CHAPTER I

THEORETICAL FRAMEWORK

1.1 Background

The development of technology has helped humans in facilitating a job. Pellet making machine is a tool specially designed for making fish feed (Zikri, 2014). Pellet making machine has high efficiency. This machine uses a screw working principle that utilizes a screw as a container carrying the material and pressing it towards the form hole plate. This machine has been designed in such a way, which will make the material into solid pellets.

One of the efforts made to save production costs is to design production equipment capable of producing pellet feed products. Based on research, this tool has a pellet pressing screw. This pressing screw pushes the material towards the end of the cylinder and emphasizes the perforated plate as a pellet presser. The plate hole moves the presser according to the desired pellet size. After that, the material will be cut by the cutting knife. (Satriyo et al., 2014). Research conducted by Aria Triwissaka et al. (2014) titled designing a fish feed pellet machine with a “screw press” mechanism used a capacity of 50 kg/hour. Silvia Uslianti et al. (2014) made a pellet machine to help fish pond business groups overcome the high price of fish feed.

In pellet processing, a printer is needed to produce or form a dough used as animal feed in pellets with a predetermined size. The Pellet press tool is perfect and efficient for making animal feed. The pellet press aims to re-examine the development of the tool and the quality produced. The fish farming business is one of the efforts to support the community’s economy amid difficult jobs and increasing demands.

In addition to profiting from the sale of fish meat, this business can also be used as a means of entertainment, such as fishing business. Therefore, it is necessary

to develop technology in it. The feed has a significant role in the growth and reproduction of fish farming. (Eko Murtanto, 2015).

Pellets are artificial foods made from several kinds of materials, mixed and made into a dough, then molded into small bars or spheres. Feed is one of the essential components to support fish farming. Therefore, the available feed must be adequate and meet the needs of the fish. The increase of feed efficiency through fulfilling nutritional needs is needed to reduce production costs. In this globalization era, the increasingly expensive fish feed ingredients affect the general cost of feed. Many feed ingredients must be obtained from imports. Therefore, the cost of feed can be considered as the highest expenditure factor. In addition to the cost of feed, the nutritional needs of fish must also be considered. (Ayuda, 2011)

This modern era requires humans to live an easy life in carrying out all activities in daily life. Nowadays, time and effort are considered expensive. Therefore, humans need to make everything efficient with tools. Additionally, innovation is required in order to support and simplify life. One way to make life easier is to create a tool to increase time and energy efficiency. In fish farming, feed, pellets, or fish food is the highest active ingredient in aquaculture activities. The need for fish feed plays an important role (about 70%) in fish farming business activities. The current obstacle is that factory feed or factory pellets are very expensive. Therefore, it will reduce the profits obtained. In fact, so many fish farmers go bankrupt because the price of fish pellets or fish feed is too high. Based on the author’s survey, many home industries still make fish feed or pellets manually. The manual system makes the fish feed or pellets producing process impractical, less hygienic, and requires many workforces. Besides, the equipment used for manual processing is still cast iron or not yet stainless. By looking at the problems above, the

author is interested in doing a final project titled “Design and Build of Floating Pellet Machine for Small Farmer.”

This machine is equipped with a gasoline motor or diesel engine. It can be used as a grinder drive system for the main transport in a cross-sectional container. This machine can move the screw and increase the tube volume to enlarge the production capacity results. Under these conditions, this machine will help producers carry out and speed up the grinding process of fish feed or pellets.

The study aims to determine the components used to make a fish feed grinding machine with a semi-automatic screw system. This study also aims to determine the sequence of work in building a feed or fish pellet grinding machine with a semi-automatic screw system. The benefit of this research is as a material to socialize the fish feed grinding machine to be the choice of fish feed or pellet entrepreneurs in order to improve the feed or pellet production process. This research can improve time and energy efficiency after using this technology and can be a reference for application and knowledge, both theory and practice, about feed grinders or fish pellets at Universitas Negeri Surabaya.

Indonesia is rich in biological resources, one of which is a source of animal protein, especially fish. Indonesia is also rich in fisheries diversity, both marine and freshwater fish. Fish contains an ideal nutritional composition, which is 18 percent protein consisting of essential amino acids, which will not be damaged during cooking. The fat content of fish is 1-20 percent fat, which is easily digested and can be used directly by body tissues. The fat content of fish is primarily unsaturated fatty acids needed for growth and lower blood cholesterol.

According to Arestya (Ariestya Meta Devi, 2010), an extrusion process is a processing process in which there is mixing, kneading, shearing, heating, cooling, and

shaping. This process is assisted by using a device called an extruder. Extruders work by pushing the raw material to be processed out through the die hole. Die functions as forming or printing materials after processing in the extruder. Extruders that are widely known nowadays are screw-type extruders, in which the screw rotation will pump the material out through the die. The principle of extrusion in food processing is to combine pushing, mixing, and forming. This breakthrough provides fundamental knowledge for HTST (High-Temperature Short Time) extrusion.

In this era of globalization, the increasingly expensive fish feed ingredients affect the price of feed in general. Many feed ingredients must be obtained from imports. Therefore, the cost of feed is the highest expenditure factor. In addition to the cost of feed, the nutritional needs of fish must also be considered. A good fish feed must contain nutrients such as protein, fat, carbohydrates, vitamins, minerals, and energy in sufficient quantities to support fish growth properly. The quality of feed depends on the feed raw materials. Hence, the availability of raw materials must be maintained in terms of quality and quantity (Ayuda, 2011).

Fish feed generally consists of fish meal, shrimp meal, soybean meal, rice bran, vitamins, and minerals. The fish feed consists of two kinds, namely natural feed and artificial feed. Natural feed is usually found in living things (plankton), which is rather difficult to develop. Meanwhile, the artificial feed comes from ingredients that meet the needs of fish. One of the most commonly found artificial fish feed on the market is pellets.

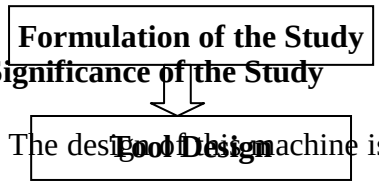
1.2 Formulation of the Problem

In this design, the capacity and power of the floating pellet press machine and how to design the floating pellet machine are determined. Therefore, the working

mechanism of the floating pellet press machine can be known.

1.3 Objective of the Design

1. Design a floating pellet press machine with a capacity of 50 kg/h.
2. Test and calculate the machine elements on each component of the tool.



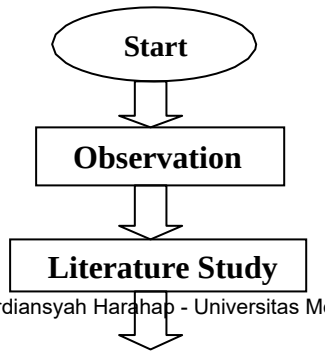
1.4 Significance of the Study

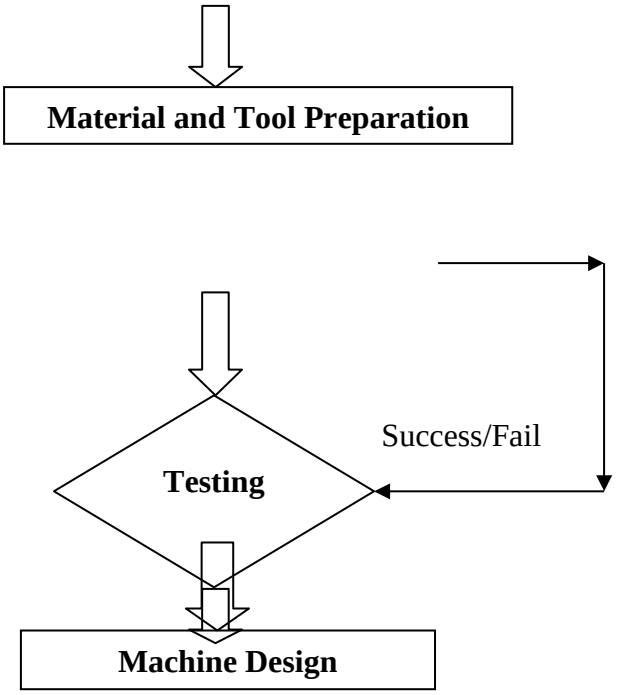
The design of this machine is expected to be useful for readers and the public. The significance obtained include:

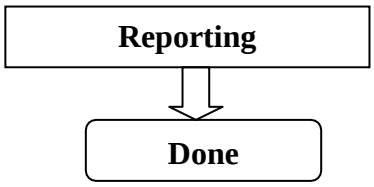
1. Help farmers in getting a pellet press machine.
2. As material to provide information for readers to develop and enrich their knowledge.
3. As a material to be developed into a technology that is useful for the community.

