Palestine Polytechnic University

College of Engineering

Design and Implementation of Soap Forming Machine Prototype

By

Ibraheem Zaitoun Obadah Al- Qawasme

Supervisor: Prof. Dr. Sameer Hana Khader

Submitted to the College of Engineering

in partial fulfillment of the requirements for the

Bachelor degree in Electrical Engineering

Hebron, Jan 2018

Palestine Polytechnic University

College of Engineering

Department of Electrical Engineering

Hebron - Palestine

Design and Implementation of Soap Forming Machine Prototype

By

Ibraheem Zaitoun Obadah AL- Qawasme

Submitted to the College of Engineering
in partial fulfillment of the requirements for the
Bachelor degree in Electrical Engineering

Supervisor Signature

……

Chair of the Department Signature

…….

January - 2018

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.

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

شكر وتقدير

نتقدم بجزيل الشكر والتقدير والإمتنان العظيم إلى المشرف الأستاذ الدكتور سمير حنا خضر لما منحه لنا من وقت وجهد وتوجيه وإرشاد وتشجيع. كما و نتقدم بجزيل الشكر إلى أساتذتنا الكرام .

وأيضا جزيل الشكر والإمتنان لمن سهر الليالي لنصل لما وصلنا إليه اليوم أهلنا الكرام.

كما ولا ننسى أن نشكر جامعتنا الموقره لما وفرته لنا طوال الفتره الدراسية.

ونشكر أصدقاءنا وزملاءنا الذين كانوا خير عون خلال سنين الدراسة, شكرا لكم جميعا.

الملخص

"تصميم وتنفيذ نموذج لماكينة تشكيل الصابون"

يهدف هذا المشروع للخروج بماكينة تعمل على تقليل الجهد اللازم لعملية تشكيل الصابون المحلي المصنع يدويا, وأيضا لزيادة إنتاجية الصابون في فلسطين وكذلك زيادة قدرة الصابون المحلي على المنافسة في السوق المحلي وفي الأسواق العالمية وذلك من خلال تصميم وبناء ماكينة مؤتمتة بشكل كامل.

بداية سيتم دراسة آلية عمل الماكينات المستخدمة عالمياً لتصنيع الصابون ومن ثم العمل على تصميم ماكينة تعمل على عملية التشكيل للصابون وإضافة الروائح العطرية والألوان ليتم بعدها تحديد المعدات والأجهزة اللازمة لبناء هذا المشروع شاملاً لبرنامج التحكم على الـ PLC.

تم في هذا المشروع إنتاج نموذج للماكينة حيث تقوم بعملية الخلط للصابون الخام مع الألوان والروائح العطرية وعملية الضغط للصابون الناتج وتشكيله وتقطيعه حسب الحجم المطلوب مما سيوفر إنتاج صابون متعدد الأشكال والألوان والروائح العطرية جاهز للتغليف والتسويق.

Abstract

This project aims to produce a machine that minimizes the efforts required for the process of forming handmade local soap. As well as, increasing the quality of local soap to compete in the local and global markets. The project is designing and constructing a fully automated machine.

At the beginning, the researchers studied the mechanism of operating of the machines, used worldwide, that produce soap. Then, they worked on the designing of a machine that works on the formation of soap, adding aromatic smells and colors the equipment and devices necessary for the construction of this project have been determined, including PLC control program.

The project produced a model of machine for mixing raw soap with aromatic smells and colors; in addition, it extrudes the produced soap, forming and cutting it according to the required size. This process provided a production of various shapes of soap with a wide variety of colors and aromatic fragrances. This soap is ready for packaging and marketing.

Table of Contents

APPENDIX	
APPENDIX A	**PLC Delta User Manual**
APPENDIX B	**304/304L STAINLESS STEEL Datasheet**
APPENDIX C	**Mechanical Design**
APPENDIX D	**Electrical Design**
APPENDIX E	**PLC Code**

List of Figures

List of Tables

List of Equations

1

Chapter One

Introduction

1.1 Introduction

This project aims at design full-automatic forming machine to be used for soap shaping, and prototype implementation.

The machine will be able to convert the raw soap material into aromatic, colorful and multi-shaped soap bars. The proposed prototype will produce soap bars with suitable size for kids use and even for hotel use.

1.2 Background

Handmade soap can be made from scratch, by either hot or cold process, handmade soap made from scratch require three ingredients to become soap: oil (animal or vegetable oil), water and lye. These ingredients are mixed together in proper proportions, combine and chemically change into soap. They may include other ingredients to provide additional benefits or to color or scent the soap, but these are not part of the chemical process that results in basic soap [2].

- Methods of soap making:

1. The term "cold process" refers to the fact that no heat is applied during soap production process.

The lye solution is normally cooled to room temperature before it is added to the oils. The oils are then heated as necessary to melt any solid fats or butter and generally cooled to between 80° - 110° F, depending on the recipe formulation [2].

2. The term "Hot process" soap refers to the fact that an outside source of heat is applied to make the soap.

   With hot process soap, the lye solution and oils are mixed together and then an outside source of heat is used to keep the temperature high. The added heat reduces the time needed to ensure the chemical process is completed [2].

After the chemical stage, it comes the process were the resulting mixture is dried that usually takes very long time up to 7 days or more in some cases.

In Nabulsi soap and after drying comes the cutting stage where the soap is cut manually into cubic form soap and then is left to dry completely.

In the traditional process, it is hard to add colors and aromat to the chemical soap mixture and to shape the soap in other forms as long as the way of production is the same.

It is a good idea to design a machine that enhances the soap appearance and smell for marketing reasons and kid's attractiveness and comfortably. After This machine implementation, it will be the first machine in Palestine to form the soap and add color and aromat to it.

1.3 Problem Statement

The project idea came up from the status of Nabulsi Soap handmade craft that has some drawbacks:

- It requires great efforts to produce the soap bars.
- Nabulsi soap is losing the competitiveness in the local and international market because of its general appearance and final finishing even with its good quality.
- Soap bars come in single shape, color, and inability to add various aromat.
- The soap waste rate is high during the cutting process.

1.4 Objectives

The main project objectives are to overcome the up mentioned problems as following:

- Design a forming machine that reduces the effort needed for forming process for better use and management in existing workforces.
- Increase the Nabulsi soap competitiveness in the local and international market.
- Reducing the wasted material in the forming process
- To be able to produce a multi-shape, colorful, and aromatic soap bars.

- The final machine prototype will be able to produce soap in multi-shapes and colours with good smell and small sized soap bars that are good for kids and hotels use.

1.5 Project Scope

The project main purpose is to transform raw soap into a multi-shape, colorful and aromatic soap bars not to make the soap from scratch. The machine will mix, extrude, form, and cut the soap, and it will be implemented as a prototype, not a big machine and the soap will be small not as the regular soap bars size.

