Cereal processing

Level-II

Based on October 2019, Occupational standards

Version 2

Module Title: Operating an Extrusion Process

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LG 36	LO 1- Prepare the extrusion equipment and process for operation

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Confirming available materials to meet operating requirements. • Selecting and fitting machine components and related attachments • Identifying and confirming cleaning, maintenance and service requirements • Defining operation equipment and process • Entering processing and operating parameters with safety production. • Checking and adjusting extrusion equipment performance • Carrying out pre-start checks with workplace requirements This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Confirm available materials to meet operating requirements. • Select and fit machine components and related attachments • Identify and confirm cleaning, maintenance and service requirements • Define operation equipment and process • Enter processing and operate parameters with safety production. • Check and adjust extrusion equipment performance • Carryout pre-start checks with workplace requirements
Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1- Confirming available materials to meet operating requirements.

1.1 Raw materials available for extrusion process

The most commonly used raw materials in the extrusion process are starch and protein based materials. The structure of the extruded products may be formed from starch or protein polymers. Most products, such as breakfast cereals, snacks and biscuits are formed from starch, while protein is used to produce products that have meat-like characteristics and that are used either as full or partial replacements for meat in ready meals, dried foods and many pet food products. In general, the chemical or physicochemical changes in biopolymers that can occur during extrusion cooking include: binding, cleavage, loss of native conformation, fragment recombination and thermal degradation. The composition of raw materials can be altered by physical losses including leakage of oil and evaporation of water and volatile compounds at the die. Since most chemical reactions occur in the high-pressure zone of the barrel, thermally labile compounds such as flavors and vitamins may be injected immediately before the die to minimize exposure to heat and shear.

The structure of an extruded product is created by forming a fluid melt from a polymer and blowing bubbles of water vapor into the fluid to form foam. The bubbles rapidly expand as the superheated water is released very quickly at atmospheric pressure. In the extruded structure, the fluid melt of the polymers forms the cell walls of the gas bubbles. After gas expansion, the rapid drop of temperature caused by water evaporation and the rapid rise in viscosity due to moisture loss, solidifies the cell structure. The rapid increase in viscosity is followed by the formation of a glassy state. Starch polymers are very good at this function and also expand well. Structure forming polymers must have a minimum molecular weight sufficient to give enough fluid viscosity to prevent or control shrinkages of an extrudate after it reaches its maximum expansion.

Cereals as raw material are primarily graded on the basis of their physical properties: size, shape, weight of 1000 kernels, test weight (kg per hectoliter), color, hardness, presence of other grains and other foreign kernels, percentage of damaged grain (mechanically, by heat, by insect, due to sprouting, and so on). Cereals are products usually stored for a long period. Therefore, water activity is the most important item for their acceptance and storability. The content of water is controlled mainly by rapid methods using near infrared spectroscopy.

Figure 1 extrusion cereals

1.2 Operating requirements of raw materials

Process parameters associated to raw material

- Composition: Oil, starch, protein, fiber
- Moisture
- Particle Size
- Additives

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. Why need to check raw materials at receiving area?
    a. To assure quality
    b. To assess critical hazard
    c. To reduce the possible risks
    d. all
2. Among the following which one is used for extruding products
    a. Corn
    b. Wheat
    c. Pulses
    d. All

Test II: Short Answer Questions (3 points each)

1. Write some of the common cereals used for extrusion process?
2. List operating requirement parameters of raw material

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 10 points**	**Unsatisfactory below 10 points**

Information Sheet 2- Selecting and fitting machine components and related attachments

2.1. Introduction

Extruders come in several designs, dependent upon their application. Some extruders are designed simply to convey the raw materials, while others are designed to mix and knead them; most, however, are designed to impart mechanical and thermal energy to the raw materials to bring about desired physico-chemical changes.

2.2. Components of extruder machine

Extruders are composed of five main parts

- Pre-conditioning system
- Feeding system
- Screw or worm
- Barrel
- Die and the cutting mechanism

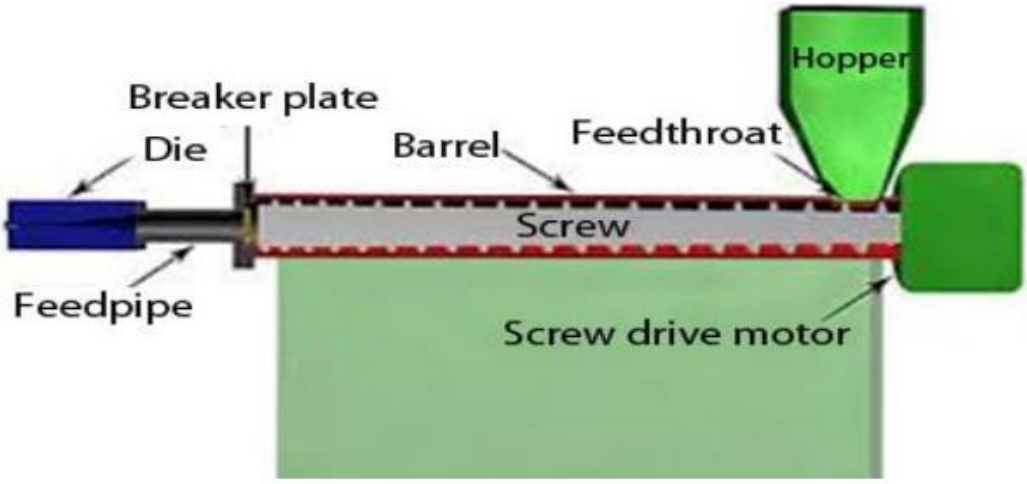

Figure2. Different components of extruder

Extruders can be broadly categorized on the basis of:

- Method of operation:
  - ✓ Cold Extruders and
  - ✓ Hot Extruders (Extrusion Cooking)

- Method of construction:
  - ✓ Single screw extruder
  - ✓ Twin- screw extruders.

The most commonly used extruders are single and twin-screw. Extruders with more than two screws have been used in the plastics industry but not in food processing.

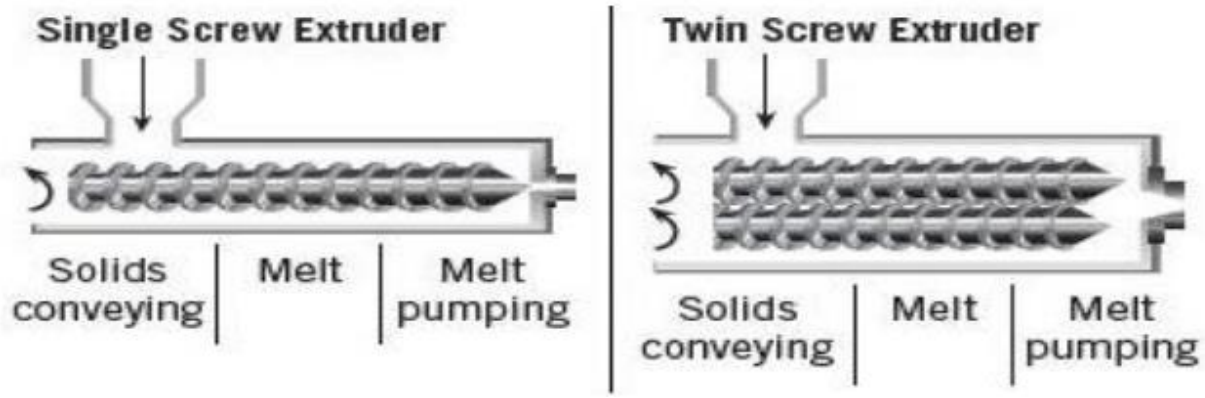

Figure3. Single and double screw extruder

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 points each)

1. List the main components of extruder?
2. Write the two types of extruder on based design?
3. List the types of extruder based on method of operation?

You can ask you teacher for the copy of the correct answers.

Note: Satisfactory rating 9 points	Unsatisfactory below 9 points

Information Sheet 3- Identifying and confirming cleaning, maintenance and service requirements

3.1 Cleaning and maintenance status

Maintenance is the practice of maintaining equipment on a regular schedule based on elapsed time or meter readings. The intent of preventive is to “prevent” maintenance problems or failures before they take place by following routine and comprehensive maintenance procedures. Also maintenance is the upkeep of all furniture, fittings and equipment to an exacting standard within the property so that all areas look consistently new and pristine. The goal is to achieve fewer, shorter, and more predictable outages.

Cleaning is the removal of all visible soil in an approved way with the use of mechanical and chemical action or both, so that all areas are cleaned and sanitized to a high standard. Cleaning is an investment in the assets of a building. Cleaning also the complete removal of food soil using appropriate detergent chemicals under recommended conditions. It is important that personnel involved have a working understanding of the nature of the different types of food soil and the chemistry of its removal.

3.2 Cleaning Methods

Equipment can be categorized with regard to cleaning method as follows:

- Mechanical Cleaning. Often referred to as clean-in-place (CIP). Requires no disassembly or partial disassembly.
- Clean-out-of-Place (COP). Can be partially disassembled and cleaned in specialized COP pressure tanks.
- Manual Cleaning. Requires total disassembly for cleaning and inspection.

Clean Out of Place (COP) Tanks

- Automatic equipment parts washing
- Thorough pre-rinse required
- Be sure all parts are adequately covered

- Test kit verification of concentration
- Control cleaning solution
- temperature to melt fats
- Separate rinse and sanitize steps

3.3 maintenance requirements of extruder

Preventive maintenance includes measures such as systematic and routine cleaning, adjustment, and replacement of equipment parts at scheduled intervals. Manufacturers generally recommend a set of equipment maintenance tasks that should be performed at regular intervals: daily, weekly, monthly, or yearly. Following these recommendations will ensure that the equipment performs at maximum efficiency and will increase the lifespan of the equipment. This will also help to prevent:

- Inaccurate test results due to equipment failure
- Delays in reporting results
- Lower productivity
- Large repair costs.

Maintenance plan A will include preventive maintenance procedures as well as provision for inventory, troubleshooting, and repair of equipment. When implementing an equipment maintenance program, some of the initial steps will include what follows.

- Assign responsibility for providing oversight.
- Develop written policies and procedures for maintaining equipment, including routine maintenance plans for each piece of equipment. The plan should specify the frequency with which all maintenance tasks should be performed.
- Develop the format for records, create logs and forms, and establish the processes to maintain records.
- Train staff on the use and maintenance of the equipment, and assure that all staff understand their specific responsibilities.

3.4 Equipment maintenance documentation

Equipment documents and records are an essential part of the quality system. The policies and procedures for maintenance should be defined in appropriate documents, and keeping good equipment records will allow for thorough evaluation of any problems that arise. Each major piece of equipment will have its own equipment maintenance document. Smaller, commonly used equipment such as centrifuges and pipettes may be managed with an equipment maintenance document or manual that deals with all such equipment in the laboratory.

An equipment maintenance document should include: step-by-step instructions for routine maintenance, including frequency of performance, and how to keep records of performance, instructions for carrying out function checks, frequency of performance and how to record the results, directions for calibrating the instrument, guide for troubleshooting, any required manufacturer's service and repair; list of any specific items needed for use and maintenance, such as spare parts.