1.5 Data Collection Techniques

1. Literature study, namely reading reference books related to the compiled design technique.
2. Conduct a field study to find out the efficient and straightforward process of making floating pellets.
3. Discuss with the academic adviser (supervisor).
4. Consult with people who understand the field of machine construction.







CHAPTER II

LITERATURE REVIEW

2.1 Definition of Extrusion and Screw

Foodstuff extrusion is a process in which materials are forced to flow under

the influence of one or more operating conditions, such as mixing, heating, and cutting (*sher*). through a die designed to form a variable extrusion yield. (https://www.coursehero.com)

Single screw extruders were initially used in 1935 to extrude products in the form of pastes. Since 1935, the use of such tools in the food industry has increased, especially in processes that require cooking or gelatinization at a particular stage, such as producing snacks, pasta cereals, confectionery products, pet food and other feeds, sausages and the like, protein supplements, and meat-based products. (https://fdocument.com)

Extrusion functions include gelatinization/cooking, molecular cutting, mixing, sterilization, shaping, and puffing/drying. Combining one or more of the functions mentioned above is an inseparable part of the extrusion process. It is important to note that the extrusion process cannot be separated from the overall process since several interrelated interactions between the conditions will occur before and after extrusion.

Extrusion technology has opened up opportunities for food entrepreneurs to produce food products with various shapes and textures. Extrusion cooking is used to replace conventional cooking methods due to various reasons as follows: (1) can be changed so that the same machine can cook and transform products with different formulas; (2) gives shape and texture to the product; (3) has continuous production capability; (4) efficient, in terms of power, energy and factory area; (5) pasteurization of final production; (6) dry process with little or no spillage.

Extrusion technology can produce snacks with a various selection of shapes and sizes (Figure 13.1). With extrusion technology, the industry can produce food products in the form of curls, rounds, pellets, twists, rods, or even pillow shapes and other unique shapes. The feed flavor, color, and taste can also vary. These various

products are produced by extrusion technology, using a main tool or machine called an extruder.

Figure 2.1 Various shapes and sizes of extruded products

2.1.1 Extruder

Extruder application in the food industry began in the mid-1930s, where extruders were used to make pasta. Furthermore, in the 1940s, extruders began to be applied to the oil extrusion process. In the 1960s, extruder applications began to be used for the production process of various snack products and ready-to-eat breakfast cereals (RTE cereals).

An extruder is basically a device that will force raw materials to flow under certain operating conditions and simultaneously force the material to start a thin die.

2.1.2 Extruder Type

Depending on the tool type, extruders can be divided into three types: piston extruders, roller extruders, and screw extruders. For the various food industries, the screw extruder type can be illustrated in the figure below. The screw-type extruder is a device consisting of a screw that rotates in a fairly little beret. In its operation, the raw material (which is generally a chamber bitter of one or more materials) is fed into the extruder through a hopper at one end of the extruder. With the rotation of the

extruder screw, the materials will be pushed into a narrow space, which will finally be forced to pass through a narrow slit in a particular shape. By controlling several extruder design parameters, several processes will occur at once. These processes include the process of mixing, stirring, cooking, forming, and expanding. Thus, from the tool side, the basic components of the extruder are screws and die. In its operation, the extrusion process parameters that need to be controlled are (i) temperature, (ii) pressure, (iii) rotational speed, and (iv) die diameter. Practically, the screw design of an extruder can vary, with some common terminology as shown in the figure below. Based on the number of screws, the popular screw-type extruders are single-screw extruders and twin-screw extruders.

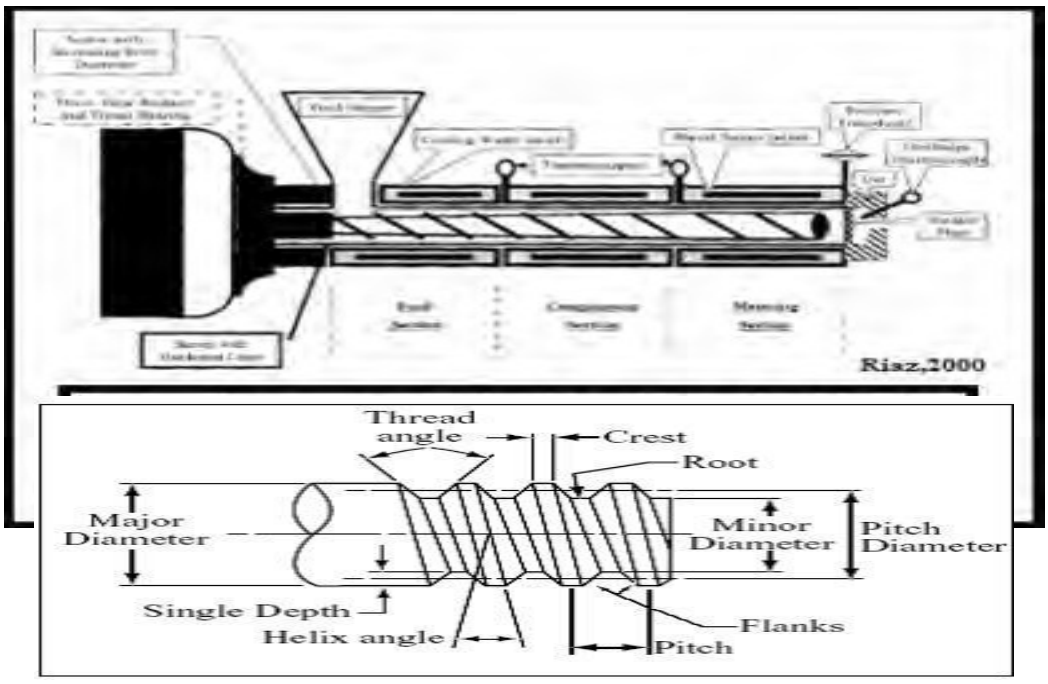


Figure 2.3 Some Screw Terminology

2.1.3 Extruder Type

1. Single Screw Extruder

Based on its working principle, a single screw extruder can be considered a pump. To flow this extruder material relies on friction between the material, the barrel wall, and the screw. Single screw extruders are widely used in the food industry, such as pasta extruders.

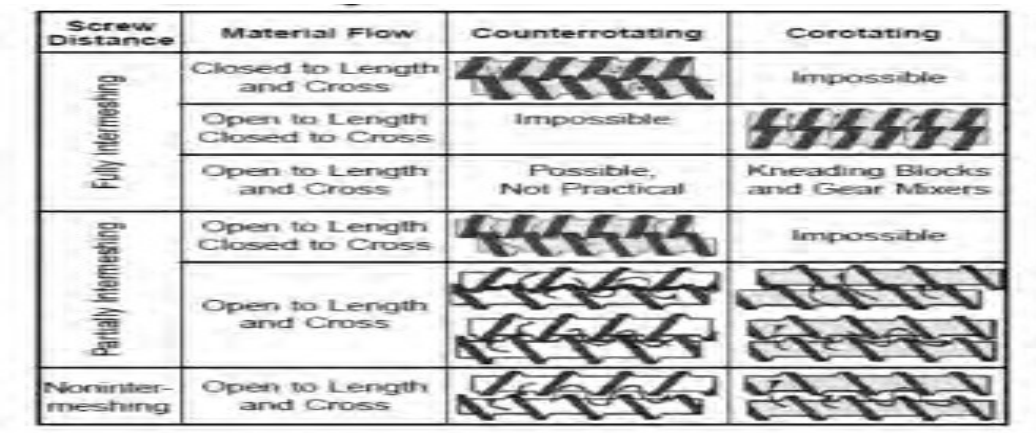


Figure 2.4: design variations of the extruder screw and barrel to give different pressure effects

The screw is driven by an electric motor with varying speeds, which is very powerful for pumping the material and applying pressure (and heat) in the extruder barrel. Screw speed is one of the main factors that may affect the extruder's performance since it will affect product residence time, pressure, heat, kneading quality, and/or material recovery. The screw speed ranges from 150-600 rpm, depending on the application.