1.6 Cost Table

The following table shows the expected cost for the machine ±15%. (See Table 1.1)

Table 1.1: Cost Table

Item Name	No. of Items	Total Cost (NIS)
Selector Switch	**2**	**140**
Emergency Switch	**1**	**40**
Push Buttons	**4**	**120**
Double Acting Cylinder	**1**	**150**
Solenoid Valve	**1**	**90**
Aromat mini pump	**1**	**100**
3 phase Induction Motor	**2**	**600**
Gears	**2**	**400**
Contactor	**3**	**150**
MCB	**2**	**200**
Relay	**5**	**240**
PLC	**1**	**1400**
Rack	**1**	**250**
Overload	**2**	**200**
Overall Machine Body + Extruder and Mixer Lathing Cost	**1**	**8500**
Electric Panel	**1**	**200**
Wires	**-**	**300**
Power Supply	**1**	**150**
Total Cost		**13330 NIS**

1.7 Time Table

The following time table shows the project introduction work divided in fifteen weeks of the second semester as following. (See table 1.2)

Table 1.2: Time Table

Weeks / Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Introduction Chapter (1)	■	■	■												
Main Design Concepts Chapter (2)		■	■	■	■										
Mechanical Design Chapter (3)			■	■	■	■	■	■	■						
Electrical Design Chapter (4)								■	■	■					
Project Implementation						■	■	■	■	■	■	■	■	■	
Testing and Calibration														■	■
Conclusions and Recommendations Chapter (5)								■	■	■	■	■	■	■	■

2

Chapter Two

Main Design Concepts

2.1 Introduction

2.2 Soap Forming Machine Stages

2.3 Process Flow Chart

2.4 Required Components

2.1 Introduction

The forming process is an essential process in many industries, in soap, it is required to give it shape in order to make it easier to use and attractive to the customer. Also, giving the soap aromatic smell and colorful appearance is important as forming for marketing reasons.

2.2 Soap Forming Machine Stages

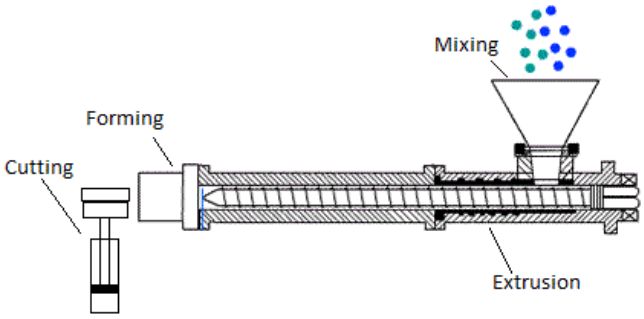

Figure 2.1: Forming Machine Stages

2.2.1 Mixing Stage

As the figure below shows the soap mixer consist of three main components, mixing container, mixing screw that is driven by a motor and a mini pump that supplies raw soap with aromat and color.

Mixing raw soap is done after adding raw soap into the mixing container.

As the mixer motor starts its operation a pump starts to add the aromat and color mixture to the raw soap. The mixing process needs a certain time to finish that will be calibrated after the project implementation.

Figure 2.2: Soap Mixer

2.2.2 Extrusion Stage

Extruder consists of three main parts the main extruder barrel and a screw inside it driven by a motor gearbox combination.

After mixing is done the resulting mixture enters the extruder and start the extrusion stage to give the mixture the homogeneity needed and clear it from air bubbles and transfer it to the shaping stage as the figure below shows.

Figure 2.3: Extruder

2.2.3 Shaping Stage

Shaping stage is simply a shaped template that is constructed at the end of the extruder that can be replaced easily to different shaped templates. The outcome of this stage is a long bar of soap shaped as the template as the figure below shows.

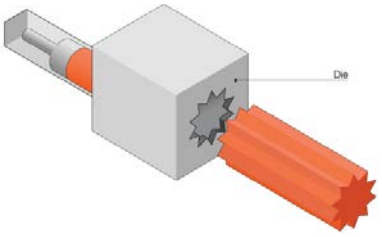

Figure 2.4: Shaping Templates

2.2.4 Cutting Stage

Cutting stage consists of cutting blade mounted on a pneumatic cylinder, that cut the soap every specified period of time depending on the desired soap width.

2.3 Process Flow Chart

The following flow chart shows the machine principle of operation See figure below.

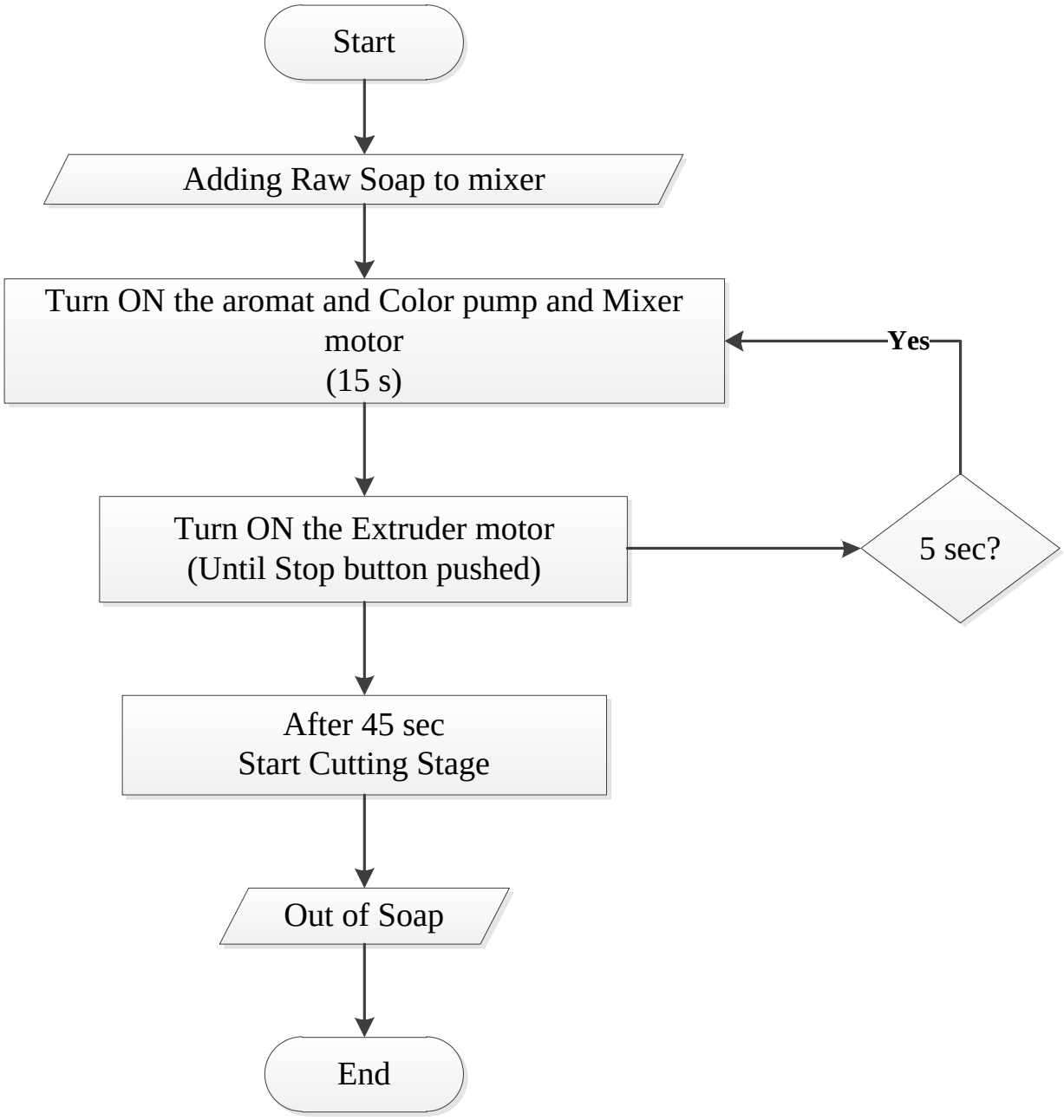

Figure 2.5: Process Flow Chart

2.4 Required Component

2.4.1 Motors

The machine needs two three-phase squirrel cage induction motors, one for the mixer and the other for the extruder screw. They will drive the mixer and extruder via the gearbox connected to the shaft of the motor, see figure below.

