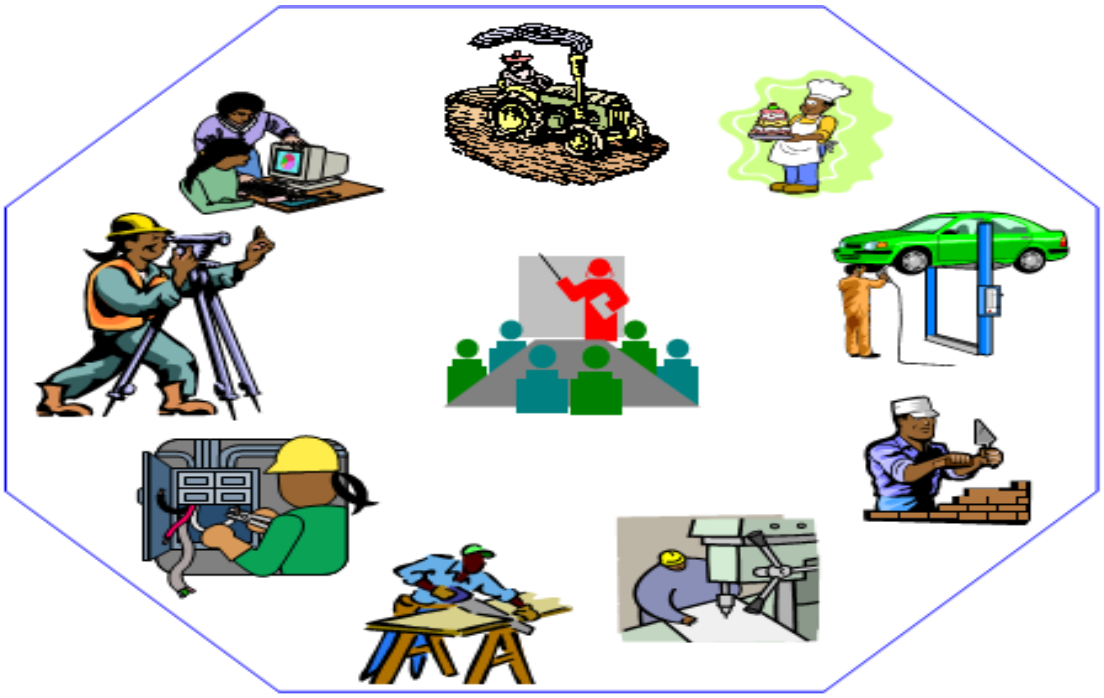
Edible oil and fats processing

Level-III



Based on October 2019, Version 2 Occupational standards and March 2021 V1 Curriculum

Module Title: Operating a Fractionation Process

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Table of Contents

LG #44	LO #1- Prepare the fractionation equipment for processing

Instruction sheet

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

- Confirming and made available materials to meet operating requirements.
- Identifying and confirming cleaning and maintenance
- Confirming and made available different services in required quantities
- Fitting and adjusting machine components and related attachments
- Entering production/process parameters as required meeting safety and production requirements.
- Checking and adjusting fractionation equipment performance.
- Carrying out pre-start checks fractionation equipment

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 and made available materials to meet operating requirements.
- Identify and confirming cleaning and maintenance
- Confirm and made available different services in required quantities
- Fit and adjusting machine components and related attachments
- Enter production/process parameters as required meeting safety and production requirements.
- Check and adjusting fractionation equipment performance.
- Carry out pre-start checks fractionation equipment

Carrying out pre-start checks

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 and made available services and materials

1.1 Confirming and made available services and materials

1.1.1 Confirming and made available services

a) Lighting and power

Where lighting is needed, florescent tubes use less electricity than bulbs, but care is needed when using fluorescent lights fractionation machine and other equipment that has moving or rotating parts. This is because they can make machinery appear stationary at certain speeds, causing a hazard to operators.