Maintenance information each piece of equipment should have a dedicated logbook documenting all characteristics and maintenance elements:

- Preventive maintenance activities and schedule
- Recording of function checks and calibration
- Any maintenance performed by the manufacturer
- Full information on any problem that the instrument develops, the subsequent troubleshooting activity, and follow-up information regarding resolution of the problem.

3.5 Services required in extrusion operation

Common services required to extrusion process

- power
- steam
- fuel
- vacuum
- compressed and instrumentation air

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 point)

1. Off the following methods of cleaning which one is required partially disassembled the machine.
    a. Clean in place method
    b. Cleanout place method
    c. Rinsing
    d. sanitizing
2. The effectiveness of cleaning may depends on
    a. cleaning agent
    b. type of method
    c. mechanical force
    d. all

Test II: Short Answer Questions (3 points each)

1. Describe the roles of cleaning and maintenance?
2. Write some the procedures of cleaning operation of extrusion?

You can ask you teacher for the copy of the correct answers.

Note: Satisfactory rating 10 points	**Unsatisfactory below 10 points**

Information Sheet 4- Defining equipment operation and process

4.1 Introduction

Extrusion processing has become an important food process in the manufacture of pasta, ready-to-eat cereals, snacks, and textured vegetable protein. An extruder consists of a tightly fitting screw rotating within a stationary barrel. Preground and conditioned ingredients enter the screw where they are conveyed, mixed, and heated by a variety of processes. The product exits the extruder through a die where it usually puffs and changes texture from the release of steam and normal forces.

4.2 Extrusion Processes

The extrusion process is a form of extrusion used in food Processing. It is a process by which a set of mixed ingredients are forced through an opening in a perforated plate or die with a design specific to the food, and is then cut to a specified size by blades.

During extrusion, raw materials are forced to flow under controlled conditions along the length of the extruder barrel and through a shaped opening (called die assembly) at a defined throughput. First, raw materials are commonly ground to the preferred particle size. Frequently they are passed through a preconditioner in which other ingredients are added and steam may be injected. During extrusion the product is cooked and mixed by three separate energy sources: mechanical energy (shear caused by the screw elements), thermal energy that comes from the heating system, and self-heating due to the melt viscosity in the barrel. As the rheological behavior of the dough in the barrel greatly affects finished product quality, it is very important to control temperatures and process times to optimize food quality and heat transfer.

Variables that influence the extrusion process can be separated into three main categories:

- Raw material composition and formulation (viscosity, moisture content, chemical composition)

- Thermomechanical cooking factors, including technology design (screw profile, length/diameter of the machine) and operating conditions (screw speed, temperature profile, water content, dry mix rate, residence time)
- Die texturization factors (die design, insert shape, opening section).

There are four main categories of extrusion processes,

- **Cold extrusion:** is used to gently mix and shape dough without direct heating or cooking within the extruder. It is used mainly for producing pasta and dough.
- **Hot extrusion:** thermomechanical transforms raw materials through short-time and high-temperature conditions under pressure. This type of extrusion is used mainly to cook raw materials to produce textured food and feed products.
- **Steam-induced expansion:** defines the melt expansion at the die exit due to water flashing off, leading to highly expanded products. Subsequent processing then determines the textural attributes of extruded products. Examples of products produced using this type of extrusion is expanded snacks and breakfast cereals.
- **Expanded co-extrusion:** combines steam-induced expansion and filling injection for expanded products with dual textures (usually crispy shell and soft filling).

Extruder manufacturers must offer highly flexible equipment to meet the broad scope of applications. For example, the material that the extrusion die is made from can have a significant effect on final product properties. Bronze dies are known to produce higher quality, rougher-surfaced pasta products than stainless steel dies. Flexible vertical cutting systems are popular with snack manufacturers to realize new product geometries, including cup-shaped snacks and a wide range of 3D shapes. As product development is usually performed on small-sized machines, it is critical to be able to scale up easily from an R&D machine to a production-sized extruder

Pre-conditioner: In pre-conditioning process, raw ingredients are uniformly moistened or heated by contact with water or live steam for hydration to required moisture before pumping into inlet of the extruder. Pre-conditioning can be done in atmospheric or pressurized chambers. Pre-conditioners act as cooking chambers with high temperature and long residence time. It will impact little shear to the ingredient and does not contribute much to reform the molecular confirmation of feed ingredients. It will deliver uniformly, pretreated ingredients to the feeder of the extruder.

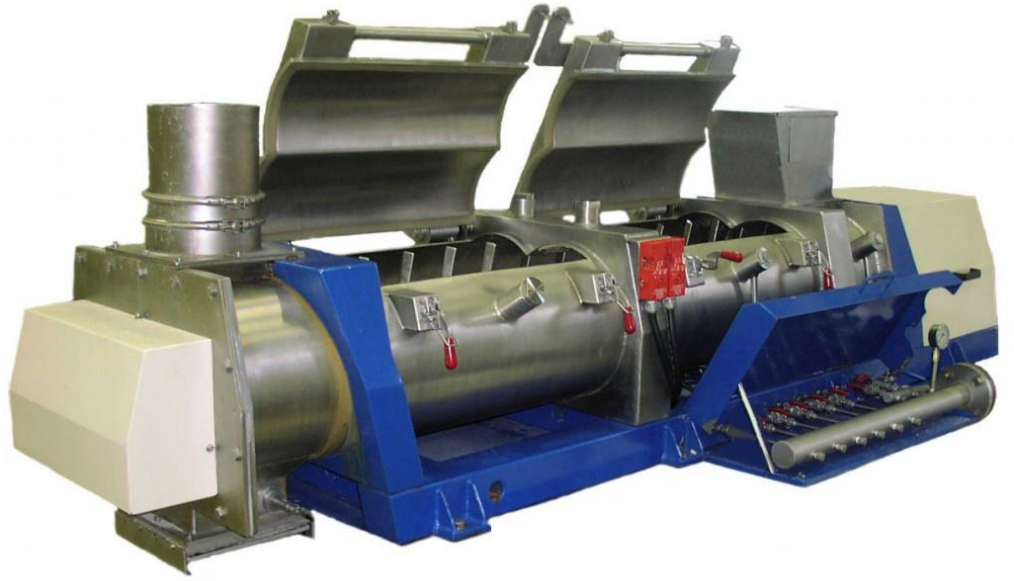

Figure 4. Preconditioner

Screw: Major transformation of molecular confirmation of raw or preconditioned food ingredients takes place in the screw. Heat is added by mechanical energy or by the heat transfer through the barrel jackets or transportation of direct steam. Energy can enter the extruder in three ways.

- Convection: Steam contributes part of the cooking energy by convection
- Conversion: Friction between the screws and barrel on the ingredients will generate
- Heat Here mechanical energy is converted to heat.

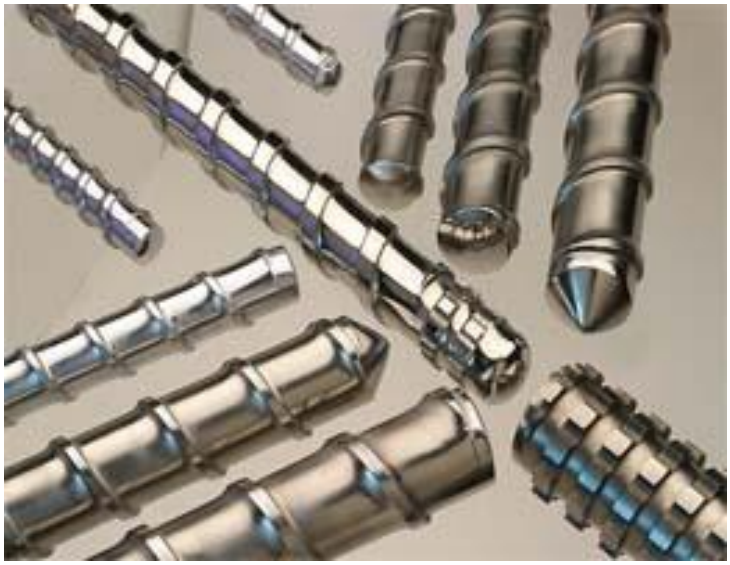

Figure 5. Screw

Die: Diameter of the die influences the shape and texture of the extruded material. Tapered die holes will reduce backpressure requirements and create smoother product surface and cause less damage to the extruded ingredients. Teflon coated inserts are also used to create a smoother surfaced product.

