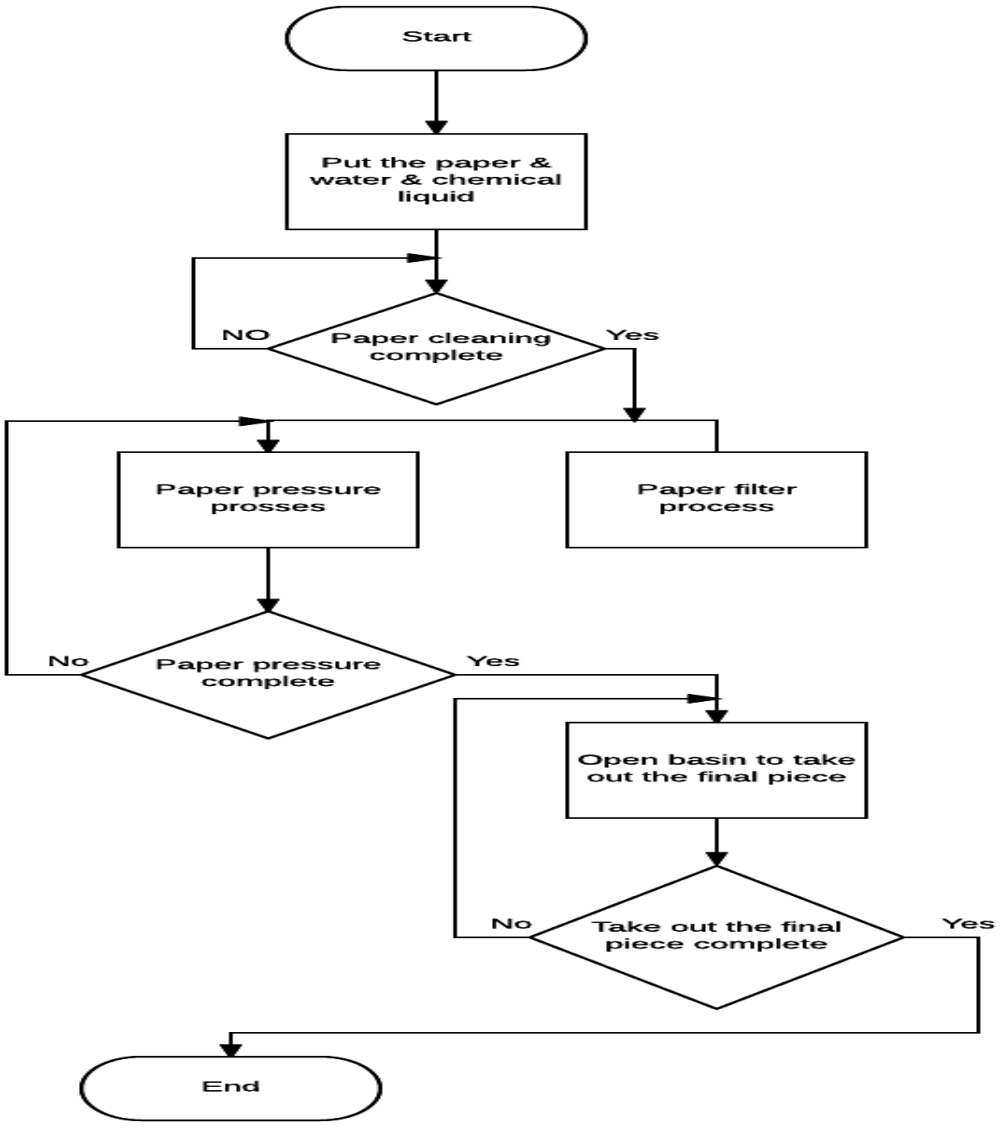

5.3 Specific Flow chart

5.4 PLC Code

5.5 Electrical Board

5.6 Result and Recommendation:

Result:

In this project we design and implementation an environmental paper recycling machine for heating purposes, this project was going through three stages, First stage is cutting process, Second stage is cleaning process and the last stage is pressure and forming process.

But because of increased project coast and lack of financial support required .we did not use the first stage (cutting process), and we cutting the paper manually .without need to use blades type of shredder high coast. And also we replaced some of automatic process to the manual process like adding water and chemical material which contributed to reduce the coast some extent.

Recommendation:

We recommend completing this project in the coming stage and implementation the project at all stage using paper cutter and add automated processes that we did not use. Also make machine stainless steel to avoid rust.

Reference:

[1]http://www.paperrecovery.org/uploads/Modules/Publications/Final_MonitoringRepor4014.pdf

[2]http://www.al.com/news/birmingham/index.ssf/2014/12/how_textbooks_become_toilt

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Strk F., 1971. Mie zanie i mie zalniki, WNT, Warszawa

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APPENDIX