The building interior should be equipped with adequate light and lighting facilities to permit employees to carry out their designated tasks in areas where:-

- processing
- handling
- storage
- testing
- Inspection and cleaning activities take place.

b) Water supply and sanitation

Edible oil extraction can **use** a relatively large quantity of **water** throughout the **process** primarily for:

- Raw ingredient cleaning
- Cooling water in crude oil production
- Chemical neutralization
- Washing and deodorization
- Cleaning process areas
- Steam production

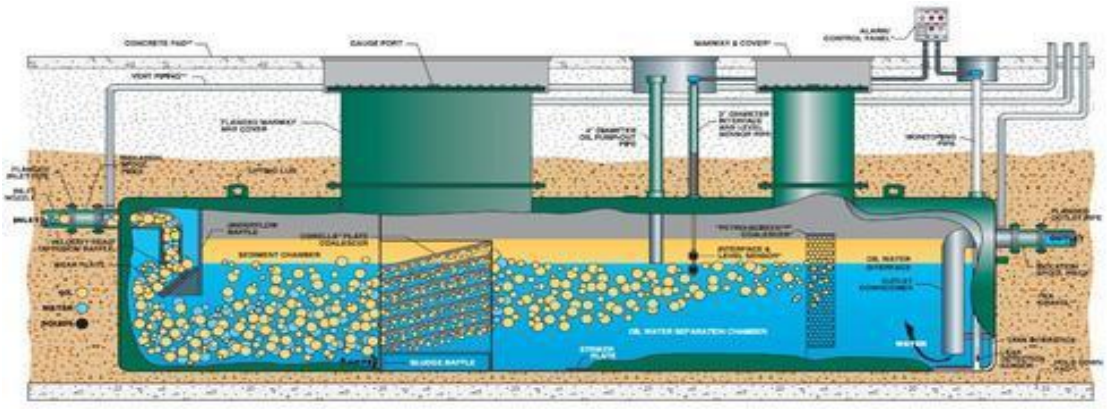

Figure 1 Oil water separation

c) Compressed Air

In edible oil processing, compressed air is essential. Edible oil is a very sensitive foodstuff, and every effort must be made at the production and packaging stages to prevent contamination with even the faintes.

Compressed air is used in a broad range of applications in the food processing industry. In many of these applications, compressed air is direct or indirect contact with food product, and impurities in the compressed air may contaminate the oil, which can result in changes of color and taste, and reduced shelf life. Also, exposure to bacteria and other microorganisms can result in product recalls.

Figure 2 Compressed Air

c) Steam

Steam refining of fatty oils to reduce the partially high free fatty acid content of certain crude oils before conventional refining has been practiced in Europe for many years. Intensive laboratory testing indicated that crude palm oil could be pretreated to remove trace metals and certain heat resistant organic compounds.

This pretreated oil could then be steam refined and simultaneously steam deodorized to produce high quality finished edible oil. Analytical data on crude and finished oil quality and operating yields are presented to illustrate the steam refining/deodorization process.