Note: All the motors and gears sizing calculations will be shown in the following chapters.

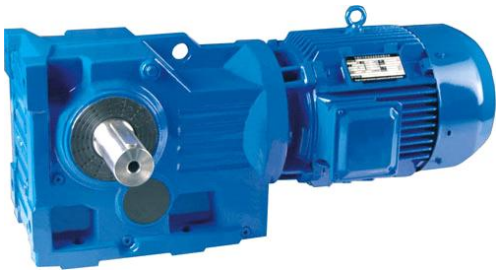

Figure 2.6: Motor-Gearbox Combination.

2.4.2 Pneumatic Components

One pneumatic cylinder will be needed for the cutting stage as mentioned in section 2.2.4. The piston will need solenoid valve to be controlled by PLC, see figures below.

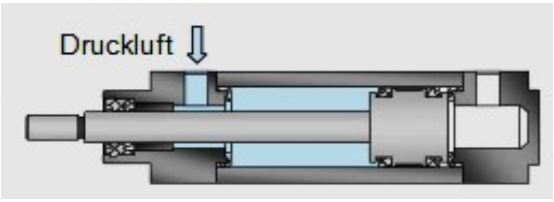

Figure 2.7: Double Acting Cylinder

Figure 2.8: Solenoid Valve

2.4.3 Protection & Switching Devices

Every motor needs an overload, three-phase circuit breaker that is used to protect the motors and their installations also, an earth leakage circuit breaker. In addition, they need a contactor to control the motor ON/OFF operations. Emergency switch is also needed for emergency cases, as the figures shows.

Figure 2.9: Protection and Switching Devices

2.4.5 PLC (Programmable Logic Controller)

A programmable logic controller (PLC) is a microprocessor-based piece of hardware that is specifically designed to operate in the industrial environment.

Figure 2.10: PLC DELTA-DVP32ES2

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.

The PLC type that will be used is DELTA-DVP32ES2 that has 16 inputs and 16 outputs. We chose delta PLC because of its good quality, it is easy to be programmed, has accepted price and meet the required purpose. (See figure 2.10)

The PLC DELTA-DVP32ES2 Datasheet is attached in the Appendix A.

3

Chapter Three

Mechanical Design

3.1 Introduction

This chapter will include the 3D Design for all the machine stages using SOLIDWORKS software. The sequence shown in this chapter is the machine sequence of operation that means it starts with the raw soap input stage until the soap is completely ready. This chapter will include also the mechanical calculations needed for the motor sizing in the next chapter.

Note: The detailed design and dimensions of all the machine parts is attached in Appendix C.

3.2 Overall Machine Assembly

The following figure shows the overall machine and the following sections shows every stage and all the parts.

Table3.1: Machine Stages

Stages	
1	Mixing
2	Extrusion
3	Shaping
4	Cutting
5	Control Panel

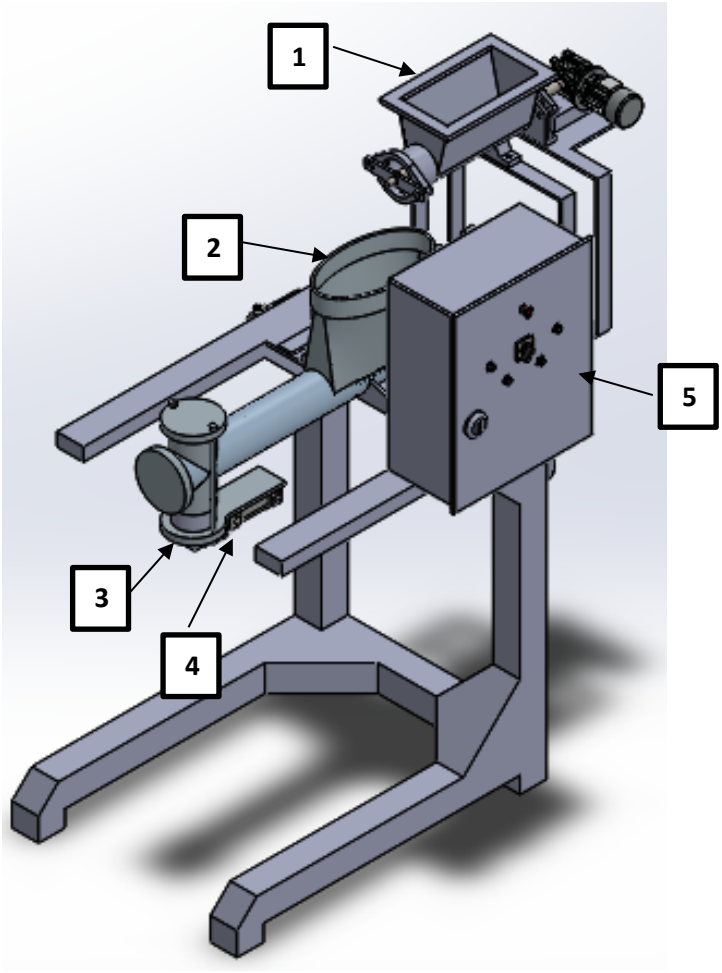

Figure 3.1: Machine Assembly

3.3 Mixing Stage

The mixing stage contains four main parts as following:

1- Aromat and color mini pump

This pump supplies the mixer container with aromat and color for mixing them with the added raw soap, see figure below.

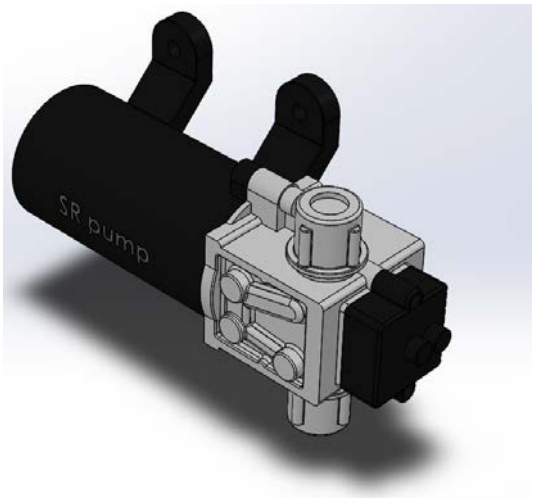

Figure 3.2: Aromat-Color Mini Pump

2- Mixing Container

The raw soap will be added firstly to the mixing container in order to mix it with the aromat and color, see figure below.