Figure 6. Extruder die

4.3 Equipment operation

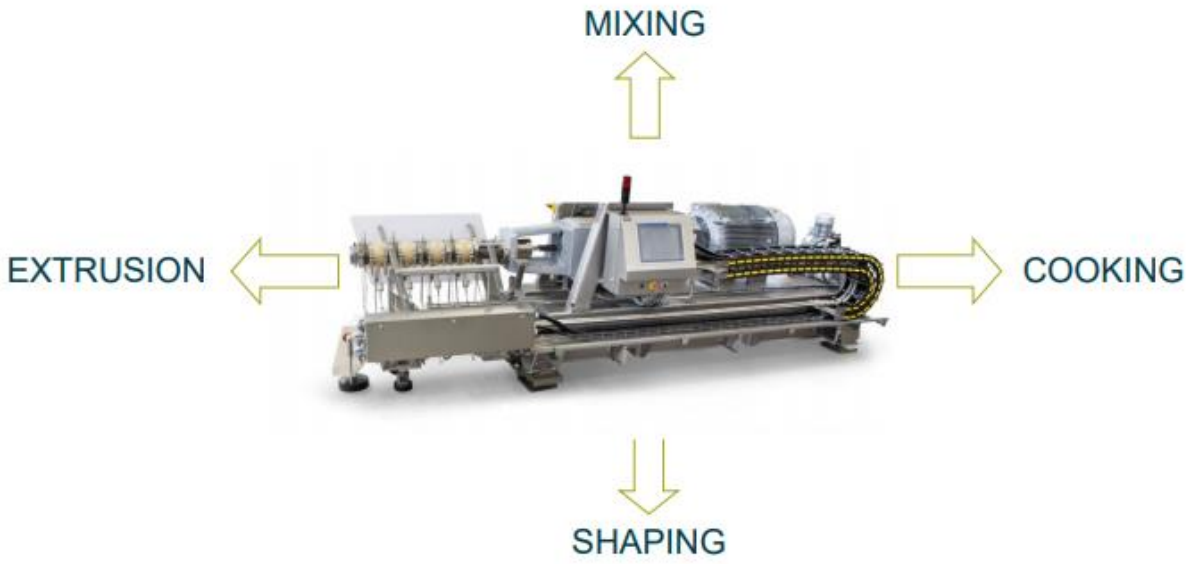

Figure 7: Main operational parameters of extruder

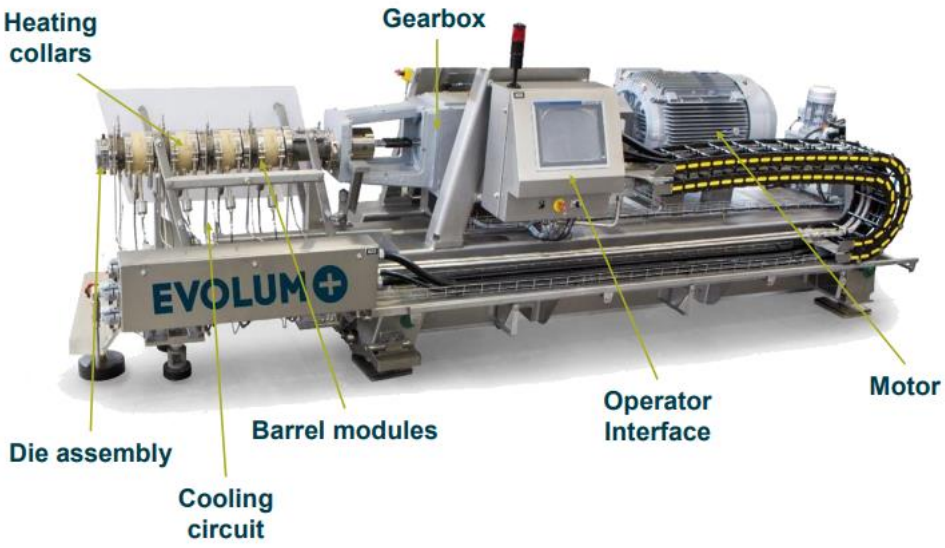

Figure 8: Basic description twin screw extruder

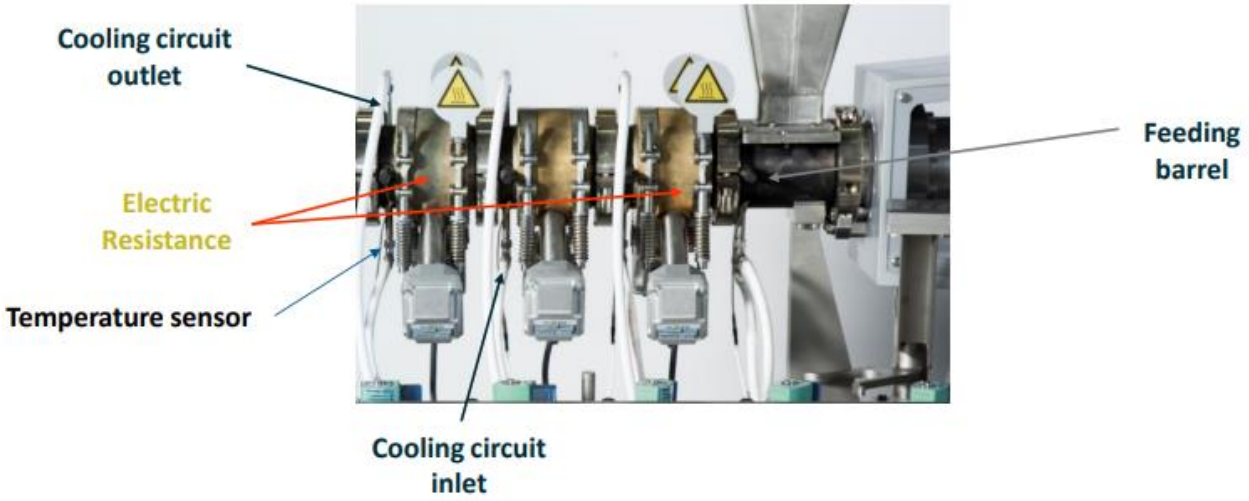

Figure 9: Barrel temperature control

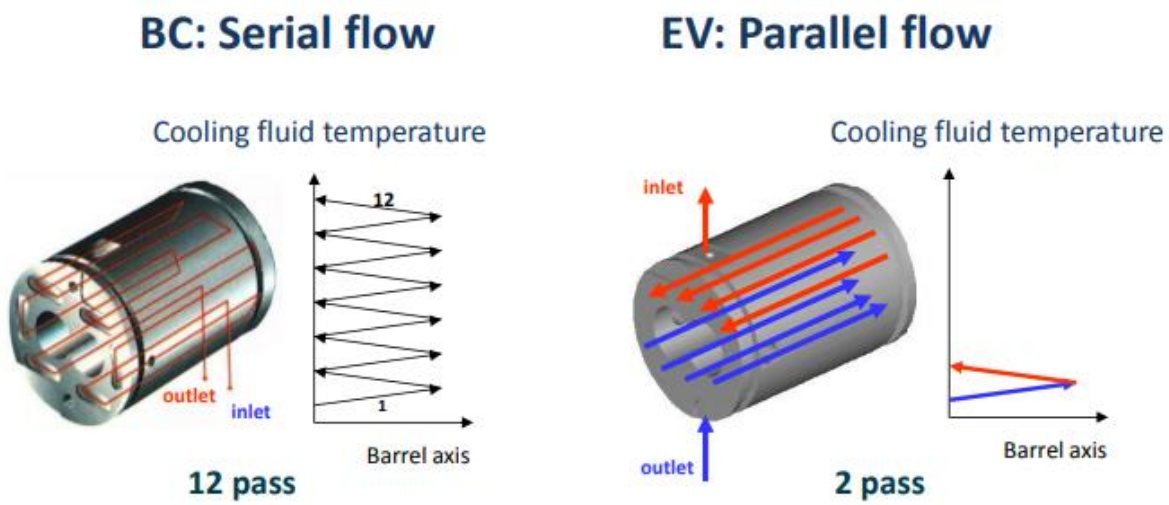

Figure 10: Barrel cooling system

4.4 Components of Extruder

Drive: The Power supply in food extruder is done by Electric motors. The size of the motor depends on the capacity of the extruder and may be as large as 300 KW. The screw speed on extruder is a valuable control parameter. The speed on food extruders is normally less than 500 rpm. Thrust bearing must be able to sustain the load produced under normal extrusion conditions giving an expected life of 20,000 to 50,000 hr.

Feeder: A device providing a uniform delivery of food ingredients which are often sticky, non-free-flowing substances. It will regulate rate/pressure of flow. Some types of feeders commonly used are vibratory feeders, variable speed auger and weigh belts.

Barrel: The barrel is made up of segments. The barrel is fabricated by clamming or blotting together several segments make it relatively easy to alter the interior conformation of the barrel and to replace the discharge section which wears the most rapidly.

Figure 11: Single screw barrel.

Figure 12: twin screw barrel

Screw (single or twin): These are the screw which conveys the materials. Diameter of the screw of a single screw extruder normally varies between 2-15 cm, their length to diameter ratio varies between 8-20 and helix angle between 20^{o}– 30^{o}.

Die or nozzle: It will give shape to the products. The size, shape, number and location of the dies or die insert all the independent variables.

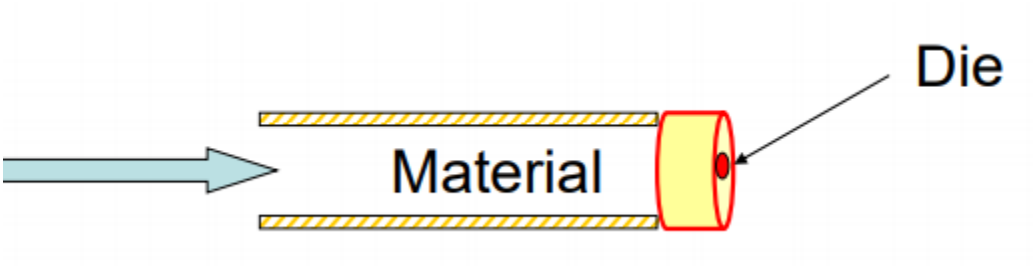

Figure13: extruder die

Self-check 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2point)

1. Which one of the following parameters affects the extrusion process?
    a. Raw material composition
    b. Technology design
    c. Operating condition
    d. Die shape
    e. All of the above
2. Among the components of extruder which parts used to moistened raw ingredients uniformly and heated by contact with water.
    a. Pre conditioner
    b. Screw
    c. Die
    d. feeder

Test II: Short Answer Questions (3 points each)

1. List the four main categories of extrusion processes?
2. Write the basic components of extruder with functions?
3. Describe the roles of extruder die?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 10 points**	**Unsatisfactory below 10 points**

Information Sheet 5- Entering processing and operating parameters with safety production.

5.1 Introduction

Extrusion is a method of forming substances by forcing them through a perforated plate or die to produce tubes, rods, or other desired shapes. Extrusion can take place under high temperatures and pressures or can be simply a non-cooking, forming process. The main purpose of extrusion is to increase the variety of foods in the diet by producing a range of products with different shapes, textures, colours and flavours from basic ingredients. Today, food extruders are used to produce pasta, ready-to eat cereals, snacks, pet food, confectionery products, modified starches for soup, baby food and instant foods, rice and dhal analogues, beverage bases and texturized vegetable proteins.

5.2 Processing variables of extruder

Preconditioning processing variables include dry recipe flow rate; water injection flow rate; steam injection flow rate; additive(s) injection flow rate; preconditioner configuration; preconditioner speed; average retention time; and degree of mixing. This list of variables may be limited by some preconditioner installations and enhanced by others due to the particular options included. Two of the most important processing parameters are average retention time and degree of mixing. These variables are those which really determine how effective the preconditioning process is at meeting the objectives of hydration, heating and mixing.

The most influence the nature of the extruded product are the rheological properties of the food and the operating conditions of the extruder. The properties of the feed material have an important influence on the texture and color of the product; the most important factors are:

- The type of feed materials
- Their moisture content
- The physical state of the materials

- Their chemical composition, particularly the amounts and types of starches, proteins, fats and sugars
- The pH of the moistened material.
- Feed rate
- Screw speed
- Barrel temperature
- Die characteristics
- Screw design

5.3 Operating parameters of extruder

The most important operating parameters in an extruder are

- Temperature: Increase in extrusion temperature results in higher degree of gelatinization.
- Pressure: Diameter of the die apertures (Increase in diameter reduces gelatinization of starch)
- Shear rate
- Moisture