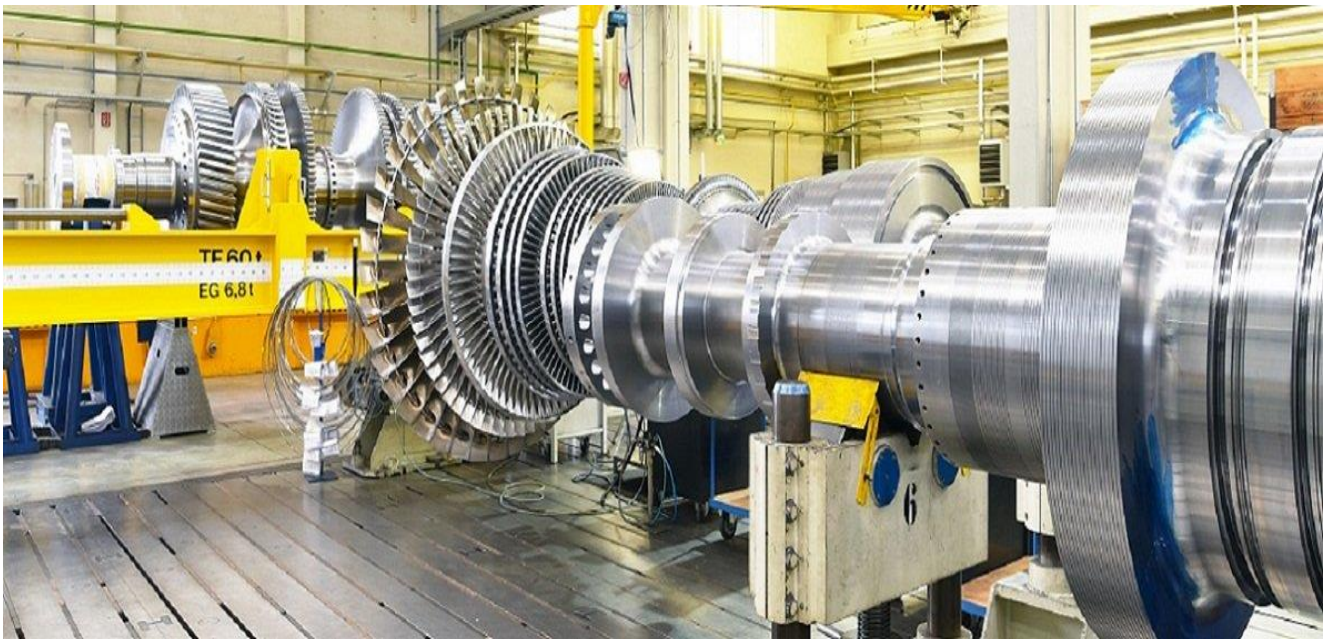

Figure 3 Steam Turbine

d) Vacuum

Today nearly exclusively those ejector systems are used in the edible oil industry worldwide. The advantages are obvious:-

- Large mass flows can be moved within acceptable plant sizes and sensible steam requirement figures (300 kg/h stripping steam at 2,5 mbar still represent a volumetric flow of 150 000 m³/h, that can be conveyed by 1450 kg/h motive steam = 0,4 MW therm.)
- Low investment costs
- Low maintenance costs, easy to install and to operate

Figure 4 Vacuum

- **Multistage Ejector Vacuum System with Liquid Ring Vacuum Pump**

It is sensible in the case of multi-stage compressions to combine the advantages of steam ejectors and water ring pumps.

That means up to the first possible condensation stage the stripping steam is exclusively compressed by ejectors (so called boosters); after the first condenser a combination of steam ejectors and water ring pumps can be implemented.

The available coolant and its temperature have a decisive influence on the design of the first inter condenser, the number of ejector stages and on the total motive steam consumption for the plant.

Figure 5 multi-stage ejector vacuum systems

1.1.2 Confirming made available materials

A) RBD oil

RBD (Refined, Bleached, and Deodorized) palm oil was obtained from plantation. Then, the palm oil was subjected for dry fractionation to obtain the stearin and the olein fraction. The dry fractionation process was done in a pilot plant crystallizer equipped with high pressure filtration. All chemicals were either of analytical or high-performance liquid chromatography (HPLC) grades.

RBD-palm oil was fractionated into stearin fraction (the cake, as solid phase) and olein fraction (the filtrate, as liquid phase). Physical appearances in room temperature (25-30°C), the stearin was solid while the olein was liquid compared to the initial palm oil that was semi-solid. The physical changes of the fractions compared to the initial RBD-palm oil were influenced mainly by shifted in the chemical compositions. As consequences, thermal behavior of the oils was found to be different among each other.

B) Detergent

The surfactant we will use is dish **detergent**, which helps break up the surface tension between **oil** and water because it is amphiphilic: partly polar and partly nonpolar.
As a result, **detergents can** bind to both water and **oil** molecules.

Method

The working method is done on the separation process of stearin and olein is weigh detergent as much as 0.2 grams then dissolve with 0.8 grams of water, input into beaker glass then add 100 grams of CPO(crude Palm Oil) to homogeneous stir. Then place the CPO mixture into the water bath containing the pieces of ice, mix the CPO mixture with a temperature of 10 °C for ± 2 hours until the crystal is formed.

After that heat up, to form 2 layers. Then put on for 15 minutes, after centrifying process will form 3 layers, after separated weigh each layer is done density identification test, to be known at which layer there is stearin. After stearin is identified, wash with hot water then input into separating funnel, remove the bottom layer, recalculate the saponification number and do test density test and melting point.

C) Solvent

The detergent fractionation is the batch or continuous cooling crystallization and the separation of the fractions either gravity or centrifugation after the addition of surfactans.

The processing of crude palm oil (CPO) in vegetable oil plants aims to improve the function and benefits of palm oil. Where expected oil produced can be consumed by consumers and as raw materials in the factory.

Solvents that have been used for solvent fractionation of oil and fats are:

Table solvents

	B.Pt (°C)	**Heat of evaporation (kJ/kg)**
Acetone	56.6	518
Hexane	69	365
Isopropyl alcohol	82	779
Methanol	646	1099
2-Nitropropane	120.3	410

Choice of solvent depends on:

- Polarity. Which effects solubility of both major and minor components?
- Energy required for solvent recovery (heat of evaporation).
- Explosion/ignition risk.

- Toxicology, e.g. probable carcinogenicity of 2-nitropropane.