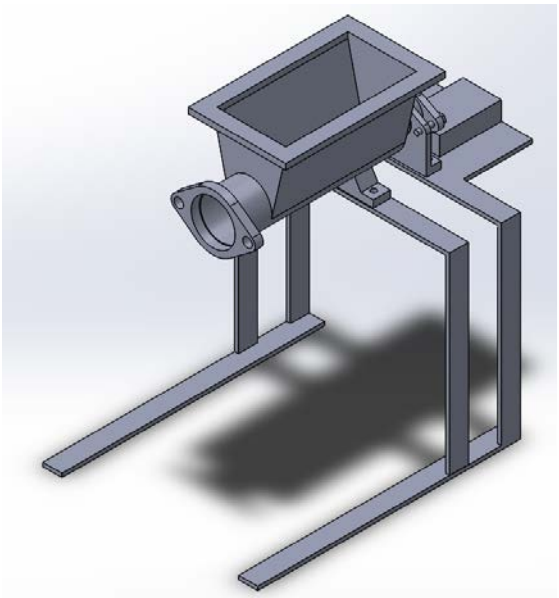

Figure 3.3: Mixer Container

3- Mixing Screw

The raw soap is mixed in the container by the motor driven Screw that insures the aromat and color are mixed properly with raw soap and also it conveys the soap for the next stage, see figure below.

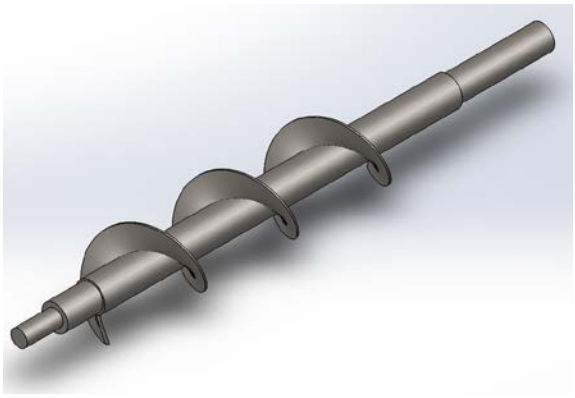

Figure 3.4: Mixer Screw

4- Mixer Motor and gearbox combination

The motor is the main actuator for mixing that means it gives the mixing screw the mechanical movement needed for the process and the gear box decrease the motor speed and increase the torque, see figure below.

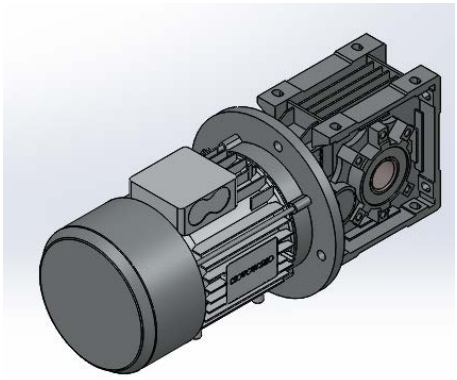

Figure 3.5 Mixer Motor and Gearbox Combination

3.4 Extrusion Stage

In this stage, there is three main parts:

1- Extruder Barrel

This part is the extruder body that is responsible to transfer the soap from mixing stage to shaping stage, see figure below.

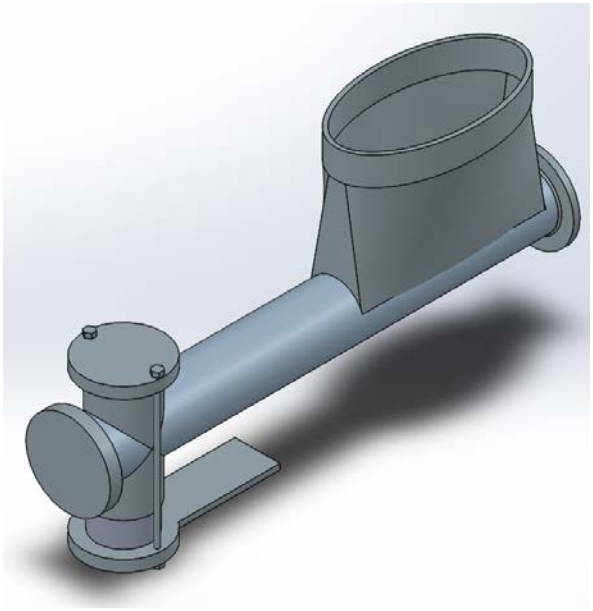

Figure 3.6: Extruder Barrel

2- Extruder Screw

This part extrudes the mixed soap and gives it solid state and make it easier to shape. and it transfer the soap to shaping stage. This part is motor driven, see figure below.

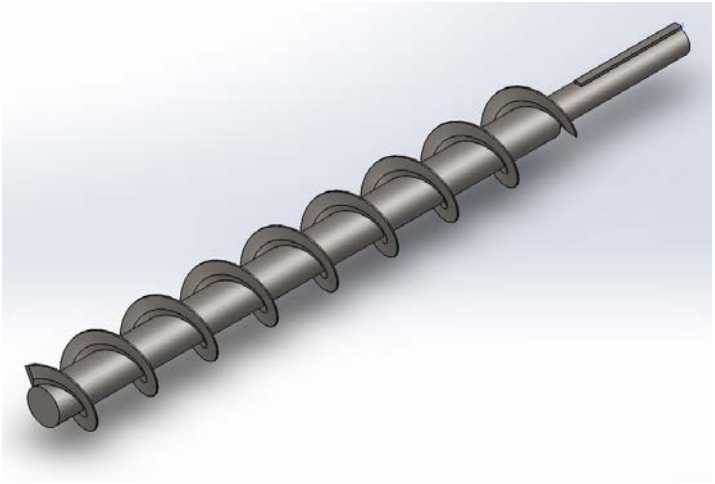

Figure 3.7: Extruder Screw

3- Extruder Motor and Gearbox Combination

This motor drives screw. Same as mixer gear box it decreases the speed and increase the torque, see figure below.

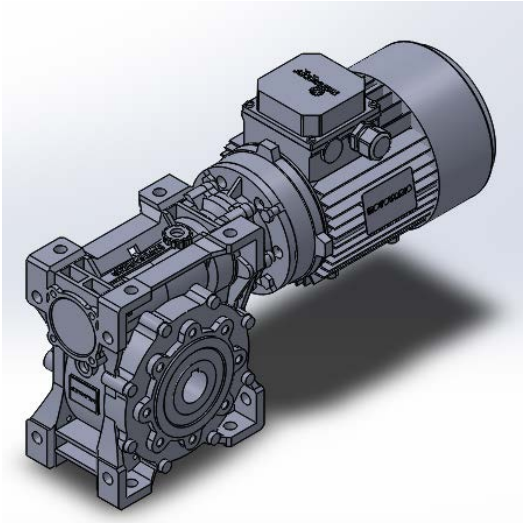

Figure 3.8: Extruder Motor and Gearbox Combination

4- Extruder Table

This table caries the extruder barrel and the mixer container as illustrated below.

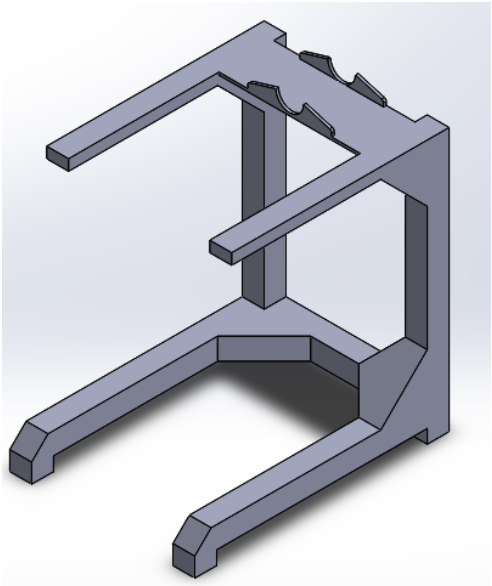

Figure 3.9: Extruder Table

3.5 Shaping Stage

A shaping template is fixed at the extruders end to give the solid soap a certain shape as the producer desires, see figure below.