The accumulation of pressure in the barrel due to the backpressure by the die (which is very small) can also be controlled by various screw and barrel design combinations, as shown in the figure. The die pressure varies between 2000 kPa for

low viscosity products to 17000 kPa for developed snack foods.

Single screw extruders can be classified based on their shear strength into (i) high shear, (i) medium shear, and (iii) low shear. High shear extruders are usually operated to produce cereal and are used for expanded snack temperatures. Medium shear extruders can be used for making bread, texturized protein, and semi-wet pet food, as well as low extruders. Shear is widely used to make pasta, meat-based products, and chewing gum. Operation data with various extruders are listed in the table below.

Parameter	High Shear	Medium Shear	Low Shear
Energy Input (kWh $kg^{-1)}$	0,01-0,16	0,02-0,08	0,01-0,04
Length/Diameter Ratio (L/D)	2-15	10-25	5-22
Screw Speed (rpm)	>300	>200	>100
Maximum Product Temperature (°C)	149	79	52
Maximum Barrel Pressure (kPa)	4000-17000	2000-4000	550-6000
Product Water Content (%)	5-8	15-30	25-75
Product Density (kg/m^3)			

Table 2.1 Operation Data of Various Types of Extruders

Extruders may also be equipped with a steam coat on the barrel and/or screw rod to add hot steam (or cooling water) for temperature control purposes. In other device designs, an electric preheat element is used to heat the barrel directly. Some products also require heating of the die to maintain the viscosity of the expansion degree. Meanwhile, other products require cooling on the die to reduce their expansion.

The five types of single-screw extruders commonly used in the food industry are as follows.

1. Pasta Extruder

This tool is used to form macaroni and similar products from a dough. From the five types of extruders, this tool is ideal because it has a smooth cylinder and does not have a constant screw geometry. This tool is the closest to the isothermal extruder type since it only causes the lowest temperature rise.

2. High-Pressure Extruder

This tool is used to compact and form a dough that has undergone gelatinization. This product was originally a product that required further processing, such as deep-fat fryers (snacks) and cereals. These tool works are similar to the one above, except that the cylinder is generally screwed. This screw requires additional force and causes an increase in temperature and the amount of heat released to the food.

3. Low Shear Extruder

This tool is used as a continuous cooker for dough with high water content. It is flexible and has a variety of uses. The cooked product must be further processed by shaping, drying, etc. The cutting in this tool is more frequent than the above types of forming extruders. However, due to the low viscosity (high water content), almost all the energy required for intake is taken from the outside (heated).

4. Collet Extruder

This tool can cool cornmeal to make puffy snack products. This type of tool is a tool that has a short residence time. The speedy release of energy in this tool is caused by the high flow velocity, deeply grooved cylinder, and very dense (low humidity). The high temperature can cause the material to lose water quickly, thus

forming a dry and bubbly product.

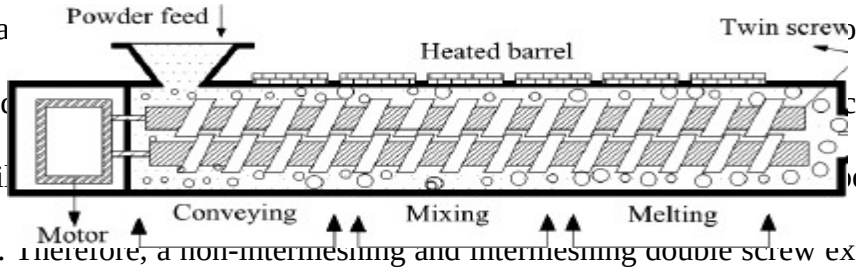
5. High-Shear Extruder

The operation of this tool is similar to a collet extruder, except that the residence time of this tool is longer, and the excess heat is removed by cooling the cylinder. This machine is more flexible than the collet extruder. The use of this machine is wider. It can be used for various products, such as bubble cereals, snacks, and dry animal feed processed from various mixtures and dry ingredients. The fast cutting and long residence time result in the mixture being well mixed. Thus, water can be injected into it from the feeder to obtain a product with optimum humidity.

Considering that the humidity of the material in this tool is generally higher than that of the collet extruder process, a product that remains high in moisture will be produced. Hence, after the extrusion process, the drying process needs to be done. The resulting product temperature and total enthalpy are lower than the extruder collet and the cooling speed. These changes lead to a longer residence time. The cooking temperature of this tool is lower, and the expansion process is less intense than the collet extruder. In addition, the product produced by this tool is usually brown, has a stronger texture, and produces a better aroma.

2.1.4 Double Screw Extruder

A double screw or twin-screw extruder consists of two screws with equal length, pa

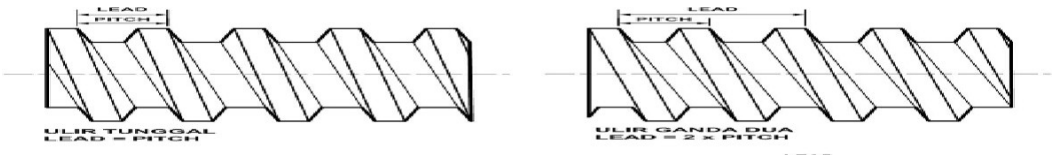


n of screw rotation, c co-rotating. Meanwhi etween the two axes. Therefore, a non-intermeshing and intermeshing double screw extruder will be obtained with the degree of their linkage.

Figure 2.5: Screw position inside the double screw extruder barrel

In a non-intermeshing configuration system, the axes of the two screws are located far enough apart so that the rotation of one screw does not significantly affect the rotation of the other screw. In this case, this non-intermeshing configuration can be considered two single screw extruders whose working principle is the same.

In the intermeshing system, the axes of the two screws are close enough so that the flight of one screw can enter the channel on the other screw in such a way that they are interconnected. Such a system allows for a more homogeneous, self-cleaning, and self-wiping mixing process, where the flight of one screw sweeps and clears material in the channel of the other screw (as illustrated in the figure). Hence, the conveying capacity of the double screw extruder, especially with the intermeshing configuration, will be increased. This good conveying capacity can transport sticky materials, which are very difficult to handle with single screw extruders.



One of the advantages of a double screw extruder is greater operating flexibility due to changes in the degree of connection between the two screws, total screws, or the screw angle. The flight profile on this double screw can be changed since various disks with different flight profiles can be disassembled as desired (as

shown in the image below). With the appropriate screw construction, multiple operations can be performed simultaneously, including conveying, kneading, cooking, cooling, shaping, without or with the end of the puffing process. With flight profiles on different screws, different pressure profiles (and temperature profiles) will also be produced. It can also be adjusted according to processing needs. In addition, some types of extruders also make it possible to adjust the distance between the screws.

2.1.5 Production Process

1. Variations with Extrusion Technology

Nevertheless, in general, the production process of snacks using extrusion technology can be described above, where the snack extrusion process can be divided into direct-expanded snacks.

Direct expanded products are products produced directly from the extrusion process, are final products obtained, formed, and expanded on an extruder die, and generally do not require further processing, except a little drying to control the final water content. Most of these products are extruded through a die with a round diameter and cut immediately after exiting the die. The cutting speed will determine the product's shape and size. The product may be curly if the cutting is slower. Most products of this type are produced from corn using a single screw extruder.