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: say true or false

1. Hexane is one solvent used in edible oil processing ….?(2pts)
2. RBD-palm oil was fractionated into stearin fraction (the cake, as solid phase) and olein fraction (the filtrate, as liquid phase). ….?(2pts)

Test I: Choose the best Answer

1. **Which of the following is included in to services which are used in edible oil processing industry?**

A) steam C) water

B) power D) All

2. **Which of the following is solvent used in edible oil processing?** (3pts)

A) Isopropyl alcohol

B) Methanol

C) 2-Nitropropane

D) All

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 10 points**

Information Sheet 2- Identifying and confirming cleaning and maintenance

2.1 Identifying and confirming cleaning and maintenance

- **Cleaning and maintenance**

The cleaning program shall be established and validated to ensure that all the parts of the facility and equipment are cleaned.

An organization must follow a schedule of cleaning the premises which shall include:

*Place to be cleaned:

- ✓ When to do the cleaning?
- ✓ Who will do the cleaning?
- ✓ How the cleaning should be done?

The inspection should be done before post –clean /pre-start up.

Cleaning of Equipment should be set in either way to facilitate cleaning in place (CIP) or cleaning out of place (COP).

The machines should be lubricated periodically to ensure smooth running and food grade lubricants should be used for this purpose.

The working station, floor or equipment should be cleaned immediately in case of spillage or food left over.

Cleaning chemicals shall be handled and used carefully as per the instructions given on the MSDS (Material Safety Data Sheet) and shall be stored separately away from food materials.

- **Wash down**

Most of the plant used in an edible oil refinery must undergo regular cleaning. This will generally be performed after a week's production or between changes in feedstock; batch equipment may be cleaned after each batch has been processed.

Cleaning of vessels is usually effected using live steam and hot water on a CIP system, thus ensuring optimum use of steam, reduction in effluent volume, improved hygiene and reduced manual labor.

Other cleaning, such as floor cleaning, is conducted using hot water as necessary. This fat and oil bearing effluent is discharged to the sewer via fat traps, where the oil rich scum is recovered and sent for reworking.

Figure6 Cleaning and maintenance

2.1.2 Maintenance

Maintenance is crucial to ensure plant assets have good maintainability, availability and reliability during plant operation. Any failure in equipment's, system and machinery can disrupt the production line; concurrently cutting off the company profit. This problem becomes worse when the wrong decision is made during corrective maintenance and troubleshooting that can give bad impact to the plant's performance since the impact of human error is pressing.

2.1.2.1 Types of maintenance

a) Preventive maintenance

Preventive maintenance defined as an equipment maintenance strategy based on replacing, or restoring, an asset at a fixed interval regardless of its condition.

b) Time-based maintenance

Time-based maintenance refers to replacing renewing an item to restore its reliability at a fixed time, interval or usage regardless of its condition.

c) Predictive maintenance

Predictive maintenance where we use potentially many process parameters gained from online sensors to determine if our equipment is moving away from stable operating conditions and is heading towards failure.

d) Corrective maintenance

Corrective maintenance is strategy only restores the function of an item after it has been allowed to fail.it is based on the assumption that the failure is acceptable (i.e. no significant impact on safety or the environment) and the preventing failure is either not economical or not possible.

Machine breakdowns arise from a number of different causes. They reduce productivity and increase production costs. Poorly maintained machines also produce substandard products and can contaminate products with metal fragments, as well as being a potential hazard to operators. To put preventive maintenance into practice, the following actions are needed:

Identify priority machinery which have components that wear out more frequently.

Make a clear description of the procedures and standards for the work of machine operators and maintenance workers (such as lubricating, tightening bolts, adjustments etc.) In daily, weekly and monthly routine maintenance plans

Organize a schedule and train staff to implement maintenance plans.

Prepare a maintenance budget

Record inspection results, analyses the records and evaluate the success of maintenance

Figure7 Maintenance of vacuum pump

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: Choose the best Answer

1. Cleaning of Equipment should be set in either way to facilitate cleaning in place (CIP) or cleaning out of place (COP)…..?(4pts)

Test I: Choose the best Answer

1. **Which of the following is defined as an equipment maintenance strategy based on replacing, or restoring, an asset at a fixed interval regardless of its condition.…?(**3pts)

A) Preventive maintenance

B) Time-Based maintenance

C) Corrective maintenance

D) All

2. Which of the following is refers to replacing renewing an item to restore its reliability at a fixed time, interval or usage regardless of its condition …?(3pts)