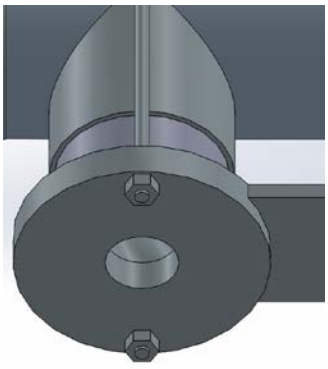

Figure 3.10: Shaping Template

3.6 Cutting Stage

The cutting stage is a cutting blade attached to a pneumatic cylinder as a linear actuator, both are constructed after shaping stage directly as illustrated below.

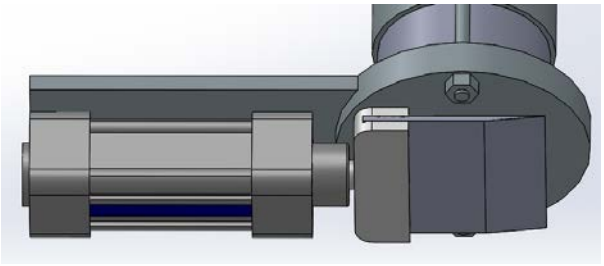

Figure 3.11: Cutting Stage

3.7 Control Panel

Control panel contains all the electrical parts (contactors, overloads, relays, PLC, DC PS, MCB's, …etc.) also the control PB's, mode selector switch, and emergency switch, see figure below.

Figure 3.12: Control Panel

3.8 Mechanical Calculations

Extruder

$$m = D * V \qquad \textbf{(3.1)}$$

Where:

m: Mass in Kg

D: Density in Kg/m^3

V: Volume in m^3

The following table shows the extruder mass results.

Table 3.2: Extruder Mass Results

Component	Density(Kg/m^3)	Volume(m^3)	Mass(Kg)
Extruder Screw	8030*	0.0015	12.045
Soap filled in the Extruder	880[1]	0.00466	4.1

*This Value is taken from Appendix B.

$$Jeq, ex = Jm1 + a1^2 Jsc \qquad \textbf{(3.2)}$$

Where:

Jeq,ex: Extruder equivalent Moment of Inertia in kg*m^2

Jm1: Extruder Motor moment of Inertia kg*m^2

Jsc: Extruder Moment of Inertia kg*m^2

a1: Gears Ratio for extruder motor = Nm/Ns = 0.0333

$$J = \frac{1}{2} m * r^2 \qquad \textbf{(3.3)}$$

Where:

r: radius in m.

The following table show moment of inertia results for the extruder.

Table 3.3: Moment of Inertia Results for Extruder

Jm1(kg*m^2)	Jsc(kg*m^2)	Jeq,ex(kg*m^2)
0.045	0.52	0.102

$$Teq, ex = Jeq, ex * \alpha^2 + W * b \quad \textbf{(3.4)}$$

Where:

Teq,ex: Equivalent torque for extruder motor in N.m

α: Acceleration

W: Shaft speed in rad/s

b: Kinematic viscosity for soap = 2.48 m^2/s

$\boldsymbol{Teq = 7.4\ N.m}$

$$Pex = Teq, ex * W \quad \textbf{(3.5)}$$

Where Pex: extruder motor output power in kW

$\boldsymbol{Pex = 1.069\ kW}$

Mixer

The following table shows the mixer mass results.

Table 3.4: Mixer Mass Results

Component	Density(Kg/m^3)	Volume(m^3)	Mass(Kg)
Mixer Screw	8030	0.000137	1.1
Soap filled in the Mixer Container	880	0.0189	16

$$Jeq, mix = Jm2 + a2^2 Js \quad \textbf{(3.2)}$$

Where:

Jeq,mix: Equivalent moment of inertia for mixer in $kg*m^2$

Jm2: Mixer Motor Moment of inertia in $kg*m^2$

Js: mixer Screw Moment of inertia in $kg*m^2$

a2: Mixer Motor gear ratio

The following table show moment of inertia results for the Mixer.

Table 3.5: Moment of Inertia Results for Mixer

Jm2(kg*m^2)	Js(kg*m^2)	Jeq,mix(kg*m^2)
0.00562	0.12	0.0017

$$Teq,mix = Jeq,mix * \alpha^2 + W * b \quad \textbf{(3.4)}$$

Where:

Teq,mix: Equivalent torque for mix motor in N.m

α: Acceleration

W: Shaft speed in rad/s

b: Kinematic viscosity for soap = 2.48 m^2/s

$$\boldsymbol{Teq,mix = 2.4\ N.m}$$

$$Pmix = Teq,mix * W \quad \textbf{(3.5)}$$

Where Pmix: mixer motor output power in kW

$$\boldsymbol{Pmix = 0.36\ kW}$$

3.9 Soap Flow Calculation

The capacity of a screw conveyor depends on the screw diameter, screw pitch, speed of the screw and the loading efficiency of the cross-sectional area of the screw. The capacity of a screw conveyor with a continuous screw. [1]

$$Q = V * \rho \quad \textbf{(3.6)}$$

$$Q = 60 * \left(\frac{\pi}{4}\right) * D2 * S * N * \psi * \rho * C \quad \textbf{(3.7)}$$

Where:

Q = capacity of a screw conveyor

V = Volumetric capacity in m^3/hr.

ρ = Bulk density of the material, kg/m^3 =880kg/m^3

D = Nominal diameter of Screw in m = 0.095 m

S = Screw pitch in m = 0.0955 m

N = rpm of screw =27.6 rpm

Ψ = Loading efficiency of the screw = 0.12

C = Factor to take into account the inclination of the conveyor = 0.65

$$\boldsymbol{Q = 20\ kg/hr}$$

4

Chapter Four

Electrical Design

4.1 Introduction

In this chapter, we will size both extruder and mixer motors and gearboxes depending on the results from the previous chapter. also, Protection circuits will be sized. Power circuit and control circuit will be explained in this chapter.

4.2 Motors Sizing

Extruder Motor Sizing

Selected Extruder Motor = 1.1 kW = 1.5 hp

Mixer Motor Sizing

Selected Extruder Motor = 0.37 kW = 0.5 hp

The following table describes selected motors specifications.

Table 4.1: Selected Motors Nameplates

Name	phase	P / kw	V	A	rpm	f/Hz
Extruder Motor	3Φ	1.1	380	2.8	1380	50
Mixer Motor	3Φ	0.37	380	1.1	1400	50

4.3 Protection Circuit Sizing

Extruder Motor Protection Circuit

- Overload

  OL = In
- MCB (Miniature Circuit Breaker)

  MCB = Next Slandered(1.25In) **Equation (4.1)**

- Contactor

  Contactor = Next Slandered(1.1*Pin) **Equation (4.2)**

Mixer Motor Protection Circuit

- Overload

  OL = In
- MCB (Miniature Circuit Breaker)

  MCB = Next Slandered(1.25In) **Equation (4.1)**
- Contactor

  Contactor = Next Slandered(1.1*Pin) **Equation (4.2)**

The following table shows the selected components ratings.