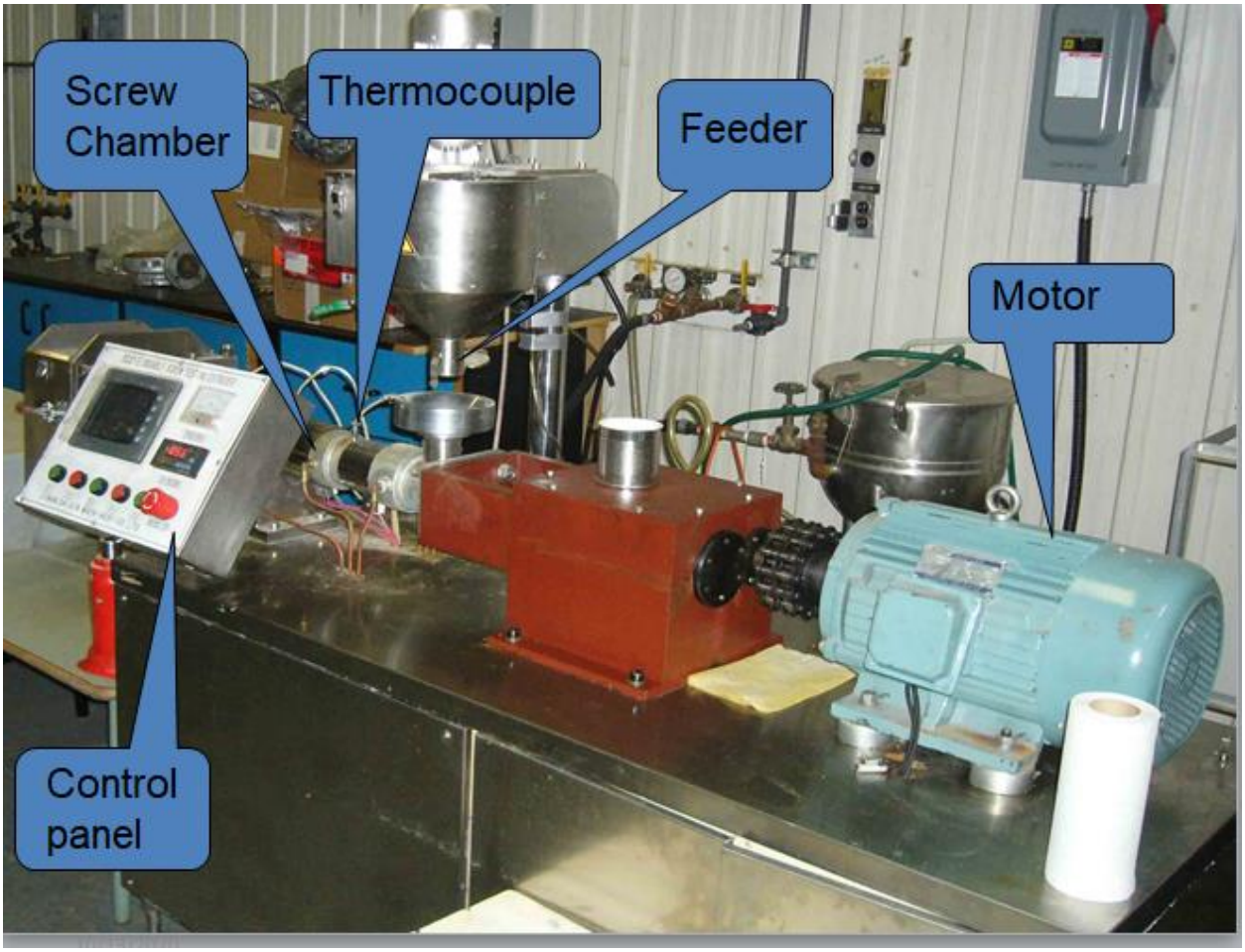

Figure 14: operating components of extruder

Self-check 5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 point)

1. The main purpose of extrusion process
    a. Increase variety of food
    b. alter texture of food
    c. modify food
    d. all
2. In the precondition process the different variables should be monitored, what are this variables,
    a. preconditioner configuration
    b. flow rate
    c. degree of mixing
    d. average retention time
    e. all of the above

Test II: Short Answer Questions (3 points each)

1. List the process variables of extruder?
2. Write the most important factors of feed materials?
3. Discus the operating parameters of extruder?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 10 points**	**Unsatisfactory below 10 points**

Information Sheet 6- Checking and adjusting extrusion equipment performance

6.1 Extrusion equipment

In the process of grain, oil, and food processing, extrusion technology is one of the high and new technologies in modern food engineering. It has been focused on by many food enterprises, especially food processing enterprises. It uses cereals and root and tubers as the primary raw materials. As far as the traditional cereal processing methods are concerned, it is generally necessary to go through crushing, mixing, molding, baking, or frying and other production processes. Each process needs to be equipped with the corresponding equipment.

When using extrusion equipment technology to process cereal food, only after the raw materials are crushed and mixed, the cooking, enzyme inactivation, sterilization, forming, pre-drying, and other processes can be completed on one extruder. So the process is greatly simplified, the energy consumption is reduced, the whole production process is almost no loss, the manufacturing cost is obviously reduced, and there is no pollution. Therefore, extrusion equipment technology is a multifunctional, high output, high-quality new food processing technology.

Extruded expanded food has many advantages, wide varieties of crispy texture, delicious taste, easy to carry after eating, easy to digest, and absorb. As a kind of leisure food, expanded food is popular and welcomed by consumers, especially young people.

Figure 15: extruder expansions

6.2 Common extrusion equipment

- **Mixer**

Mixers help automate the repetitive tasks of stirring, whisking or beating. When the beaters are replaced by a dough hook, a mixer may also be used to knead.

Figure 16 : multipurpose mixer

- **Conditioners**

The preconditioner is used mainly for food products flakes or pellets for cereals and snacks. It is also used for ingredients used in pet food and fish feed. The preconditioner heats, hydrates and mixes the dry raw materials before extrusion and automatically doses the pre-treated product into the extruder. It optimizes the capacities and the performance of the extruder and enhances final product features.

Figure 17: conditioners

- **ex-panders**

Figure 18: ex-pander

- **Cookers**

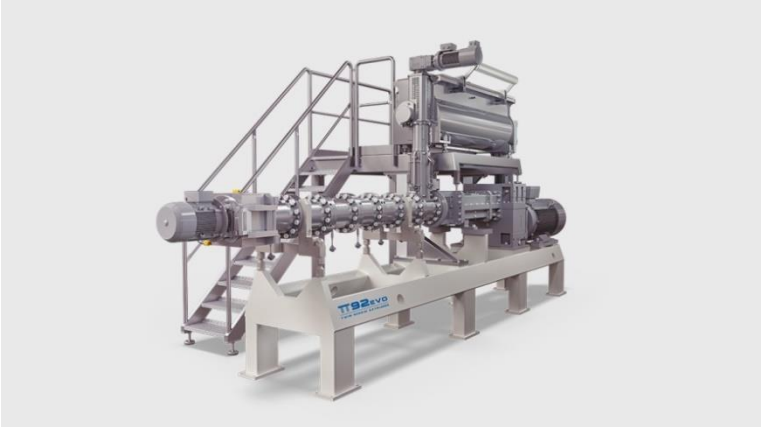

Figure 19: Extruder cooker

- **dryers and coolers**

Figure 20: dryers and coolers

- screens and sieves

Figure 21: screen and sieves

- Cutting/stamping equipment

Once a product has been extruded through a die, extruder cutters are used to cut it to size. This is done by a cutting machine or additional cutting equipment that is positioned immediately after the die exit. Critical factors of an extruder cutter are the cutting mechanism or method, blade shape, blade thickness and cutting speed. Cutting is intrinsic to overall process design and may also contribute to the shaping of the final product.

Figure 22: cutting machine

6.3 Characteristics of extrusion equipment

The extrusion process and technology has their own advantages and features over traditional food processing methods.

- Improve practical quality and easy to store. The rough tissue structure of corn and sorghum, which initially contained more cellulose and vitamins, can be expanded and soft by using our leader corn extrusion equipment, and the maillard reaction produced in the process of expansion increases the color, aroma, and taste of food. Company to improve the sound quality, the snack has a light body, crisp, rich flavor.

- Improve product quality and reduce harmful substances. The extrusion process of corn extrusion equipment is a typical high temperature, high pressure, and short time process, which makes the material treatment limited, so almost all the nutrients in the raw material are retained in the final product. At the same time, the short-term process of high temperature can still reduce adverse product factors such as harmful enzymes and microorganisms.

- The applicability of raw materials is broad, and there are many kinds of products. Many raw materials can process corn extrusion machinery, which can not only profoundly process grain, potato, beans, and other grain. Make coarse grain fine and produce exquisite snacks, but also machining fruits and vegetables, spices, and some animal proteins.

- High production efficiency and low production cost. Compared with the traditional cooking method, the processing of products by food extrusion machine technology has a noticeable reduction in time consumption, energy consumption, labor force, occupation of the factory building, and so on.

- Waste less, no waste Generally speaking, except for starting and stopping the machine, there is almost no waste discharge in the whole production process, and there is no waste phenomenon.

6.4 Checking and adjusting equipment performance

- Special arrangements or attachments:

Example: knife, co-extrusion unit. Examples of screw element variations Large Pitch Conveying: Its conveying capacity is more.

- ✓ Small Pitch: conveying its conveying capacity is low.
- ✓ Kneading or Cut Flight: These are the kneaders or cutters it will mix or cut the materials.
- ✓ Shear lock: High pressure & inject is required.
- ✓ Reverse Pitch: Higher pressure is required

After equipment has been installed, the following details need to be addressed before putting the equipment into service:

- Assign responsibility for performing the maintenance and operation programs;
- Develop a system for recording the use of parts and supplies
- Implement a written plan for calibration, performance verification, and proper operation of the equipment;
- Establish a scheduled maintenance program that includes daily, weekly, and monthly maintenance tasks;
- Provide training for all operators; only personnel who have been trained specifically to properly use the equipment should be authorized as operators. Designate those authorized to use the equipment and when it is to be used.

Self-check 6	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer

1. Extruded expanded food has many advantages among thus,

a. Make easy to eat
b. Easy to digest
c. Delicious taste
d. Crispy texture
e. all

2. The extrusion process technology contains different operation in one extruder among thus, which one is included.

a. Mixing
b. Cooking and sterilization
c. Forming
d. Pry-drying
e. all

Test II: Short Answer Questions (3 points each)

1. Describe some of the common extrusion equipment and their functions?
2. Type the characteristics of extrusion equipment?
3. What components of extruder check for performance before operation?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 10 points**	**Unsatisfactory below 10 points**

Information Sheet 7- Carrying out pre-start checks with workplace requirements

7.1 Carrying out pre-start checks

It is important to carry out a series of checks before using a piece of machinery. This is particularly important in situations in which a number of people use the same machine. Larger companies and organizations usually have a system of checks, and a maintenance department that will deal with reported defects. Individuals working alone or in small teams will be responsible for checking and maintaining their own machines. Learners should be able to follow a checklist to ensure that they complete all the necessary checks. This may mean using either a pre-set format like the one shown on the focus page or the list from an operator manual.

Pre start checks are pretty much exactly what they sound like, they are checks made to something - most often a piece of plant, equipment or machinery prior to that thing being started or used; or checks made prior to doing something specific - like a days work or specific hazardous activity. Pre starts often involve routine inspections conducted by the machine or equipment operator. Because of this, pre starts often take the form of a pre start checklist or inspection form.

Self-check 7	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 points)

1. Brief pre-start checks?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 3 points**	**Unsatisfactory below 3 points**

Operation Sheet 1- procedures of equipment and process operation

2.1 wearing personal protective equipment's (PPE)

- Safety glasses
- Safety shoes
- Gloves
- Thermal insulated gloves
- Hard hats
- Face shield
- Goggles

2.2 Procedures of equipment and process operation

Step1. Open Opto Control from the shortcut (OPTO EXTRUDER) on the desktop. Close the event log viewer window. Start the extruder program.