A. Preventive maintenance
B. Time-Based maintenance
C. Corrective maintenance
D. All

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 10 points**

Information Sheet 3- Confirming and made available different services in required quantities

3.1 Confirming and made available different services in required quantities

a) Electrical energy

In addition, high cost of production, the epileptic supply of electrical energy supply from the national grid, inadequate production and distribution of the growing concern over global warming have created complex and some- times conflicting challenges for industrial operations. The industries must operate a system that runs effectively in order to survive in today's highly competitive world market. Hence, the industries are seeking cost effective energy saving technology and practices that will minimize energy use while maintaining or increasing product quality and quantity.

b) Water Usage

Typical **SWI** (specific Water Intake) figures for the edible oil industry

- Average monthly oil production (t)
- Average monthly3water intake (m^3)
- Specific Water Intake (m^3/t)

It must be noted that almost every plant producing edible oil also produces secondary products such as margarine, peanut butter and mayonnaise. The figures quoted in Table 1 refer specifically to oil milling and refining. An average SWI of 1, 4 m3/t was found for the manufacture of margarine.

The weighted average SWI was found to be 2, 6 m3/t for milling and 3,8 m3/t for refining. It is important to consider that for the edible oil industry in general, only about 65% of capacity is currently being utilized.

The variation in SWI was found to be 2,1 to 3,1 m3/t for milling and 3,2to 4,6 m3/t for refining. This is a clear indication that opportunities for better water management do exist within the industry..

c) Compressed air

If the HACCP/risk analysis is pursued in detail, every location in which compressed air is used would be correctly identified as a CCP. This is true whether it comes in direct or indirect contact with the food product. Unfortunately, there are no standards or laws that exist that define a minimum acceptable level of “cleanliness” (filtration specification) when compressed air is used in food manufacturing. As a result, most companies devise their own internal compressed air quality “standard” or “specification.” The most common standard that is used is the ISO8573.1-2010 in conjunction with section 6 of The Code of Practice. Section 6 of this Code defines three separate categories of compressed air as used in the food industry:

- Direct contact with food
- Indirect contact with food or noncontact, high risk
- Noncontact – no risk

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: Say true or false

1. The industries are seeking cost effective energy saving technology and practices that will minimize energy use while increasing product quality and quantity….?4pts

Test II: Choose the best answer

1. **Which of the following compressed air as used in the food industry:**

A) Direct contact with food

B) Indirect contact with food or noncontact, high risk

C) Noncontact – no risk

D) ALL

2. **Which of the following SERVICES are used in fractionation process….?**(2pts)

A) Compressed air
B) Electricity
C) Specific Water Intake
D) All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 4 points**

Information Sheet 4- Fitting and adjusting machine components and related attachments

4.1 Fitting and adjusting machine components and related attachment

Installation issues include:

- Misalignment
- Soft foot — A soft foot exists when not all a machine's feet sit flat on the supporting base, so that tightening the foot bolts distorts the machine case. This can make a machine difficult to align and a distorted case can result in poor overall machine performance, according to EASA.
- Improperly set packing
- Bearings installed with a hammer or without being properly heated
- Incorrect tightening of bolts or other fasteners
- Installing the wrong component
- Using the wrong lubricant.

I) Tanker

In the oil industry, there are various types of tanks, vessels and pits that store or process fluids which contain oil in their composition.

One of them is the crude oil tank, which can be and is used for the storage of crude oil.

A crude oil tank can be

- a bolted steel tank (API 12B),
- a welded steel tank (API 12F-BS 2654),
- a flat-sided (API 620) or a Field-welded (API 12D-API 650) tank.

It is usually made of carbon steel which is capable of external and/or internal painting, galvanized coating or polymeric coating for corrosion protection