Table 4.2: Selected Protection Components Ratings

Name	Overload size	MCB size	Contactor size
Extruder Motor	6 A	6A	4kW – AC3
Mixer Motor	6 A	6A	4kW – AC3

4.4 PLC Input-Output table

Note: PLC Control Circuit and Connection Diagram are attached in APPINDIX D and PLC Code in APPINDIX E.

The following table shows the PLC I/O's table.

Table 4.3: PLC I/O's

Symbol	Function	Address
Inputs		
Start	**Start**	**X0**
Em	**Emergency Switch**	**X1**
Stop	**Stop**	**X2**
Auto	**Auto**	**X3**
Manual	**Manual**	**X4**
Manual_Mix	**Manual PB Mixer**	**X5**
Manual_Ex	**Manual PB Extruder**	**X6**
Outputs		
Y0	**Main Contactor**	**Y0**
Mix_Motor(K2)	**Mixer Motor**	**Y1**
Y_Cut(Y1)	**Cutting Piston**	**Y3**
V_Aromat and Color	**Color and Aromat Valve**	**Y4**
L_Start	**Start Lamp**	**Y5**
L_Mix	**Mixer Lamp**	**Y6**
L_Ex	**Extruder Lamp**	**Y7**
L_Stop	**Stop Lamp**	**Y10**
Ex_Motor(K1)	**Extruder Motor**	**Y11**

4.5 Motors Power Circuit

The following figure show motors power circuit.

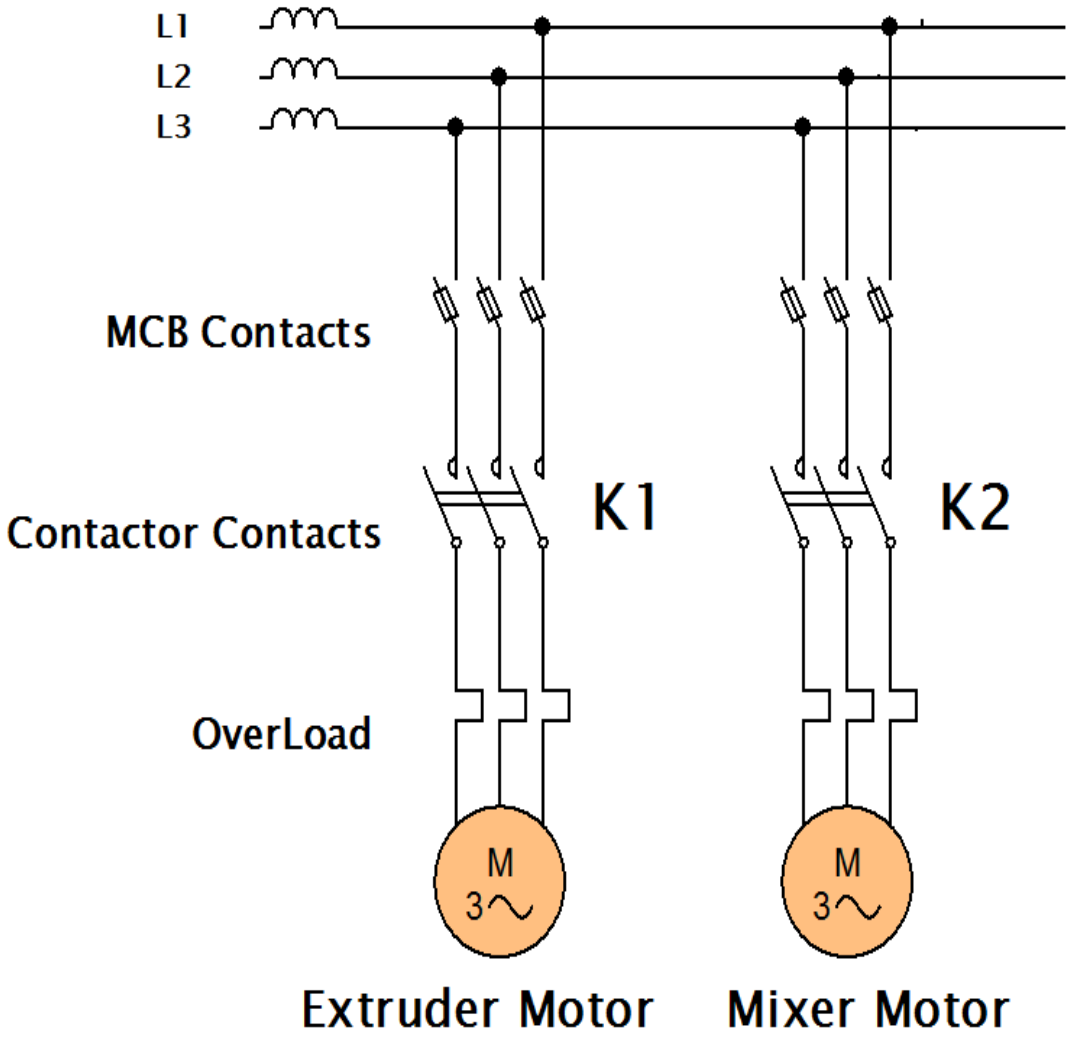

Figure 4.1: Motors Power Circuit

4.6 Pneumatic Power Circuit

Pneumatic Power Circuit is shown below.

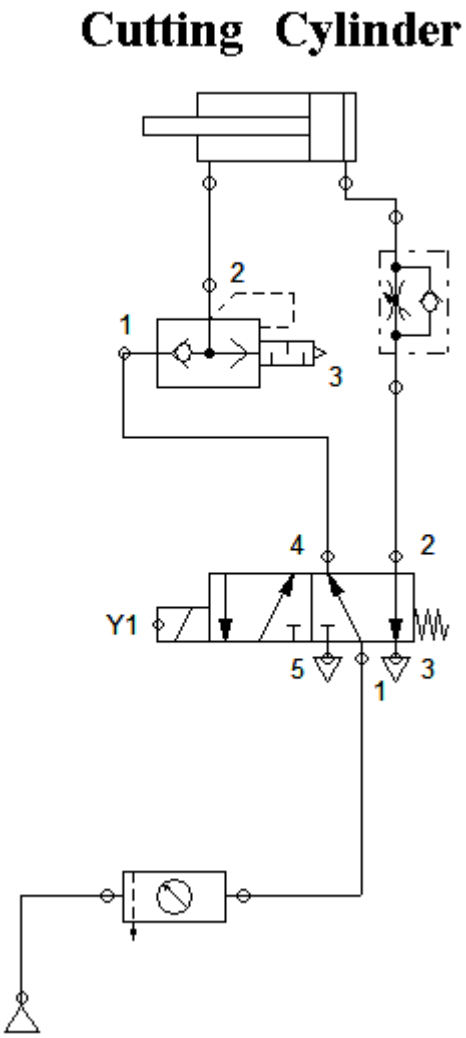

Figure 4.2: Pneumatic Power Circuit

5

Chapter Five

Results and Recommendations

5.1 Introduction

5.2 Experimental Results

5.3 Recommendations

5.4 Project Cost

5.1 Introduction

This chapter provides experimental results and some recommendations for future work for this project. In this chapter we are listing some goals hope to be accomplished or to be considered for future project.

Note: All machine pictures are attached in appendix F.

5.2 Experimental Result

In this section some experimental results will be presented for the soap pieces weight.