Step 2. Select Auto mode for zones 1, 3 and the die heat control.

Step3. Select manual mode for zone #2, in zone #2 enter zero in the MV numeric window.

Step4. For operation in Auto mode: Set all control windows except heater #2 control to Auto, Set the set point (SP) to the desired value, 150-170 deg C is recommended as a set point for zones 1, 3 and the die heater. Zone two is not actively heated; it will heat from conduction from zones one and three.

Step 5. When the die and zones 1 – 3 reach a minimum of 140 degrees Celsius and the melt zone is at a minimum of 115 degrees C you are ready to attempt to extrude.
Step 6. Verify that the speed control potentiometer is set to zero.
Step7. Now push the red button on the extruder, this will apply power to the motor. The motor will not rotate until you increase the speed control potentiometer.

Step8. Very gradually, increase the speed control potentiometer just until the motor begins to rotate. Allow the motor to run at this very low RPM (revolution per meter) for 1 – 2 minutes in order to stabilize the motor. Observe the torque meter on the extruder, torque should never exceed 600. If the torque meter starts to move rapidly or erratically, immediately shut down the motor by depressing the red motor power button, and then contact the lab manager. Do not shut down the computer; do not close the opto program.

Step 9. Once the extruder motor has stabilized at a low RPM, gradually increase the motor speed to the desired level. Continue to closely observe the torque meter for any erratic reading. If the torque is approaching the 600 mark, reduce the speed.

Step10. Under optimal conditions the torques should not exceed 100.

Step11. Supplemental material is available in the extruder manual.

Step12. Data is stored at C:\ DATA extruder. Save your data to a flash drive after each session.

Operation Sheet 2- procedures of carrying out pre-start checks with workplace requirements

2.1 wearing personal protective equipment's(PPE)

- Safety glasses
- Safety shoes
- Gloves
- Thermal insulated gloves
- Hard hats
- Face shield
- Goggles

2.2 Procedures of carrying out pre-start checks of extruder

1. Verify that the main air pressure valve is open.
2. Open the main cooling water valve ½ turn.
3. Verify that the main power button on the extruder is off, the indicator light should be off.
4. Verify that the toggle switch on the extruder, by RPM dial, is set at local.
5. Verify that the motor speed control toggle switch is set to "fine speed control".
6. Verify that the fine speed control is set to zero.
7. Open water-cooling valves to the feed hopper, flow should be set at 0.5-g.p.m. Cooling water is not required for the take-up rollers.
8. On the main control unit the old control unit under the newer control cabinet verifies that the main power and heat zone toggle switches are in the off position, they do not affect Opto control.
9. On the right side of the older control unit, verify that the three solenoid toggle switches are in the on position. These switches must be on in order for Opto to control the coolant airflow.

10. The Opto software incorporates PID control for the three heating elements in the extruder barrel and the die heating element. The motor speed is controlled manually using the speed control knob on the extruder.
11. The Opt heating control software can be operated in either manual or auto mode. Normal operation is in auto Mode. A description of manual mode operation is given for reference. To operate in manual mode set all control windows to manual mode, the “M” should be displayed in each control window - set the manipulated variable (MV) to the desired value.

LAP TEST	Performance Test

Name…… ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** minutes. The project is expected from each student to do it.

Task1: Apply wearing of personal protective equipment's (PPE)

Task2: Perform Procedures of equipment and process operation

Task3: Perform the procedures of carrying out pre-start checks

LG 37	LO2- Operate and monitor the extrusion process

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Delivering ingredients and additives to the extrusion process
- Preparing and monitoring the mass suitable for extrusion.
- Operating the extrusion process with workplace policies and procedures
- Monitoring equipment variation in operating conditions
- Identifying variation in equipment operation and reporting maintenance requirement
- Monitoring the extruded product as specifications met.
- Identifying, rectifying and reporting out-of-specification product/process
- Maintaining the work with housekeeping standards.
- Conducting work with workplace environmental guidelines.
- Maintaining workplace records

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Deliver ingredients and additives to the extrusion process in the required quantities and sequence
- Prepare and monitor the mass suitable for extrusion.
- Operate the extrusion process with workplace policies and procedures
- Monitor equipment variation in operating conditions
- Identify variation in equipment operation and reporting maintenance requirement
- Monitor the extruded product as specifications met.
- Identify, rectify and report out-of-specification product/process

- Maintain the work with housekeeping standards.
- Conduct work with workplace environmental guidelines.
- Maintain workplace records

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1- Delivering ingredients and additives to the extrusion process

1.1 Introduction

The extrusion mechanism can be stated as process that combines various unit operations, including mixing, homogenization, kneading, heating, shearing, cooking, cooling, shaping, degassing, and forming. Basically, it is a simple piston contained within a cylinder, which is capped with a shaping orifice referred to as the die. When the material is loaded into the cylinder, the piston moves forward creating pressure at the die, and hence the material emerges in its shaped form from the die. This type of extrusion operation is batch process in nature because the piston must be retracted periodically to permit refilling of the chamber. The extrusion process can be made continuous by replacing the piston with a helical screw. Material is fed continuously into an inlet hopper and pushed forward by the rotation of the screw. The rotating screw moves material from inlet to the discharge point. As the material reaches the die, the pressure increases to the level required to propel the extrudate through the die orifice. These type of screw extruders can be either single or multi screw in design.

1.2 Ingredients and additives of extrusion process

Raw materials for extruded foods tend to be mostly cereal flours, however, other ingredients from diverse food sources may be incorporated, provided they fit the required raw material characteristics for the equipment.

Raw materials for extrusion processing include,

- Cereals and pseudo-cereals
- Legumes
- Pulses
- Oilseeds
- Roots and tubers
- Nuts

These raw materials are often used in various combinations, and products of different shapes, textures, colors, and appearances could be produced by altering raw material mix, equipment assembly and operating parameters.

1.2.1 Extrusion Process of food

Extrusion can be briefly described as a process where the material which is moistened, expandable in nature along with the proteinaceous materials are plasticised and cooked in a tube by combination of moisture, pressure, temperature and mechanical shear. Extrusion is a processing technique' that involves the addition of thermal and mechanical energy to an uncooked mass such as soybean, wheat flour etc. Extrusion processing is used to restructure the starch and protein based material to manufacture quality products. It involves compressing, working raw materials e.g., flours, starches, proteins, salt, fat, vitamins and minerals and other ingredients to form a semi-solid mass under a variety of controlled conditions. This is accomplished by feeding the raw material into a hopper, which introduces the raw material between a rotating screw and a stationary barrel. The friction between the material and screw surface results in increase in temperature. This temperature, which is generated within the system, helps the material to absorb heat. As the material is constantly exposed to this temperature, cooking takes place in presence of moisture. The result is cooked and/or shaped product. The high shear and temperature conditions inside the screw channel result in the mixing of the material and leads to the chemical reactions that constitute the cooking process. Some of the changes that occur include, gelatinization of starch molecules, cross-linking of proteins, and the generation of flavors. Depending on the requirement, heat can either be applied directly or indirectly.

2.2.1 Types of extruder

Extruders are broadly categorized as:

- ✓ single screw
- ✓ twin-screw extruder

- ✓ **single screw**

This type of screw consists of a screw rotating with in a cylindrical barrel.

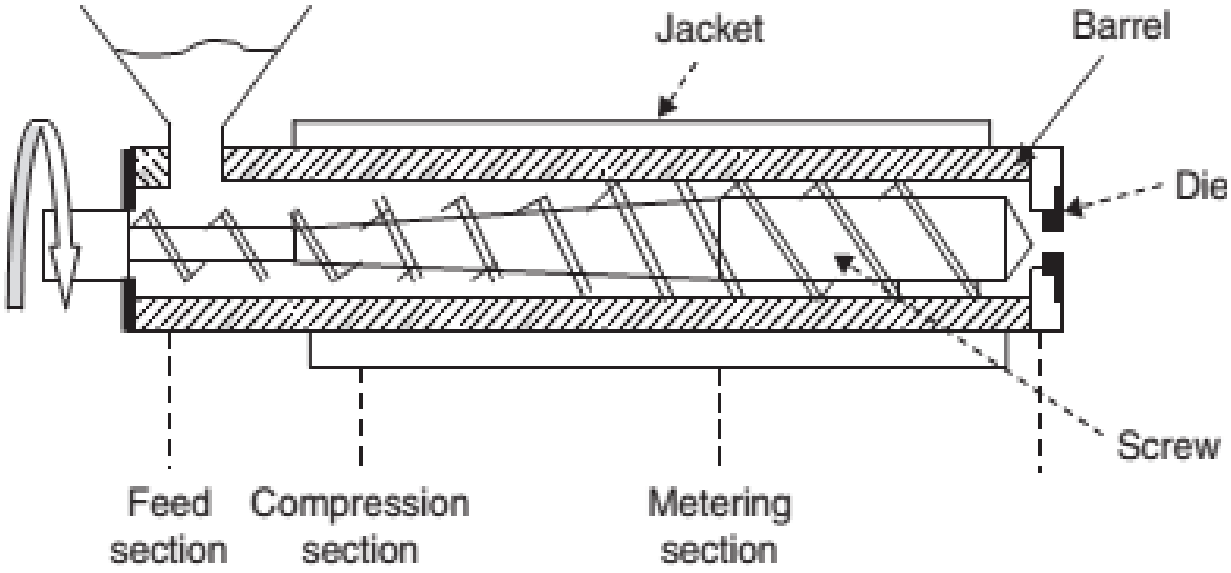

Figure 23: single screw extruder

- Sections of the extruder
  - ✓ Feed section
  - ✓ Transition section
  - ✓ Metering section

- ✓ **Feed section**

This section has deep flight to allow rapid and easy filling. In some operations this section may not be filled giving conditions of starving feeding.

- ✓ **Transition section**

Depth of screw is decreased to initiate the compression and the processing of product. Raw materials begin to undergo cooking and change in structure.

- ✓ **Metering section**

Leads the product to the outlet and most of the pressure build-up occurs here.

Extrusion processing can be schematically shown as follows.