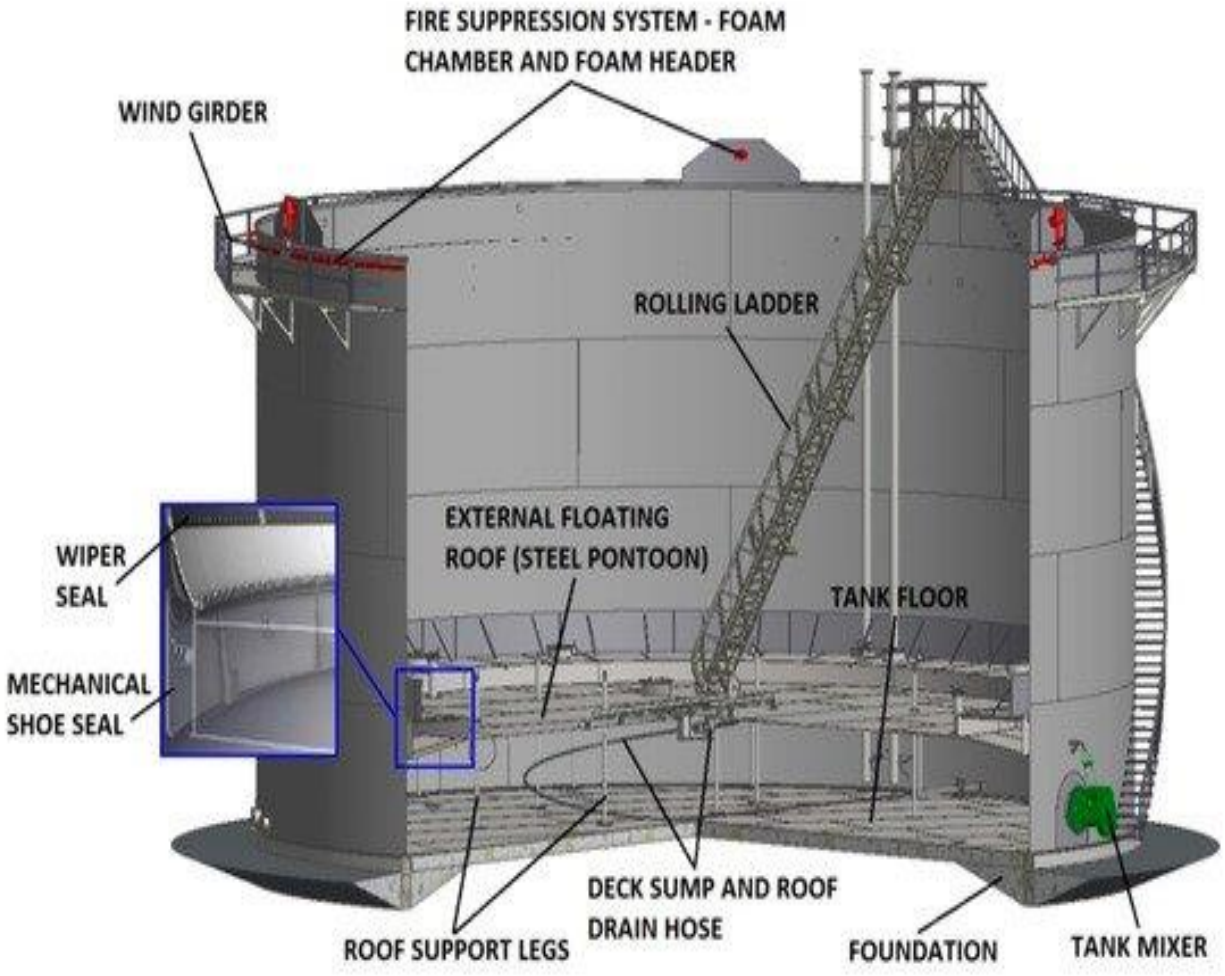

Figure8 Tanker components

II) Pump

The main components in a pump are the casing, **impeller**, **backing plate**, **shaft** and **shaft** seal, and the **motor** adapter. Some pumps have the **backing plate** as part of the casing in which case you would have a removable cover. The **shaft** seals are a critical part of the pump and selecting the right seal is an important step.

Main parts of centrifugal pumps

- Impeller- Impeller is a rotor used to increase the kinetic energy of the flow.
- Casing (Volute) - The casing contains the liquid and acts as a pressure containment vessel that directs the flow of liquid in and out of the **centrifugal pump**.
- Shaft (Rotor)
- Shaft sealing.
- Bearings.