Indirect-expanded snacks are also often referred to as "third-generation snacks, half-products, or snack pellets". These products generally have low water content and do not expand, so they are similar to dry pasta. These products will expand after further processing, especially the frying process or hot air puffing process.

Subsequently, it can be seen that extrusion technology can provide variety to

food products, especially snacks. This variation is not only in terms of shape and size but also in terms of taste, aroma, and color. Thus, extrusion technology can expand various types of products to meet the demands of consumer choice.

2.1.6 Application

The operating conditions and applications of the five types of extruders above can be seen in the table below:

Parameter	Pasta Extruder	High-Pressure Printing Extruder	Low Shear Extruder	Collect Extruder	High-Shear Extruder
Feeding humidity (%)	22	25	28	11	15
Water content of products (%)	22	25	25	2	4
Maximum temperature of products (℃)	52	79	149	199	149
Maximum pressure (kPa)	-	1500-7000	-	70000	17000
Residence time (det)	-	15-45	-	-	30-90
Screw speed (rev/min)	30	40	60	300	450
Net energy input to the product ($kWhkg^2$)	0,02	0,03	0,07	0,10	0,07

Table 2.2 operating conditions of the five types of extruders

Parameter	Pasta Extruder	High-Pressure Printing Extruder	Low Shear Extruder	Collect Extruder	High-Shear Extruder
Flour-based products: - Snacks and dry bread - Cereals - Pasta	X	X	X X	X X	X X
Confectionery (chewing gum)		X	X		X
Protein-based foods: - Feed - Sausage - Meat - Analog			X X	X X	X X

Table 2.3: application of the five types of extruders;

We have two kinds of floating fish feed pellet mill machine for making fish feed pellets, one of which is a machine using a dry method, and the other is a fish feed extruder machine using a wet method, which needs to be used with a steam boiler to inject steam during pelletizing. The floating fish feed machine is used to make pellets from grains, soybeans, cereals, or other materials.

We export our floating fish feed machine to South Africa, the Philippines, India, Malaysia, Australia, Pakistan, Nigeria, Turkey, Chile, Maputo, Tanzania, Zimbabwe, America, Venezuela, Thailand, Myanmar, Vietnam, and almost all over the world.

Figure 2.7 Floating Pellet Machine

The pellets can float on water for at least about 24 hours. Pellets are explicitly used for aquacultures, such as fish, shrimp tortoise, and other aquatic products. Pellet diameter may vary. Fish feed pellet machines can produce many kinds of feed for different types of animals. The floating fish feed pellet mill can make poultry, pet and fish feed. The fish feed pellet machine is applied to the pre-treatment of various fish feed to reduce the loss of nutrients and advance the protein ratio. However, if you want sinking pellets, we have other types of fish pellet equipment for making sinking fish feed pellets.

Figure 2.8 Floating Pellet Machine

The materials for the floating fish feed pellet mill are as follows:

1. Raw Material: corn, wheat, soybean, grain, bone powder, etc.
2. The raw material needs to be ground to 60-80 raw material content; moisture mesh: 13-18%
3. Rice Powder: contains about 10-14% protein and contains vitamins B1, B2, B6, and a small number of enzymes.

Figure 2.9 Pellet

4. Mustard Cake: Mix a maximum of 40% cake into fish feed. However, do not use more than 20% of cookies. The mustard cake contains 30-32% protein.
5. The floating fish feed making machine also contains a high level of fat.
6. Wheat Chaff: contains fiber, controls many types of fish diseases.
7. Corn: contains protein, carbohydrates, fat, vitamins A and E.

Figure 2.10 Floating Pellet Machine

8. Cotton Seeds: contains about 54% protein. This is a better material for making supplementary fish feed.
9. Fish Powder: easy to digest for fish. The fish powder contains about 55-60% protein.
10. Bone Powder: indispensable for building fish bones. The ratio of calcium and magnesium in bone powder is 2:1.
11. Innards: very suitable bait and ideal for catfish. It contains 52% protein.
12. Our fish feed extruder is a single screw design.
13. We provide technical formula for making wild fish feed pellets after place an order.
14. We send easy-to-use parts for free with one hand, one screw, one cutting knife, and three die molds.

Figure 2.11 Floating Pellet Machine

The advantages of the floating fish feed machine are:

1) With different molds, the floating fish feed pellet mill can produce food of different diameters, from 0.9mm to 10mm. The food can meet different stage fish. Food can float for 24 hours.
2) The floating fish feed pellet mill can produce different shape feed for fish, dogs, cats, etc. Through feed pre-treatment, it can reduce nutrient loss and increase protein ratio. Thus, the feed will be easily digested by animals.

Figure 2.12 Floating Pellet Machine

3) The floating fish feed machine has high efficiency and low power consumption.
4) The screw sleeve of this minnow food extruder adopts alloy-coated steel structure, which ensures a long service life.
5) Different molds can be selected to make pellets of different diameters and shapes.
6) The final feed pellet produced by the fish feed machine is 0.9-15mm.

Figure 2.13 Various Shapes of Pellets

Model	capacity (t/h)	power (kw)	feeding power (kw)	screw diameter (mm)	cutting power (kw)
DGP-40	0.03-0.05	3	0.4	φ40	0.4
DGP-50	0.06-0.08	11	0.4	φ50	0.4
DGP60	0.1-0.15	15	0.4	φ60	0.4
DGP70	0.15-0.3	18.5	machanism feeding	φ70	0.75
DGP80	0.3-0.4	22/27	machanism feeding	φ80	1.5

‘DGP90	0.4-0.5	30/37	1.1	φ90	1.5

Table 2.4 Diameter, Pellet Forming Pressure

Figure 2.14 Various Sizes of Pellets

The floating fish feed is produced by using a fish feed extruder machine (single screw). A single screw extruder machine is used to make floating fish feed pellets. A fish feed can float by using an extrusion machine. WFS series single screw extruders are purposely made for Aquafeed. It has impressive performance and is very efficient, especially when producing 3-5mm floating aquafeeds.

Performance Characteristics:

1. It can adapt to various production processes. The screws can be replaced and adjusted to have different configurations and to suit different target products.
2. It has stainless steel DDC with 12 steam injectors and six liquid nozzles.
3. The gearbox can withstand strong torque and push up to 400hp.
4. Barrel jacket design with liner can achieve heating/cooling function. Steam and water can also be injected directly into the barrel.
5. The screw is made of special anti-wear alloy with an L/D ratio of up to 18:1,

ensuring smooth production for all kinds of sinking/floating baits.

6. Quickly replaces the mechanism for die and screws as well as on-line adjustment for the cutter.
7. WF series extruder has a special frequency control feeder, which can ensure the feeding process to be more smooth and stable.

Model	Main Power (KW)	Feeder Power (KW)	Conditioner Power (KW)	Cutter Power (KW)	Capacity (T/h)
WFS145	75/90/100	1.5	11	5.5	1.0～3.0
WFS175	132/160/200	1.5	15/18.5	5.5	3.0～7.0
WFS215	250/310	2.2	18.5/22	7.5	6.0～12.0

Table 2.5 Diameter, Pellet Forming Pressure

Figure 2.15 Various Sizes of Pellets

Extrusion can be defined as a technological process, namely, forcing feed raw materials in one or more of the following process conditions (such as mixing, heating and cutting.) By flowing through the die, the material can be formed or can be subjected to eruptive gasification. This tool can make raw materials from a loose state into a continuously shaped dough. The paste produced by this tool is then extruded through holes in the metal plate. The diameter of the hole regulates the diameter of the

pellet, which can range from a variety of different sizes.

Figure 2.16 Various Shapes of Pellets

General Raw Material for Making Nutritional Fish Feed:

1. Rice Powder: contains about 10-14% protein and contains vitamins B1, B2, B6 and a small number of enzymes.
2. Mustard Cake: Mix a maximum of 40% cake in fish feed. However, do not use more than 20% of cookies. The mustard cake contains 30-32% protein. It also has high levels of fat.
3. Wheat Chaff: contains fiber that can control many types of fish diseases.
4. Corn: contains protein, carbohydrates, fat, vitamins A and E.