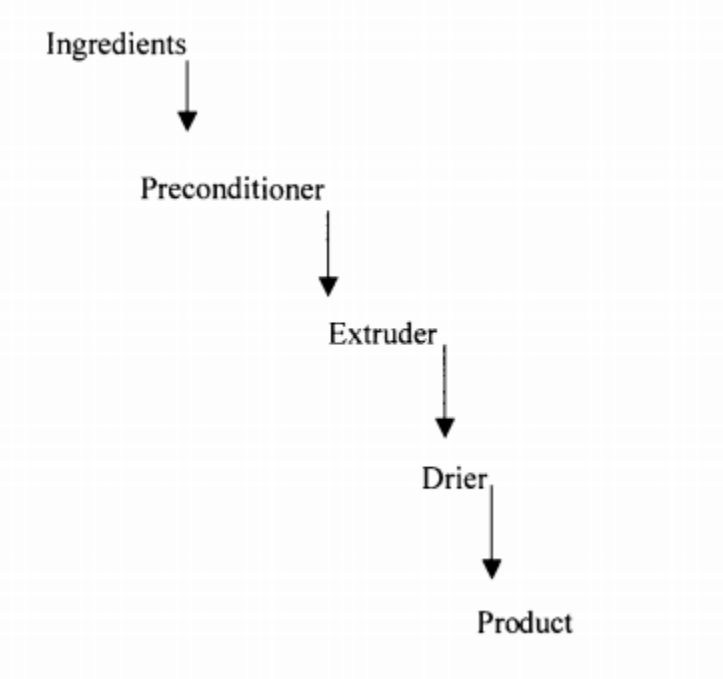

Figure 24: General Cooking extrusion Process

- **Common Applications of Extrusion**

The first major commercial application of the single-screw extruder in the food processing industry was conversion of semolina flour into pasta using solid screws, Example of products made of single screw extruders includes:

- ✓ Production of pasta and macaroni
- ✓ confectionary products
- ✓ Rice bran sterilisation
- ✓ Texturized vegetable protein (TVP)
- ✓ Ready-to-eat breakfast cereals, snack products

Table1. Extruded products for human consumption

Type	Example
Directly expanded	Breakfast cereals , corn curls
Unexpanded	Pasta
Half products	Potato pellets
Co-extruded	Fruits based cereals , jelly filled cores
Modified	Starch , fat mimics
Texturized	Meat analogs
Candy	Chewing gum
Functional food	Fortified and enrichment of food

The extrusion process related details are detailed as follows.

- Pre-conditioner: In pre-conditioning process, raw ingredients are uniformly moistened or heated by contact with water or live steam for hydration to required moisture before pumping into inlet of the extruder. Pre-conditioning can be done in atmospheric or pressurized chambers. Pre-conditioners act as cooking chambers with high temperature and long residence time. It will impact little shear to the ingredient and does not contribute much to reform the molecular confirmation of feed ingredients. It will deliver uniformly, pretreated ingredients to the feeder of the extruder.

- Screw: Major transformation of molecular confirmation of raw or preconditioned food ingredients takes place in the screw. Heat is added by mechanical energy or by the heat transfer through the barrel jackets or transportation of direct steam. Energy can enter the extruder in three ways. - Convection: Steam contributes part of the cooking energy by convection Conversion: Friction between the screws and barrel on the ingredients will generate heat. Here mechanical energy is converted to heat. Conduction: Additional energy may be supplied by conduction of external heat through the extruder barrel.

- Die: Diameter of the die influences the shape and texture of the extruded material. Tapered die holes will reduce backpressure requirements and create smoother product surface and cause less damage to the extruded ingredients. Teflon coated inserts are also used to create a smoother surfaced product.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choose the best answer

1. The extrusion process may include
   a. Kneading
   b. Heating
   c. Cooking
   d. Forming
   e. all
2. which cereal types commonly used for extrusion process
   a. corn
   b. pulses
   c. root and tubers
   d. nuts
   e. all
3. extruders based on application and screw design dived as
   a. single screw
   b. twin screw
   c. double screw
   d. all
   e. none

Test II: Short Answer Questions (3 points each)

1. Type the different sections of extruder?
2. Describe some of the application area extruder?
3. Write the different extruded cereal products?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 15 points**	**Unsatisfactory below 15 points**

Information Sheet 2- Preparing and monitoring the mass suitable for extrusion.

2.1. Preparing and monitoring the mass suitable for extrusion

Mass Flow Rate (MFR): Product MFR was determined by collecting extrudate samples at 30 sec intervals and then weighing using an electronic balance. The dry mass flow rate was determined by measuring the moisture content of the extrudate immediately upon exit from the die. Pressure at the die and torque: The temperature and absolute pressure in the die were simultaneously recorded with a combined thermocouple/pressure transducer

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 points each)

1. How to transfer mass to the extruder?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 12 points**	**Unsatisfactory below 12 points**

Information Sheet 3- Operating the extrusion process with workplace policies and procedures

3.1 Operating condition the extrusion process

The important operating conditions are the temperature and pressure in the barrel, the diameter of the die apertures and the product shear rate. The shear rate is influenced by the speed and geometry of the screw (size, number, pitch and diameter of the flights), and by the internal design of the barrel, including grooves in the barrel, or restrictions (known variously as throttle rings, kneading discs, or shear locks). Additional heating may be provided by a steam-jacketed barrel, a steam heated screw, or electric heating elements around the barrel. High-shear extruders have high screw speeds and shallow flights to create the high pressures and temperatures needed to make expanded products, medium-shear extruders are used to make texturized proteins and semi-moist foods, and low shear extruders have a deep-flighted screw that operates at low speeds in a smooth barrel to create low pressures for forming meat products or gums.

The selection of the correct type of extruder for a particular application should take account of the types of ingredients and the properties required in the product (e.g. its bulk density, texture, color and other sensory properties) and the required production rate. Dies have different shaped holes (e.g. round holes to produce rods, square holes for bars, or slots to produce sheets), or they may produce more complex shapes. The temperature and moisture content of the food and the extent of shearing in the barrel control the amount of expansion of the product and hence its texture. Some products require the dies to be heated to give the required degree of expansion, whereas others have cooled dies to reduce expansion. There are therefore a very large number of potential combinations of equipment design features and small-scale processors should seek advice from extruder manufacturers before purchasing a machine.

3.2 workplace policies and procedures of extrusion process

A policy is a set of general guidelines that outline the organization's plan for tackling an issue. Policies communicate the connection between the organization's vision and values and its day-to-day operations.

A procedure explains a specific action plan for carrying out a policy. Procedures tells employees how to deal with a situation and Using policies and procedures together gives employees a well-rounded view of their workplace. They know the type of culture that the organization is striving for, what behavior is expected of them and how to achieve both of these.

Policies and procedures should not be written once and left alone for decades. Reviewing these documents regularly and updating them when necessary is key to their success. In addition to an annual review, consider updating them when you:

- Adopt new equipment, software, etc.
- See an increase in accidents or failures on-site
- Experience increased customer complaints
- Have a feeling of general confusion or increased staff questions regarding day-to-day operations
- See inconsistency in employee job performance
- Feel increased stress levels across the office

3.3 Policies and Procedures for Health and Safety

Protecting employees' safety and well-being should be every organization's top priority. When writing your health and safety policies, include information about how to deal with illness or injury at work, equipment safety guidelines and how to report a health or safety concern. Also include procedures to follow in the event of a fire or natural disaster.

3.4 Personal Protective Equipment

Personal protective equipment exists to make jobs safer. Determine what equipment is required to do the job safely and use it. Following is some of the personal protective equipment available:

- Safety glasses
- Safety shoes
- Gloves
- Thermal insulated gloves
- Hard hats
- Face shield
- Goggles

3.5 Hazards Associated with an Extruder

The three biggest potential safety hazards associated with extruders are burns, electrical shock, and falls.

- Burns are normally caused by touching a hot die or unprotected twin screw extruder barrel sections and handling extrudate without gloves. Long sleeves with properly approved thermal gloves should be worn when working around the die, changing the die, tightening die bolts, or other functions performed on the die.

- Electrical shock exists. Check the wires to the heaters on the barrels, die, and adapters to ensure that there are no frayed, bare, or exposed wires that can cause electrical shock. In some extrusion processes, water-cooling baths are very close to the die, which can create additional electrical hazard.

- The third major potential safety hazard around extruders is falls. Pellets spilled on the floor are slippery and need to be removed immediately. At

start-up the extruder normally generates some scrap, which may be on the floor. This creates tripping hazards, and the scrap must be removed immediately.

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer

1. Off the following which one is the important operating factor of extrusion?
    a. Temperature and pressure
    b. Diameter of the die apertures
    c. The product shear rate
    d. All of the above

Test II: Short Answer Questions (3 points each)

1. List common personal protective equipment used in extrusion operation?
2. Write the policies and procedures of work place environment?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 8 points**	**Unsatisfactory below 8 points**

Information Sheet 4- Monitoring equipment variation in operating conditions

4.1 Equipment variation in operating conditions

The number of extrusion problems that can occur is nearly infinite some of the problems listed as follows.

- Output problems
- Appearance problems
- Functional product properties
- High melt temperature
- High motor load
- Wear of screw and/or barrel

Screw element variations

- large pitch conveying
- fast small pitch conveying
- slower, more kneading or cut flight
- mix shear lock
- high pressure & inject reverse pitch
- higher pressure

Moisture variations:

- plasticizer
- viscosity modifier

Impact of moisture increase:

- viscosity decrease
- torque decrease
- product temperature decrease
- bulk density increase (expansion die pressure decrease

Self-check 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test II: Short Answer Questions (3 points each)

1. Describe some of the problems occur in extrusion?
2. Type screw element variations?
3. Write impact of moistures on process parameter?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 9 points**	**Unsatisfactory below 9 points**

Information Sheet 5 - Identifying variation in equipment operation and reporting maintenance requirement

5.1 Identifying variation in equipment operation

- **Output variation**

If the problem is variation of the extruder output, we should check the nature of the variation. Is the output variation:

- ✓ Regular cyclic variation
- ✓ Gradually decreasing
- ✓ Gradually increasing
- ✓ Occasional increase or decrease without a clear pattern

- **Cyclic variation**

The variation can be categorized by how fast the variation occurs. We can distinguish:

- ✓ Fast variation, several times per revolution of the screw
- ✓ Variation at the frequency of the screw speed, i.e. each revolution of the screw
- ✓ Slow variation, every ten to twenty revolutions of the screw
- ✓ Very slow variation, occurring over several minutes
- ✓ Hourly variation, occurring over one to several hours
- ✓ Daily variation, occurring over one to several days

- **Appearance problems**

These can be: lines, discoloration, orange peel, bubbles, specks, gloss, etc. Appearance problems can originate before the extruder (e.g. contamination), in the extruder (e.g. degradation), and after the extruder (e.g. lines from the calibrator).