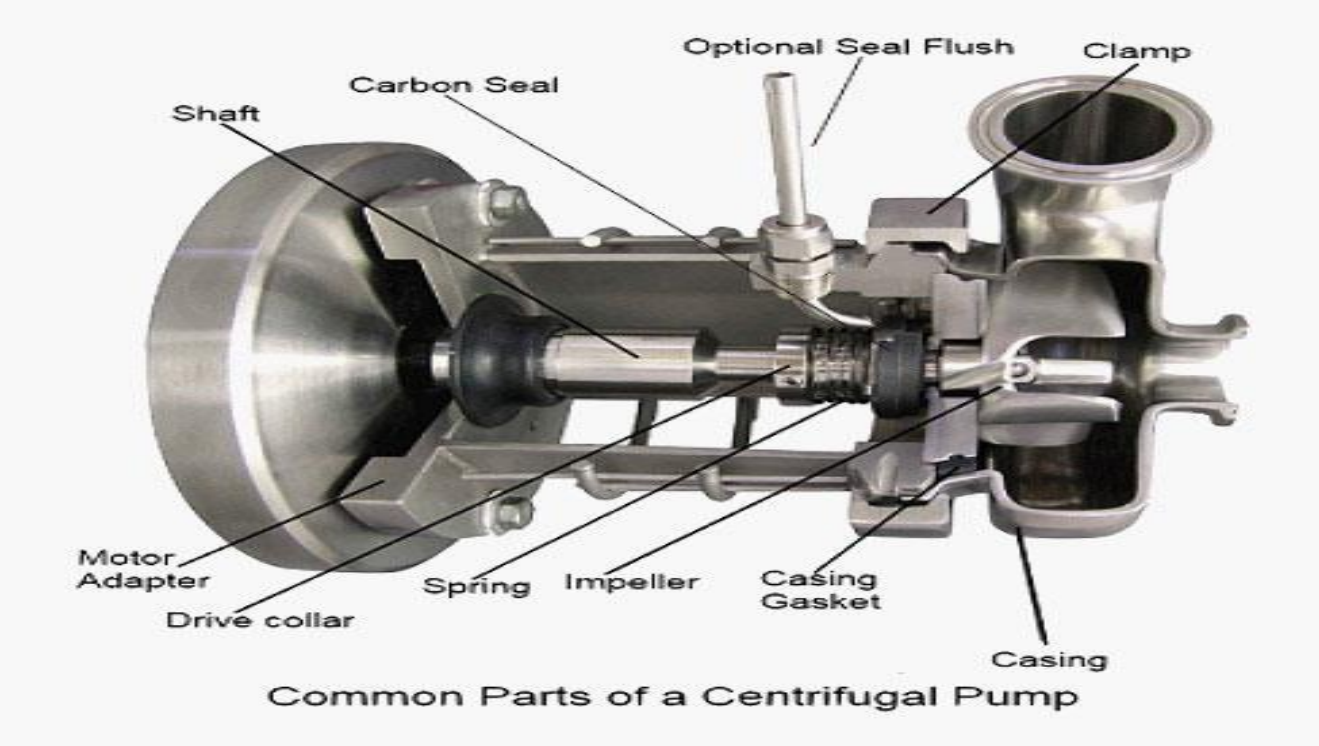

Figure9 centrifugal pumps

III) Separator

The PX range of industrial centrifuges is specially developed for processing of nearly all types of vegetable oils, lard, and tallow and fish oil. These centrifugal separators provide superior separation quality, gentle and efficient product treatment and secure high yield.

They are widely used in continuous degumming, neutralization, dew-axing, and washing in vegetable oil and animal fat refining industries. Premium quality centrifugal separators for small, medium and large plant capacities

Figure10 PX-separator

IV) Agitators

Our agitators have a flexible, modular design and enable you to tailor a mixing solution to your exact requirements. The agitator range includes top-mounted units, with or without bottom support, as well as bottom or side-mounted units.

Modularity lends itself to ease of installation and maintenance, and superior design ensures quality, performance and economy. The purpose-built agitators have impellers that promote optimal flow.

ALB

e Alfa Laval ALB bottom-mounted agitator

ALS

The Alfa Laval ALS side-mounted agitator is

Figure11 **Bottom-mounted and side-mounted Agitator**

V) Heat exchangers

Spiral heat exchangers are designed to handle the toughest heat transfer challenges. Whether it's frequent fouling from dirty media, or limitations from pressure drop and floor space, they are the ultimate problem solver for liquid-to-liquid and two-phase duties.

The robust, efficient and compact designs keep both installation and maintenance costs extremely low, and they have a proven reputation for almost never fouling up.