Figure 2.17 Heart Shaped and Bone Shaped-Pellets

5. Cotton Seeds: contains about 54% protein. It is a better material for supplementary fish feed.
6. Fish Powder: easy to digest for fish. The fish powder contains about 55-60% protein.
7. Bone Powder: indispensable for building fish bones. The ratio of calcium and magnesium in bone powder is 2:1.
8. Innards: a very suitable and ideal feed for catfish. It contains 52% protein.

Figure 2.18 Different Shapes of Pellets

2.2 Definition of Design and Build

According to *Kamus Besar Bahasa Indonesia* (The Great Indonesian Dictionary), the word design means to arrange everything before acting, making, or doing something to plan. Meanwhile, the word build means something established (Ministry of National Education, 2002). Design and Build mean planning or designing something to be made (Ministry of National Education, 2002).

The design of a tool is included in the technical method. Thus, the steps of

making an engineering design is an activity that has a specific purpose. This specific purpose includes the fulfillment of human needs, especially those that can be accepted by the technological factors of our civilization. From these definitions, there are three things that must be considered in the design, namely: 1) activity with a specific purpose; 2) targeting the fulfillment of human needs; and 3) based on technological considerations.

Design is a series of procedures for translating the analysis results of a system into a programming language to describe in detail how the system components are implemented. Meanwhile, build or building a system is an activity to create or replace or improve an existing system, either in whole or part. (Presman, 2016).

Design and Build are closely related to system design, which is a unit for designing and building an application. According to Tata Sutabri (2012: 284), system design determines the processes and data required by a new system. If the system is a computer-based system, the design may include a specification of the type of equipment to be used. Meanwhile, Jogiyanto (2012) explains that system design can be defined as drawing, planning, and making sketches or arranging several separate elements into a unified whole and functioning. The purpose of system planning is to meet the needs of system users and provide a clear picture to the programmer. These two purposes focus on designing a detailed system, namely making a clear and complete design, which will later be used for making computer programs.

From the explanation above, it can be concluded that system design is an activity of translating analysis results into a software package, which then creates a system or improves the existing system.

2.3 Definition of Pellet machine

Design of Animal Feed Pellet Making Machine with Extruder System:

The success of livestock farming is primarily determined by three equally important factors, namely breeding, feeding and management. However, when viewed from the total cost of production in livestock farming, the contribution of animal feed is the highest, which is about 75% of it.

With the development of livestock in Indonesia, the need for animal feed is also getting higher. This condition causes problems in the manufacture of animal feed, especially “Pellet” animal feed. Pellet is an animal feed that has a fairly complex composition. Pellet composition is fish meal, cornmeal, bran meal, tofu dregs, and vitamins that are mixed together. Up until now, there are still many manufacturers who mix these ingredients manually, namely mixing by hand, and some use a mixer.

Manual mixing (by hand) produces less-homogeneous pellets if compared to using a mixer. However, from both methods, the pellets produced will be in the form of irregular lumps, which, when dry, the large lumps must be reprocessed or crushed. Therefore, the author made “Animal Feed Pellet Making Machine with Extruder System”, where the pellets produced are in the form of small, homogeneous granules.

2.4 Working Principle of Pellet Making Machine

The working principle of this Pellet Making machine is that the motor drives the pulley, then the pulley is connected to the main shaft. On the main shaft, a Screw Extruder is placed, which functions to push the mixture of raw material for animal feed pellets. Animal feed raw materials are fed through the Hopper, which leads to the Screw Extruder. In the Screw Extruder, the raw material for pellets will be stirred and pushed into the printing filter and out through the Outlet Funnel in the form of pellets.

2.5 Construction of Pellet Making Machine

In general, the construction of the Animal Feed Pellet Making Machine is as shown in the picture below:

Figure 2.19 Pellet Making Machine

2.6 Main Parts of Pellet Making Machine

The main parts of the Pellet Making Machine are as follows:

1. Machine Stand: It serves as the main construction that supports all components and systems that work on the Pellet Making Machine.
2. Pulley Transmission System: It serves as a power transmission in rotation from the electric motor to the main shaft or screw extruder.
3. Hopper: It serves as a feeder for animal feed raw materials to be directed towards the Screw Extruder.
4. Main Shaft: It serves as a support for the Screw Extruder.
5. Screw Extruder: It serves as a stirrer and pusher of raw animal feed materials to mix well and move towards the pellet filter.
6. Housing Screw: It serves as a Screw Extruder holder and feeds raw material guider to be mixed and pushed by the screw extruder perfectly.
7. Pellet Filter: It serves as a filter that changes the mixture of animal feed raw

materials that have been stirred into homogeneous pellet granules.

8. Outlet Funnel: It serves as a director for pellet granules coming out of the machine.
9. Electric Motor: It serves as the prime mover of the engine system.
10. Mixer. This part serves to stir the material to make it more homogeneous and bring the material to the extruder screw. A mixer is driven by an electric motor with a 1Hp/gasoline motor (5,5 Hp). The rotating frequency is set by the Pulley/Speed Reducer.
11. Screw and Tube

Screw and tube have very varied types. The screw serves to carry, stir, and cut the material to the die hole. The screw is driven by a powerful electric motor with a power of 10 hp. The screw pressure is immense, so the protein material will be pressed with great pressure to release the oil, allowing it to be more easily digested when fish eat the pellets. Meanwhile, the tube serves as friction and cutting material until it becomes more even and homogeneous before the material reaches the die.

12. Die or Mold

Die or mold serves to form the material carried by the screw and pass through the die hole according to the existing size. Sizes can be made based on the customer's wishes, starting from 2mm. The customer will only be given three default print sizes.

13. Cutting Knife

The cutting knife serves to cut the material that has been formed by the die. The length or short of the material size can be adjusted. The pellets that have been cut will dry immediately; they just need to be aerated.

2.7 Extruder

The extruder is a process of changing the material from the pellet (PE) to extruded materials (change from solid to liquid). This change is carried out through various stages of heat. These heat stages include:

1. In the hopper, the material will fall into the screw, precisely fell into the feeding zone. This feeding zone is the deepest area. In this area, the material will be heated.
2. After being heated in the feeding zone, the material will enter the compression zone. In this area, in addition to undergoing a heating process, the material will also experience compression until it melts. This area also serves to push back the air that comes back to the feeding zone.
3. After being compressed in the compression zone, the material will then move to the metering zone. In this area, the material will enter the grooved area of the shallow channel. This channel serves to provide back pressure so that the melt and temperature will be the same. In addition, the conveying part will not be measured rapidly through the die at a constant flow rate. Thus, the output will be the same and controlled.
4. The last heating process that the material goes through is in the area around the neck and die. In this area, the heating used is usually more significant than the previous heating.

The process used in this extruder machine according to the material used is as follows:

Polymer	Extruding Temperature Range (^oC)	Injection Molding Temperature Range (^oC)
Polyethylene	120^0-150^0	140^0-160^0
High Density Polyethylene	130^0-160^0	140^0-160^0
Polyproppylene	160^0-190^0	160^0-200^0
Polylactic Acid	170^0-200^0	160^0-190^0
High Impact Polystyerene	170^0-250^0	170^0-250^0

Acrylonitrile Buladiene Styrene	210^0-250^0	210^0-250^0
Nylon 6	140^0-250^0	140^0-250^0

Table 2.6 Material Temperature

The process that is often used on this machine is an outer sheath, and materials that are often used for this process are plastic materials. The outhersheating process provides a protective layer from electrical or mechanical disturbances, which is carried out by extrusion.

In general, the extrusion process can be distinguished by how the work material is stressed (pressed).

a. Direct Extrusion

Basically, the extrusion process presses the material to be formed until it exits through the die. The material direction is in the die position direction so that the exit direction of the material will be extruded from a straight line cross-section.