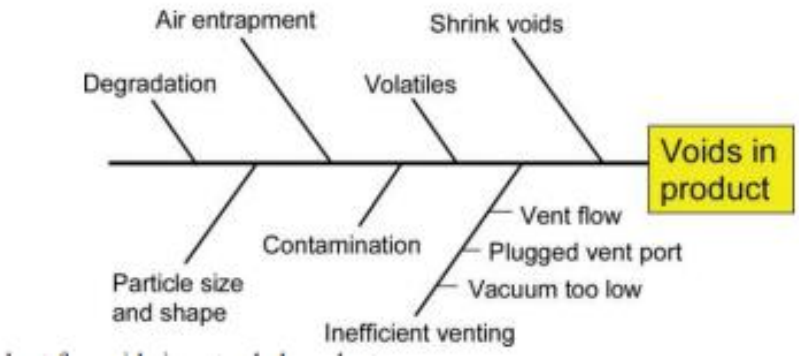

Figure 25: Fishbone chart for voids in extruded product

Self-check 5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 each)

1. Describe the problem variation of the extruder output?
2. Write the cyclic variations of extruder?

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 6 points**	**Unsatisfactory below 6 points**

Information Sheet 6- Monitoring the extruded product

6.1 Monitoring the extruded product

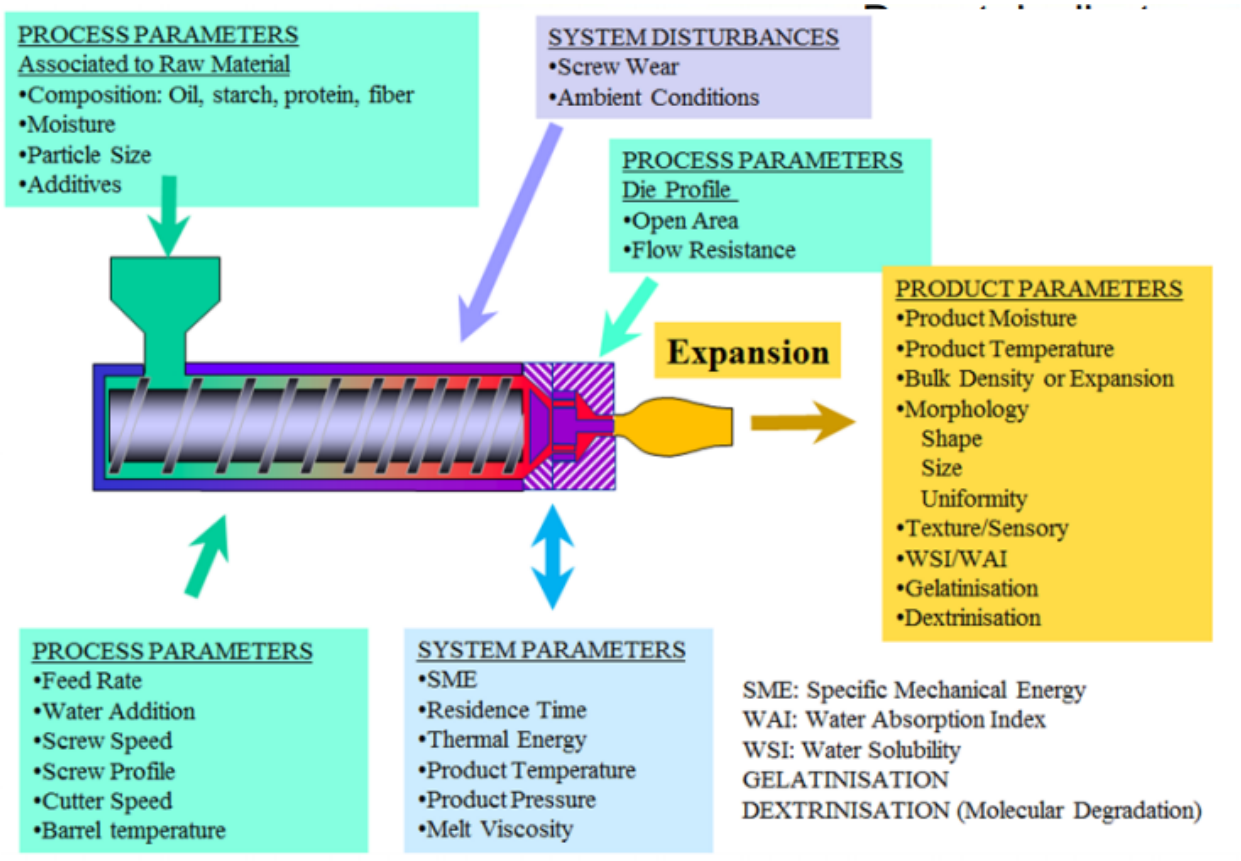

Figure 25: overall operating and monitoring parameters of extrusion

Self-check 6	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 points each)

1. List process parameters associated with raw material?
2. Describe product parameters in extrusion?
3. Type some of process parameters?

You can ask you teacher for the copy of the correct answers.

Note: Satisfactory rating 9 points	Unsatisfactory below 9 points

Information Sheet 7- Identifying, rectifying and reporting out-of-specification product/process

7.1 Reporting out-of-specification product/process

Out-of-specification results analytical results indicating that the quality parameters of starting materials or product outcomes do not meet the specification are considered to be out-of-specification results (out-of-specification -results). There shall be a procedure describing the handling and investigation of such results, in which the following aspects shall be considered and covered:

7.2 Control of out of specification products

The organization shall ensure procedures exist to investigate the cause of significant non-conformity against standards, specifications and procedures, which are critical to product quality and safety. Corrective actions taken should be undertaken in a timely manner to prevent further occurrence of non-conformity and should be accurately documented, assigning responsibility and accountability. The operator shall establish a documented procedure for dealing with products that do not comply with the intended requirements. This includes:

- Identification of product and batch code;
- Documentation
- Evaluation of the cause
- Segregation of batch or batches
- Disposal of products; and
- Internal information of relevant parties.

Self-check 7	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 points each)

1. What is out of specification product and process?
2. Write some of the corrective actions taken against non-conformity product?

You can ask you teacher for the copy of the correct answers

Note: **Satisfactory rating 6 points**	**Unsatisfactory below 6 points**

Information Sheet 8- Maintaining the work with housekeeping standards

8.1 Maintaining the work with housekeeping standards

Before each shift, evaluate the operating area and plant in general, looking for unsafe conditions, e.g., trip- ping hazards, exposed wires, and water on the floor. Determine what you are going to do on your shift and review the operation for safety. Good housekeeping is directly related to safety. A cluttered, dirty area will lead to accidents and reflects your attitude toward the job. A proper storage area for all tools and equipment makes the job easier and the plant a better place to work.

Good housekeeping practices in the laboratory have a number of benefits. For example, in terms of safety, it can reduce the number of chemical hazards (health, physical, reactive, etc.) in the laboratory and help control the risks from hazards that cannot be eliminated. Practices that encourage the appropriate labeling and storage of chemicals can reduce the risks of mixing of incompatible chemicals and assist with regulatory compliance. From a security standpoint, order in the laboratory makes it easier to identify items out of place or missing. And finally, good housekeeping can help reduce scientific error by, for example, reducing the chances of samples becoming confused or contaminated and keeping equipment clean and in good working order. Therefore good housekeeping practices are essential for all workplaces, example

- Spills on floors should be cleaned up immediately
- walkways should be kept clear of obstructions
- work materials should be neatly stored
- Any waste should be regularly removed
- Suitable containers for waste should be conveniently located and regularly emptied.

Self-check 8	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (3 points each)

1. Describe good housekeeping practices?
2. Define housekeeping?

You can ask you teacher for the copy of the correct answers

Note: Satisfactory rating 6 points	**Unsatisfactory below 6 points**

Information Sheet 9- Conducting work with workplace environmental guidelines

9.1 Conducting work with workplace environmental guidelines

- **Work Layout**

The layout of the workplace is required to allow persons to enter and exit the workplace and move within safely, both under normal work conditions and in an emergency.

- **Entry and Exit**

Entries and exits are required to be safe to allow impeded access and egress for all workers, students and visitors including those with special needs. In particular:

- ✓ entries and exits should be slip resistant under wet and dry conditions
- ✓ aisles and walkways need to be at least 600mm wide and kept free of furniture or other obstructions
- ✓ any walkways, boundaries or pathways shall be marked with 50mm wide with a contrasting colour e.g. white or yellow
- ✓ open sides of staircases should be guarded with an upper rail at 900mm or higher and a lower rail
- ✓ handrail should be provided on or at least one side of every staircase
- ✓ separate entry and exits for mobile equipment e.g. forklifts or trucks, and pedestrians are to be provided
- ✓ Power operated doors and gates should have safety features to prevent people from being stuck or trapped.
- ✓ Location of exits should be clearly marked and signs posted to show direction of exit doors to aid emergency evacuation.

- **Work Areas**

The layout of the work area should be designed to provide sufficient clear space between furniture, fixtures and fittings so workers can move freely without strain or injury also evacuate quickly in case of an emergency.

In determining how much space is required, the following should be considered:

- ✓ the physical actions needed to perform the task
- ✓ the need to move around while working
- ✓ whether the task is to be performed from a sitting or standing position
- ✓ access to workstations
- ✓ the equipment to be handled and the personal protective equipment that may be worn to

- **Floors and Other Surfaces**

Floor surfaces shall be suitable for the work area and be chosen based on the type of work being carried out at the workplace, as well as the materials used during the work process, the likelihood of spills and other contaminants, including dust and the need for cleaning.

In general:

- ✓ floors shall be free from slip or trip hazards e.g. cables, uneven edges, broken surfaces
- ✓ floor surfaces shall have sufficient grip to prevent slipping, especially in areas that may become wet or contaminated
- ✓ anti-fatigue matting, carpet, shock absorbent underlay, cushion backed vinyl shall be provided for workers where static standing occurs
- ✓ carpet shall be properly laid without loose edges or ripples and should be well maintained
- ✓ Floors should be strong enough to support loads placed on them.

- **Workstations**

Workstations should be designed so workers are comfortable undertaking their task and allow for a combination of sit and standing tasks. For tasks undertaken in a seated position, workers should be provided with seating that:

- ✓ provides good body support, especially for the lower back
- ✓ provides foot support, preferable with both feet flat on the floor, otherwise footrest shall be provided
- ✓ allows adequate space for leg clearance and freedom of movement

- ✓ is fully adjustable to accommodate different size workers (e.g. seat height, back rest height and back rest tilt adjustments) and should not tip or slip utilizing a five-point-base
- ✓ chairs shall be fitted with castors for carpeted surfaces and glides or braked castors on hard surfaces

- **Lighting**

Sufficient lighting is required to allow safe movement around the workplace and to allow workers to perform their job without having to adopt awkward postures or strain their eyes to see. Emergency lighting is to be provided for the safe evacuation of people in the event of an emergency.

The following factors are to be taken into account:

- ✓ the nature of the work activity
- ✓ the nature of hazards and risks in the workplace
- ✓ the work environment
- ✓ illumination levels, including both natural and artificial light
- ✓ the transition of natural light over the day
- ✓ Glare

- **Air Quality**

Workplace are to be adequately ventilated which includes provision of fresh, clean air drawn from outside the workplace, uncontaminated from flues or other outlets and be circulated through the workplace.

Workplace inside buildings may have natural ventilation, mechanical ventilation or air conditioning. An air-conditioning system should:

- ✓ provide a comfortable environment in relation to air temperature, humidity and air
- ✓ movement
- ✓ prevent the excessive accumulation of odors
- ✓ reduce the levels of respiratory by-products, especially carbon dioxide, and other indoor contaminants that may arise from work activities

- ✓ Supply an amount of fresh air to the workplace, exhaust some of the stale air as well as filter and recirculate some of the indoor air.

Self-check 9	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Write environmental guidelines of work station?
2. Describe some environmental guidelines of working environment?

You can ask you teacher for the copy of the correct answers

Note: Satisfactory rating 6 points	**Unsatisfactory below 6 points**

Information Sheet 10- Maintaining workplace records

10.1 Maintaining workplace records

Recording maintenance information each piece of equipment should have a dedicated logbook documenting all characteristics and maintenance elements:

- Preventive maintenance activities and schedule
- Recording of function checks and calibration
- Any maintenance performed by the manufacturer
- Full information on any problem that the instrument develops, the subsequent troubleshooting activity, and follow-up information regarding resolution of the problem.