The following readings have been taken randomly from the soap pieces produced in single cycle of operation.

Table 5.1: Experimental Results

Soap Piece No.	1	2	3	4	5	6	7	8	9
Weight (gm)	10	9	9	9	9	10	9	11	10
Width (cm)	1	1	1	1	1	1	1	1	1

From the upper table we conclude that controlling the soap width by controlling the cutting time period is a partially good method with ±2gm accuracy in weight, which is sufficient for soap production.

5.3 Recommendations

The machine main purpose is to form soap and add aromat and color to it, in order to have a full production line for soap industry it is essential to design and implement other machine extensions such as raw soap production from the main ingredients, also adding stamping and smoothing mechanisms to be ready for packaging.

If any future projects consider adding modifications for the same machine we recommend the following:

- Adding HMI to the machine to control and monitor the forming process.
- Adding VFD to control the soap flow in the machine.
- To control the cutting stage in closed loop.

- Adding two conveyers, the first one to feed the mixer with raw soap and the second to transfer the ready soap pieces to the next stage.

5.4 Project Cost

The following table represent the final cost of the project.

Table 5.2: Cost Table

Item Name	No. of Items	Total Cost (NIS)
Selector Switch	**2**	**140**
Emergency Switch	**1**	**40**
Push Buttons	**4**	**120**
Double Acting Cylinder	**1**	**150**
Solenoid Valve	**1**	**90**
Aromat mini pump	**1**	**100**
3 phase Induction Motor	**2**	**600**
Gears	**2**	**400**
Contactor	**3**	**150**
MCB	**2**	**200**
Relay	**5**	**240**
PLC	**1**	**1400**
Rack	**1**	**250**
Overload	**2**	**200**
Overall Machine Body + Extruder and Mixer Lathing Cost	**1**	**8500**
Electric Panel	**1**	**200**
Wires	**-**	**300**
Power Supply	**1**	**150**
Total Cost		**13330 NIS**

References

[1] J. Kililku, Design *of bar soap making machine for local soap industry,* B. of Science in mechanics, university of Nairobi, 2016.

[2] M.Gaboya, *Soap making, a quick guide,* Horto, Australia ,2012.

[3] R.K.Basal, *Theory of Machines,* Laxmi , New Delhi.

[4] Solidworks Corporation, *Introducing Solidworks,* 2016.

[5] Y.Sweity , *machines design 2 lectures notes,* PPU, Hebron-Palestine, 2017.

[6] 2013, القاهره, *المرجع في التركيبات والتصميمات الكهربية*, م. الجيلاني

Appendix A

“PLC Delta User Manual”

Appendix B

“304/304L STAINLESS STEEL Datasheet”

Appendix C

“Mechanical Design”

Appendix D

“Electrical Design”

Appendix E

“PLC Code”

Appendix F

“Machine Pictures”

Figure F.1: Total machine Assembly

Figure F.2: Total machine Assembly (Back view)