In this section, the material pressing process is carried out using a liquid fluid. In addition, this extrusion can also reduce friction between the pounder and the pounder wall.

b. Lateral Extrusion

Extrusion is carried out by the pounder against the material directly. Therefore, the material to be formed exits through the die. The direction of extrusion is perpendicular; the position of the pounder with the die is perpendicular. In the extruder machine, the extrusion process is carried out by a screw using a certain temperature and a certain rotational speed. Hence, the coating material is made to be used to coat the cable.

c. Extrusion Types

The type of extrusion can be distinguished by the way the material is to be formed. The die used for the extrusion process in each extrusion process is also different. The emphasis method in the extrusion type depends on the initial treatment carried out on the material to be formed. Extrusion is done by giving a specific temperature to the material to be extruded. For other heating procedures, extrusion by heating requires high heat. In this extrusion, the risk of deformation to the final result is very high.

To overcome this, it is necessary to use cooling to reduce the temperature quickly before deformation occurs. The die used is a die that has a hole for the material to be pressed out. The shape of the die hole is adjusted to the type of product being made.

1. Cold Extrusion

Cold extrusion does not use a heating method like hot extrusion but only uses room temperature to shape the material into the desired shape. Usually, this type of extrusion is used to make equipment or main components of cars, motorcycles, and also for the needs of agricultural tools.

Cold extrusion has several advantages, such as:

a) Improving mechanical extrusion products of hardness working.
b) Has good tolerance control so that the finishing process is not too much.
c) Improving surface finish.
d) The production figures and prices are more competitive by using the cold extrusion method than using other methods.
e) Stressing level on the equipment produced using this method is very high.

2. Impact Extrusion

Impact extrusion is the same as indirect extrusion and is often included in the cold extrusion category. The thickness of the extrusion pipe is smaller than the die. There is a gap between the hammer pipe and the rest of the die. This type of extrusion is intended so that the material or plate to be extruded fills the space on the die side.

3. Hydrostatic Extrusion

The hydrostatic extrusion required for the extrusion process is produced by an available fluid in the process. As a result, there is no friction on the cross-sectional wall during the extrusion process.

This method can reduce the damage to the product that can occur during the extrusion process since the increase in hydrostatic pressure for brittle materials is very suitable for successful extrusion. This is reflected in the low friction, low die angle usage, and high extrusion ratio. For commercial activities, the suitable material to use is processed by using the hydrostatic extrusion method. This method usually uses room temperature for the formation process and uses oil from plants as a fluid since it is excellent for lubrication and its viscosity has no effect on the pressing applied.

Factors that can affect the extrusion process on the material are:

1. Extrusion Type

The type of extrusion must be adjusted to the type of material to be used. Due to the different properties of some materials, it is necessary to select the type of extrusion suitable for the material.

2. Working Temperature

Each type of extrusion has its temperature depending on the type of material to be extruded. In principle, the provision of working temperature is intended to facilitate the extrusion process.

3. Cross-Section Reduction

The cross-section used for each extrusion is very dependent on the quality of the material and the state of the surface. The manufacture of cross-section and clearance according to the pounder needs to be considered in order to form the desired model.

4. Friction

Friction can occur in all components that are in contact, including the extrusion process. To avoid this, the gap between the die and the pounder is usually lubricated. This lubrication aims to reduce friction and reduce the risk of wear. In this case, lubricants also have other uses, namely:

a) Provide heat by reducing friction as small as possible.
b) Take heat away from other parts of the engine.
c) In addition, lubricants can also reduce the risk of rust.

Therefore, a good lubricant is needed for the engine. Some of the properties and requirements of a good lubricant are:

1) The viscosity must match with the type of machine operation.
2) Have good adhesion.
3) Not easily mixed with other items (dirt).
4) Have a high flash point and is not easy to volatile.
5) It must be easy to transfer heat and have a low freezing point.

2.8 Extrusion Principle

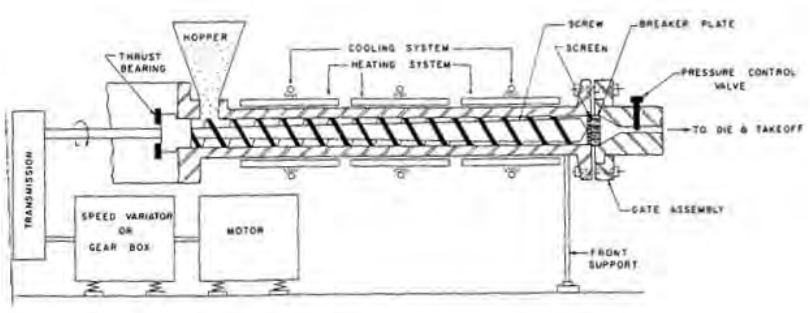


Figure 2.20: Extruder Machine Components

a. Extruder Machine Components

An extruder machine is a machine consisting of a Hopper, Barrell Screw, and Die.

1) Screw

A screw is the heart of an extruder. The screw conveys the melted polymer to the die head after undergoing a process of mixing and homogenizing.

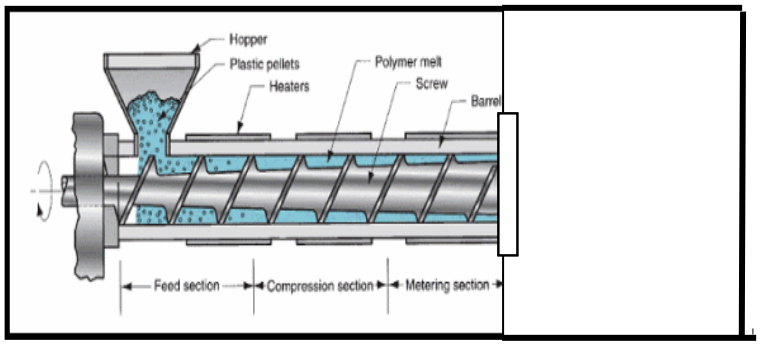


Figure 2. 21 Screw

There are several considerations in designing a screw for a particular type of material. The most important thing to note is the depth of the channel. Although a screw has a general function, it would be better to design it according to the material used to get the best results. An example is the optimal process of screw powder pellets, then followed by screws for pellet powder materials.

a) PVC Screw

PVC is an unstable material when heated. Subsequently, for this process, a screw with more depth of the channel is needed. The screw diameter varies from 30 mm to 140 mm. Its ratio varies between 18 – 22 for single screws and 16 – 18 for double/twin-screws. Screw compression varies between 1,5 – 22: 1 (for both single and twin screws). Venting (hole) in the extruder is used to remove steam/gas.

b) PP/PE Screw

PP/PE screws are almost identical, but they are designed with shallow channels, sudden compression, and a longer material zone. The L/D ratio of this type of screw varies from 24:1 to 33:1. The screw diameter is 20 mm to 250 mm, while the compression ratio is 2,5 to 3,1.

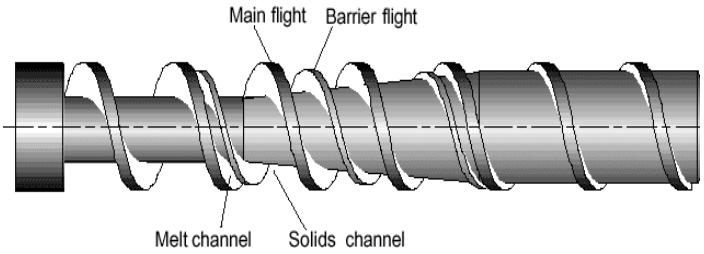
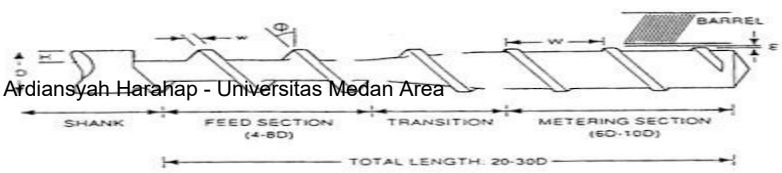


Figure 2. 22 Screw PP

c) Type Screw Barrier (2 Screws)

In some instances or due to special design requests, a screw cannot entirely complete the melting process. Hence, in some cases, the extruder will contain plastic material that has not been melted. However, this can be prevented by making a second screw (barrier) in the canal. This barrier can cut and force only melted plastic to pass. Thus, this barrier design can ensure that the plastic melt will be complete/finished in



the extruder.