In recording problems, be sure to record:

- date problem occurred, and when equipment was removed from service
- reason for breakdown or failure
- corrective action taken; including a note about any service provided by the manufacturer
- date returned to use any changes to procedure for maintenance or function checks as a result of the problem.

Some of the tools that are helpful for keeping records on equipment management are:

- charts
- logs
- checklists
- graphs
- Service reports.

Self-check 10	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 10 points**	**Unsatisfactory below 10 points**

Operation Sheet 1 – Techniques of delivering ingredients and additives to the extrusion process

1.1 wearing personal protective equipment's(PPE)

- glove
- eye google
- safety shoe
- guan
- hair net

1.2 Techniques of delivering ingredients and additives to the extrusion process

Purpose: To witness and experience the process of extrusion, recognize the components of a simple extruder, and produce common small scale made extruded products such as cookies and pasta and compare with large scale productions.

Supplies and Equipment Needed:

- food grinders: hand-cranked
- electric (food processor)
- fine and coarse discs
- pasta maker: rolling pin, cutting board, and knife
- electric attachment (food processor)
- assorted plates
- Spritz cookie presses:
- cookie dough plastic wrap plastic bags
- manual
- easy-squeeze trigger
- electric
- assorted discs
- meat flour cookie sheets
- cooked potatoes bowls spatulas
- pasta dough waxed paper cooling racks

Procedure:

Step1. Wash hands thoroughly with soap and water before and after each procedure.

Step2. Get ready the available laboratory scale extruder and make ready for operation

Step 3. Produce Pasta

- Manual process - Obtain an egg-sized amount of pasta dough. Place on a clean, floured surface. Roll out to a thickness of about 1 mm or paper thin. Using a knife, cut into narrow strips about 6 mm wide. Shake out strips and place on a towel to dry.
- Electric maker - Assemble the pasta maker attachment with the flat noodle plate. Turn mixer to speed 10. Slowly feed 1 walnut-size piece of dough into the hopper; dough should self-feed. The grind worm (screw) should be visible before adding a second piece of dough. When the extrusion is 24 cm long; stop the mixer and gently pull noodles away from the plate. Lay on waxed paper and separate immediately. Dry on a towel.
- Answer the appropriate questions in the Observations and Questions section.
- When the noodles are thoroughly dry, they will be placed in plastic bags.

Step4. Cookies pressing procedure:

- Load cookie dough into each of the three presses that have similar design discs in place. Make 4-6 cookies with each press onto a cookie sheet. (See instructions for the presses that are available at this station if you are unsure how to use them.)
- When the cookie sheets are ready, they will be taken to be baked.
- Answer the appropriate questions in the Observations and Questions section.
- When the cookies are done baking, they will be cooled and saved for sampling during the post-lab discussion.
- Make sure to maintain cool temperatures for all food products and clean up your areas as you proceed.

Operation Sheet 2 - procedures of maintaining the work with housekeeping standards

2.1 wearing personal protective equipment's (PPE)

- glove
- eye google
- safety shoe
- guan
- hair net

2.2 procedures of housekeeping standard

1. Do not block exits.
2. Change burned-out light fixtures in work areas, walkways, and exits.
3. Keep floors and work areas clean, dry, and grease-free.
4. Keep steps and ladders in serviceable condition.
5. Keep emergency equipment clean and unobstructed.
6. Ensure that all signs and caution labels are in good condition and visible.

LAP TEST	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task 1. Apply personal protective equipment

Task2: perform the extrusion process of food

Task 3: Perform the procedures of housekeeping standard

LG 38	LO- 3 Shut down the extrusion process

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Identifying shutdown procedure • Shutting down the process with workplace procedures • Identifying maintenance requirements and reporting This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Identify shutdown procedure • Know process shut down according to workplace procedures • identify and report maintenance requirements
Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks 5. Perform Operation Sheets 6. Do the “LAP test

Information Sheet 1- Identifying shutdown procedure

1.1 Shutdown procedure

Lock-out procedures work safe regulations require that all powered machinery or equipment shut down for maintenance or repair must be secured against the possibility of the equipment being accidentally turned on while being worked on. To safeguard the person working on such equipment, lock-out procedures must be posted near the equipment, and the procedures listed must be followed before repairs or maintenance can start. Locking out a machine usually means the power feeding the machine is disconnected either by pulling a plug, placing a switch in the off position, or turning a circuit breaker to the off position. The disconnected circuit is then secured in the inoperative position by the use of a padlock. The person doing the maintenance or repair keeps the key to this lock until the work on the machine has been completed. The worker then removes the lock and the machine is again operable.

Depending on the situation, the lock might be used to secure the power switch of the machine or it might be used to lock shut the door to a circuit breaker panel where the thrown breaker is located. If the machine is not wired into its own power circuit but simply plugs into the wall, the lock-out procedure may require that the machine be turned off with its power switch and unplugged from the power receptacle. The plug end of the machine must be kept in plain view of the repair person so no one can inadvertently restore power without the repair person's knowledge.

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Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test II: Short Answer Questions (3 point each)

1. Identify the shutdown procedures
2. Describe machine parts related to shut down procedures

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating 10 points**	**Unsatisfactory below 10 points**

Information Sheet 2- Shutting down the process with workplace procedures

2.1 Identifying and reporting maintenance requirements

Preventive/Predictive Maintenance Indicators of Ineffective

- Low equipment utilization due to unscheduled stoppages
- High wait or idle time for machine operators during outages
- High scrap and rejects indicative of quality problems
- Higher than normal repair costs due to neglect of proper lubrication, inspections or service.
- Decrease in the expected life of capital investments due to inadequate maintenance

2.2 Workplace procedures shutdown

- Use “hot mill” gloves and kevlar sleeves during shutdown procedure.
- Empty the fed hopper and lower the heats on the barrel to about 300 0 F. Turn off all the power to the heater bands while running the remaining material out of the barrel. Turn off the water on the feed throat.
- Run all of the remaining material out of the barrel. Some material might adhere to the barrel or screw requiring you to run a flush or purge compound to clear out the barrel. In this case the die heat may be turned back on.
- After the barrel is purged, turn the power off to the heater bands and unplug them. Turn off the barrel heaters and hit the “off “ button to turn off the screw drive motor.
- Disconnect thermos wells, pressure transducers and wires. Remove the heater bands from the die.
- Blow air on the die face to harden the extrudate enough to pull it out of the die land with pliers.
- Take bolts out of the face of the die and remove the die.
-

- Turn the extruder on and push out any core if applicable and shave any extrudate plug from the breaker plate.
- Turn the extruder off and unbolt the die clamp and remove it from the extruder.
- Turn the extruder back on and push out the breaker plate. Apply air to the face of the breaker plate and slowly pry the plug out.
- Turn the extruder speed up and run out any material remaining by blowing air into the feed hopper. Be sure no one is standing in front of the extruder.
- Clean the die parts with a brass scouring pad and spray with neutralizer.
- After the screw is empty, turn off the main power switches. Push the screw out of the extruder from the back using a long steel rod or use a hydraulic “pusher”. Tap the screw out with a hammer.
- Clean the screw with a brass scouring pad and blow out the barrel with air. In extreme cases, a motor driven wire brush may be used to scrub material out of the barrel.
- Take out the pressure transducers, if necessary, to clean plastic out of the thread wells

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test II: Short Answer Questions (3 point each)

1. Write the maintenance requirements status of extrusion machine?

You can ask you teacher for the copy of the correct answers

Note: Satisfactory rating 12 points	**Unsatisfactory below 12 points**

Information Sheet 3- Identifying maintenance and reporting requirements

3.1 Identifying maintenance requirements

A maintenance plan will include preventive maintenance procedures as well as provision for inventory, troubleshooting, and repair of equipment. When implementing an equipment maintenance program, some of the initial steps will include what follows.

- Assign responsibility for providing oversight.
- Develop written policies and procedures for maintaining equipment, including routine maintenance plans for each piece of equipment. The plan should specify the frequency with which all maintenance tasks should be performed.
- Develop the format for records, create logs and forms, and establish the processes to maintain records.
- Train staff on the use and maintenance of the equipment, and assure that all staff understands their specific responsibilities.

Maintenance and Repair Report Format

Maintenance date:	System name:		Location Building: Room:
Maintenance type: ☐ Routine ☐ Service ☐ Breakdown	Status:		
Last maintenance date:	National Board number:	Serial number:	SLAC pressure system number:
System type *(check all that apply)*: ☐ Scientific ☐ Vacuum ☐ Conventional ☐ Compressed gas ☐ Cryogenic ☐ Other *Specify*:		Year built: Manufacturer:	
Routine maintenance:		Preventive maintenance:	
Shut-down maintenance:		System failure problems:	
Repair description:			

figure 26: maintenance and repair report format

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test II: Short Answer Questions (3 point each)

1. Write the maintenance requirements status of machine?

You can ask you teacher for the copy of the correct answers

Note: Satisfactory rating 12 points	**Unsatisfactory below 12 points**

Operation Sheet 1 - Procedures of Shut down the extrusion process

1.1 wearing personal protective equipment's(PPE)

- Safety glasses
- Safety shoes
- Ear protection
- Gloves
- Thermal insulated gloves
- Hard hats
- Face shield
- Goggles

2.1 Shut down procedures the extrusion process

1. Use "hot mill" gloves and Kevlar
2. Turn off the water on the feed throat.
3. Run all of the remaining material out of the barrel. Some material might adhere to the barrel or screw requiring you to run a flush or purge compound to clear out the barrel. In this case the die heat may be turned back on.
4. After the barrel is purged, turn the power off to the heater bands and unplug them. Turn off the barrel heaters and hit the "off "button to turn off the screw drive motor.
5. Disconnect thermos wells, pressure transducers and wires. Remove the heater bands from the die.
6. Blow air on the die face to harden the extrudate enough to pull it out of the die land with pliers.
7. Take bolts out of the face of the die and remove the die.
8. Turn the extruder on and push out any core if applicable and shave any extrudate plug from the breaker plate.
9. Turn the extruder off and unbolt the die clamp and remove it from the extruder.

10. Turn the extruder back on and push out the breaker plate. Apply air to the face of the breaker plate and slowly pry the plug out.
11. Turn the extruder speed up and run out any material remaining by blowing air into the feed hopper. Be sure no one is standing in front of the extruder.
12. Clean the die parts with a brass scouring pad and spray with neutralizer.
13. After the screw is empty, turn off the main power switches. Push the screw out of the extruder from the back using a long steel rod or use a hydraulic “pusher”. Tap the screw out with a hammer.
14. Clean the screw with a brass scouring pad and blow out the barrel with air. In extreme cases, a motor driven wire brush may be used to scrub material out of the barrel.
15. Take out the pressure transducers, if necessary, to clean plastic out of the thread wells

LAP TEST	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task 1: Apply wearing personal protective equipment

Task 2: Perform shutdown procedures of extrusion process

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