Figure F.3: Control

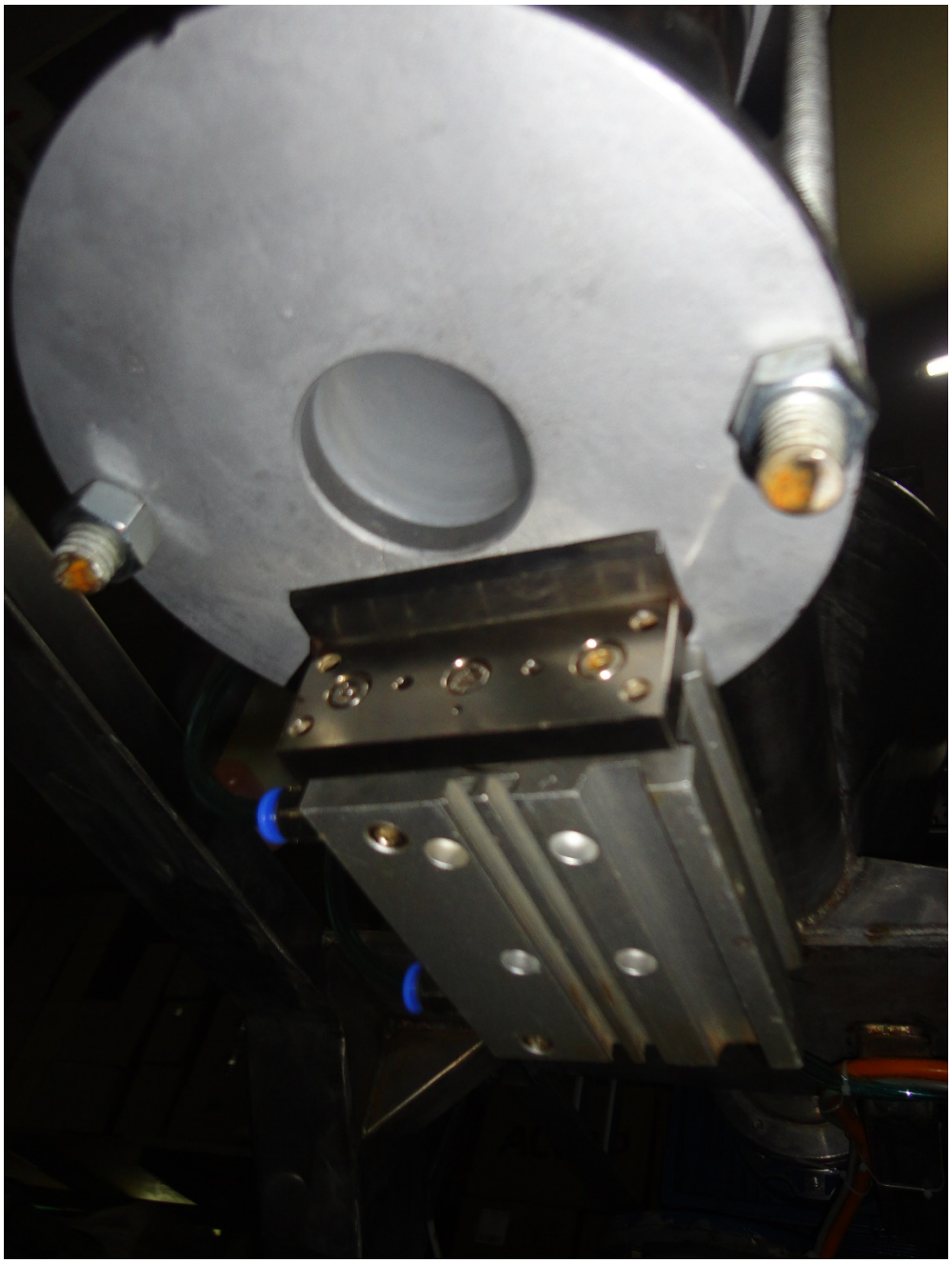

Figure F.4: Shaping and Cutting Stage

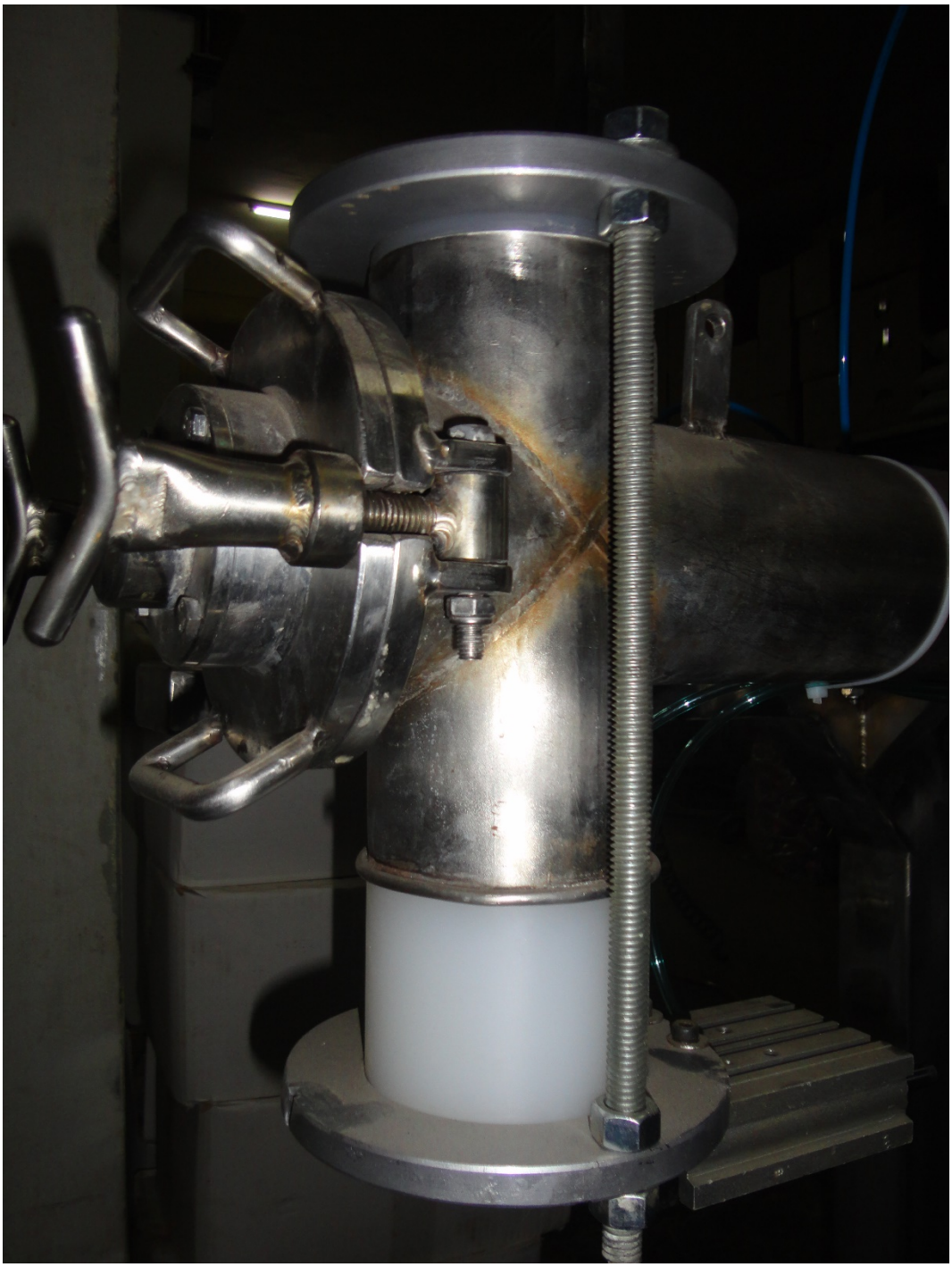

Figure F.5: Shaping Template

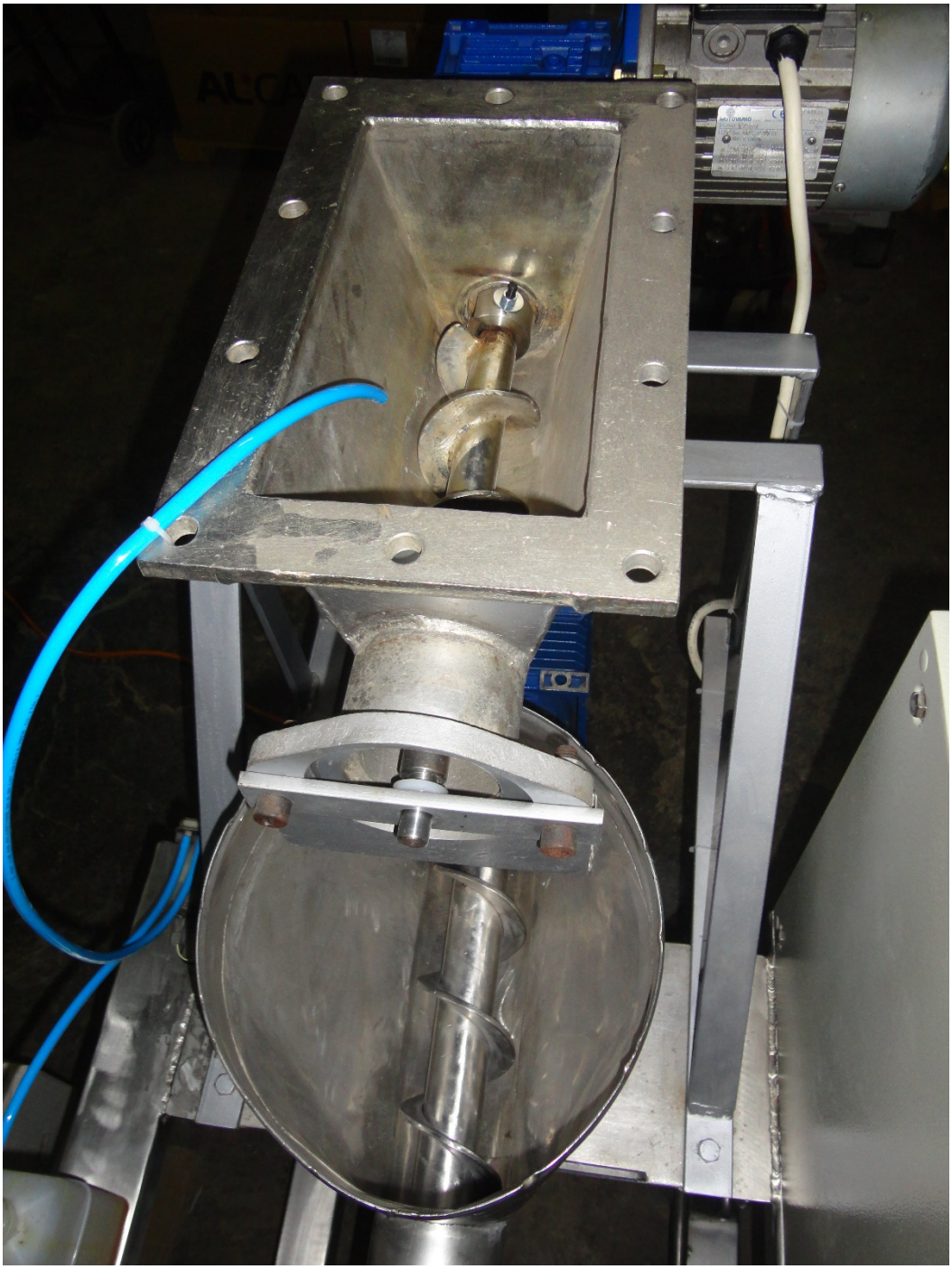

Figure F.6: Extruder and mixer Assembly