Figure 2. 23 Type Screw barrier

2.9 Screw Measurement

The screw system has been known and has been used by humans since several centuries ago. The screw system aims to get an easy way to join or connect two components. Hence, this combination will become a useful unit according to its function. Prior to industrial technology development, screw production was only done by hand, which obviously would be rough.

Nowadays, the use of a screw system for joining two components is found in almost all technological results. The results of industrial technology with a very high level of accuracy (precision) cannot be separated from a screw. The screw system has become one of the critical factors in industrial progress in all types of production. Thus, the level of screw system accuracy is also high. In order to make screw components, it is necessary to learn the ins and outs of screws, especially in the measurement system.

2.9.1 Screw Types and Functions

In general, the type of screw can be seen from the screw movement, the number of screws in each pitch, and the shape of the screw surface. The type of screw can also be seen from the standard used, such as Whitworth screw, metric screw, etc.

2.9.1.1 Screw Types According to the Screw Movement Direction

According to the direction of movement, screws can be divided into two kinds, namely left and right screws. Whether a screw is a left screw or a right screw can be

seen from the slope direction of the screw's side. It can also be checked by turning the pairs of screw components, such as nuts and bolts. If a nut is attached to a bolt and it turns out that the nut moves forward when it is turned to the right (clockwise), then the screw is a right screw.

Otherwise, if the nut moves forward when it is turned to the left (counterclockwise), the screw is a left screw. Therefore, on the right screw, if we want to remove the nut from the bolt, the nut must be turned to the left. Meanwhile, on the left screw, the release of the nut needs to be done by turning it to the right. The most widely used screw is the right one.

2.9.1.2 Screw Types According to the Number of Screws in Each Pitch

By looking at the number of screws in each pitch, it can be said that screws can be divided into single screws and double screws. A double screw means that in one turn (from the top of one screw to the top of the other screw), there is more than one screw; for example, two screws, three screws, and four screws. A double screw is usually named based on the number of screws; for example, double two, double three, and double four. The figure below shows a chart of single screws and double screws. By looking at its shape, one turn on a double screw can move a longer distance than a single turn of a single screw.

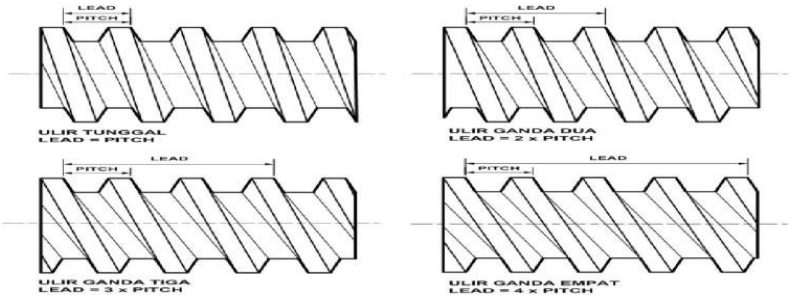
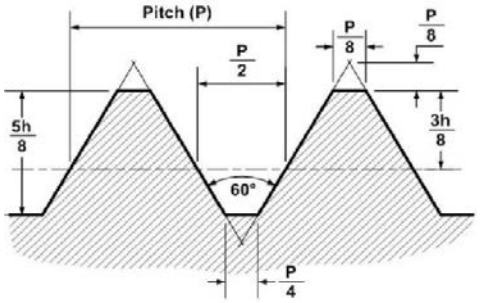


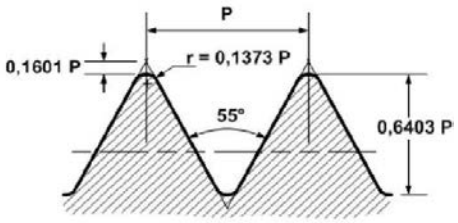
Figure 2.24 Single Screw and Double Screw

2.9.1.3 Screw Types According to the Shape of the Screw Side

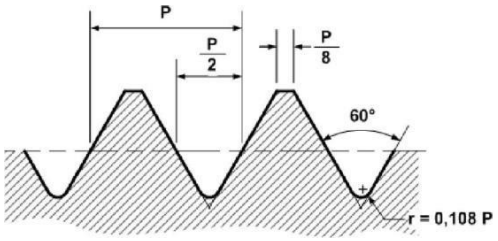
By looking at the shape of the screw side, screws can be divided into triangular, rectangular, trapezoidal, and parabolic (knuckle) screws. The screw shape is also related to the standard used. The following are some examples of screw shapes.



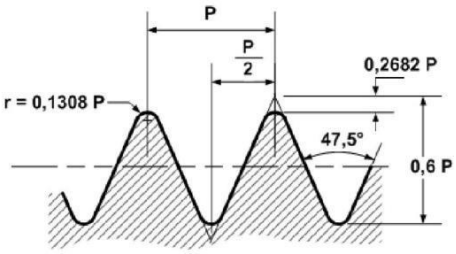
Metric Screw (ISO)



British Standard Whitwort



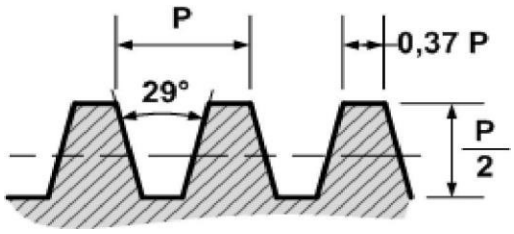
Unified Screw



British Association

Knuckle

Buttres 45^0



ACME

Figure 2.25 Screw Types According to the Shape of the Screw Side

2.10 Screw Function

The screw system allows us to combine or join several components into one finished product unit. Therefore, the general function of screws can be said as follows:

- As a unifying tool: Screws unite several components into a single unit of finished goods. The screws that are commonly used are triangular screws that use ISO standards, British Standards, or American Standards.
- As a power successor: The screw system is used to transfer one power into another, such as a screw system on a jack and a screw system on a screw shaft (transporter). With the screw system, relatively heavy loads can be held/lifted with relatively light power. Rectangular screws are widely used here.
- As a tool to prevent leakage: The screw system used in this pipe is the Whitworth screws.

2.11 Several Important Terms on Screws

The use of the terms above is not intended to indicate other meanings of a screw. In contrast, it is intended to indicate the essential dimensions of a screw. This can be seen in the following image.

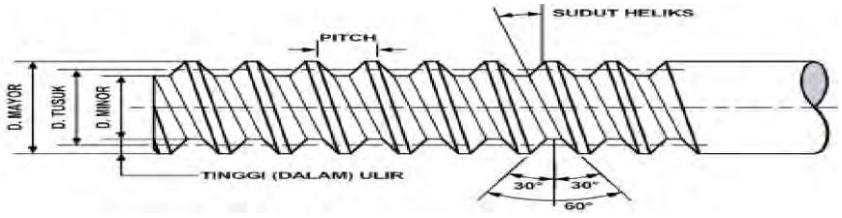


Figure 2.26. Important Dimensions of Screw

1. Major diameter (outer diameter) is the largest diameter of a screw.
2. Minor diameter (core diameter) is the smallest diameter of a screw.
3. Pit diameter is the apparent diameter between the outer diameter and the core diameter (at the radius of the core diameter). The points of tangency between pairs of two screws lie within this diameter. Hence, these points will receive the heaviest load when the screw pair is tightened.
4. The distance between the top of the screws, also known as the pitch, is a dimension that has a significant enough influence on the screw pair. If the distance between the top of one screw and the top of the other screw is not the same, this screw cannot be paired with the other screw that is not the same. Even if possible, it can only be done by coercion, which will eventually damage the correct screw. As a result, the pairing of several components in a single unit cannot last long. Therefore, in the manufacturing process, the top distance of screws must be carefully considered. Subsequently, the error that occurs at the top distance of screws is still within the allowable limits.
5. The screw angle is the angle from both sides of the screw surface (in degrees). For American Standard and ISO, the screw angle is 60°c. Whereas for the Whitworth thread, the screw angle is 55°c.
6. Screw depth is the distance between the core diameter and the outer diameter.

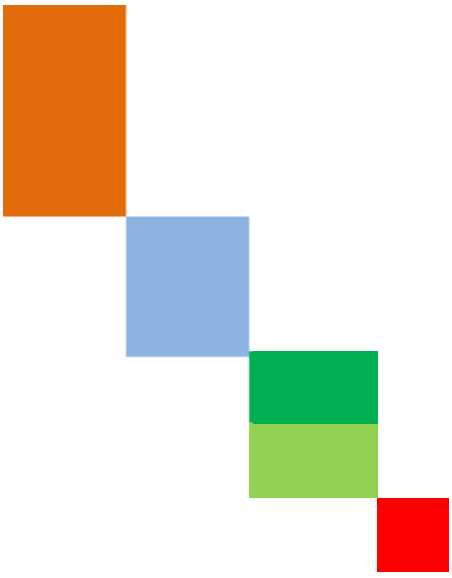
CHAPTER III

DESIGN METHODOLOGY

3.1 Time and Place

This research was conducted in the production laboratory of Universitas Medan Area, Department of Mechanical Engineering. The research schedule can be seen in the table below.

		Time (Month)			
No	**Activities**	**I**	**II**	**III**	**IV**
1	Literature search, checking the availability of tools, materials, and writing a proposal				
2	Proposal submission				
3	Proposal revision				
4	Tool preparation and installation				
5	Tool test and measurement				
6	Data processing and analysis				



7	Conclusion and Report preparation	
8	Report submission	

Table 3.1 Design Schedule

3.2 Materials and Tools

Table 3.3 Materials and Tools in Designing a Pellet Machine

No	Materials	No	Tools
1.	Bolts and Nuts	1.	Welding Machine
2.	V-belt	2.	Grinding Machine
3.	Screws	3.	Hacksaw
4.	Iron Plate	4.	Open End Wrench
5.	Weldin Wire	5.	Adjustable Spanner
6.	Sprocket	6.	Pen
7.	Pulley	7.	Pencil
8.	Zinc Plate	8.	Calculator
9.	Belt	9.	Ruler
10.	Angle Bar	10.	Electric Motor
11.	Screw Tube	12.	Drilling Machine

3.3 Design Procedure

In this study, data collection was carried out through a literature study (library), conducting experiments, field surveys, and making observations about a pellet-shaped fish feed-making tool. Hence, the design of the shape and manufacture or assembly of the components of the fish feed tool was carried out. After that, tool testing and parameter observations were also carried out.

3.4 Tool Components

This pellet-shaped fish feed tool has several essential parts, namely:

1. Tool Framework

   The tool framework serves as a support for other components, which are made of iron plates. This tool has a length of 75 cm, a width of 45 cm, and a height of 85 cm.

2. Gasoline Motor

   The gasoline motor is the driving source for driving each component in the pellet-shaped fish feed tool. In this tool, a motor with a specification of 5,5 HP and a rotation speed of 1440 rpm is used.

3. Shaft

   It is located in the center of the machine, which is made of an iron axle with a diameter of 1 inch.

4. Bearing

   The bearing serves as a support for the shaft located in the tool framework.

5. Pulley

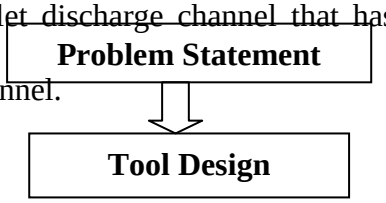
   The pulley in this tool serves as the production of the desired rotation. The pulley used in this tool is a V-belt type pulley. A pulley with a diameter of 3 inches is

found on the gasoline motor, and a pulley with a diameter of 5 inches is found on the shaft.

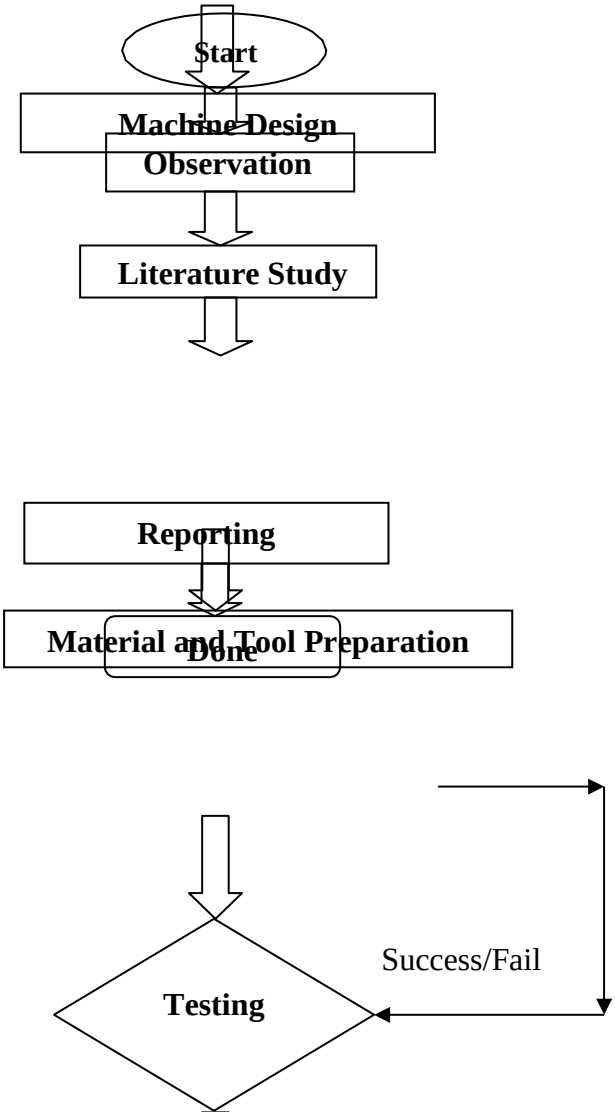
6. Mold

The perforated iron plate serves as a place for forming the pellet-shaped fish feed.

1. Fish feed dough intake channel. It serves as a place for the dough to be formed by the tool.
2. Pellet discharge channel that has been formed. It serves as a pellet discharging channel.



3.5 Planning Flowchart of Fish Pellet Making Machine



CHAPTER V

CLOSING

5.1 Conclusion

From the results of the pellet production trial, it can be processed and concluded as follows:

1. The machine runs at 864 Rpm.
2. The production process can be carried out optimally if the raw material has a water content of ≤ 10%.
3. The final result of pellet material is 3 mm in diameter and 2 mm in length.
4. The knife used is two pieces.

5.2 Suggestions

1. The machine speed should be ≤ 864 Rpm.
2. The water content of the raw material must be 10%.
3. The composition of raw materials must be appropriate.
4. The machine works within 1 hour and is capable of producing 50 kg of pellets.
5. After use, the tool should be cleaned by opening and separating the screw from the cylinder.

PROOFREADING

1.	that is	:	-
2.	producing	:	making
3.	to carry out	:	carry out
4.	the growth of fish	:	fish growth
5.	and then	:	and
6.	and	:	, and
7.	well	:	being well
8.	various	:	multiple
9.	the	:	a
10.	machine	:	machines
11.	L/D	:	an L/D
12.	which ensures	:	ensuring
13.	continuous	:	continuously
14.	means	:	mean
15.	is	:	are
16.	a livestock	:	livestock
17.	corn meal	:	cornmeal
18.	very large	:	immense
19.	long	:	length
20.	matering zone	:	metering zone
21.	greater	:	more significant
22.	aoutrsheath	:	outer sheath
23.	certain	:	specific
24.	Screw angle	:	The screw angle
25.	intended	:	is intended
26.	plate	:	plates
27.	apropriate	:	appropriate
28.	5 inch shaft	:	5-inch shaft
29.	3 inch shaft	:	3-inch shaft
30.	pwer	:	power
31.	Thus	:	Thus,