Figure12 Spiral heat exchanger

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: Say true false

1. These centrifugal separators provide superior separation quality, gentle and efficient product treatment and secure high yield? **(3pts)**
2. The **shaft seals** are a critical part of the pump and selecting the right seal is an important step? (3pts)

Test II: Choose the best answer

1. **Which of the following is true about Installation issues include:**

A. Misalignment
B. Improperly set packing
C. Bearings installed with a hammer or without being properly heated
D. Incorrect tightening of bolts or other fasteners
E. Installing the wrong component
F. All

2. **Which of the following is main component in a pump?**

A. Impeller
B. Shaft
C. Motor adaptor
D. All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 10 points**

Information Sheet 5- Entering production/process parameters as required meeting safety and production requirements

5.1 Entering production/process parameters as required meeting safety and production requirements

5.1.1 Process parameters

The basic principles sketched in this section help to explain the key aspects of a crystallizer, the technological heart of the fractionation installation.

I. Cooling speed

Fat crystallization is an exothermic reaction, so the efficiency with which this energy can be evacuated is an important design feature. For most industrial crystallizers, this ranges between 120 and 200W/m2.K.(Watt/meter square Kelvin).

Figure13 crystals formed in edible oil (especially in palm oil)

In view of this, the most important feature in fractionation technology is ensuring proper and homogeneous heat transfer in the crystallizer. At every stage of the cooling and

crystallization process, the temperature of the oil should be kept in a state that permits crystallization to the desired degree.

Generally, a crystallization process can be broken down into several temperature stages.
In these stages, the manner of oil cooling can be based on:

- Selecting a fixed oil temperature (meanwhile allowing the cooling water temperature to vary between set limits); or
- Selecting a T, a fixed temperature difference between oil and cooling water; or
- Selecting a fixed temperature for the cooling water.

II. Agitation

Since oil is a poor heat conductor, heat transfer should occur mainly through bulk mixing and friction with the cooling surface. This force is supplied by the agitator, which is often positioned quite close to the cooling surface, in order to make sure the oil just cooled can be readily brought back to the bulk.

Agitation is necessary not only for heat exchange but also for mass transfer. In fact, the cooling of oil does not only happen at the cooling surface interface; it's also the result of colder oil getting mixed with the warmer bulk oil. Specifically for mass transfer, the agitation has to prevent the settling of the crystals being formed and distribute them homogeneously over the bulk, so that concentration gradients don't get too high either.

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: Say true or false

1. The agitation has to prevent the settling of the crystals being formed and distribute them homogeneously over the bulk…?(2pts)

Test I: Choose the best answer

1. **Which of the following are process parameters that need to be controlled in an oil processing plant? 4pts**

A) Temperature

B) Pressure

C) Flow rate

D) All

E)

2. **Which of the following is true about the manner of oil cooling? 4pts**

A. Selecting a fixed oil temperature (meanwhile allowing the cooling water temperature to vary between set limits)

B. Selecting a T, a fixed temperature difference between oil and cooling water

C. Selecting a fixed temperature for the cooling water

D. all

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 10 points**

Information Sheet 6- Checking and adjusting fractionation equipment performance

6.1 Checking and adjusting fractionation equipment performance

Over all Equipment Effectiveness (OEE) is defined as a measure of total equipment performance. That is, the degree to which the equipment is doing what it is supposed to do.

The big losses to be checked are given below with some examples:

a) Downtime losses

Breakdown losses categorized as time losses and quantity losses caused by equipment failure or breakdown**.**

For example, a breakdown of palletizing plant motor in a brewery leads to downtime and thus production loss.

- Set-up and adjustment losses occur when production is changing over from requirement of one item to another. In brewery plant, this type of loss is encountered during set-ups between different products, testing during start-ups and fine-tuning of machines and instruments.

b) Speed losses

- Idling and minor stoppage losses occur when production is interrupted by temporary malfunction or when machine is idling.

For example dirty photocells on palletizing machines cause minor stoppages. Though they are quickly fixed, much capacity is lost due to their frequency.

Reduced speed losses refer to the difference between equipment design speed and actual operating speed. In a palletizing plant, use of un-adapted pallets cause longer processing time for the same number of bottles leading to speed losses.

c) Quality Losses

Quality defects and rework are losses in quality caused by malfunctioning production equipment. For example, some pallet types get stuck in between de-palletizer and un-packer are damaged.

4.1.2 Adjusting equipment performance

- **Steps for adjusting equipment performance**

Steps 1 study current setup. To initiate the setup realization process, understanding the production floor is a must. Most of the production floor will have a number of duplicate machines or groups of machines, so the setting up activities of every machine will be similar. Therefore, selecting the most important machine among the groups of machines is advisable, rather than focusing individually on each machine.

Step- 2 categorizes setup. In Step 2, the activities of setup operations are separated according to the categories. The categories are used to identify the value-added (VA) activities, non-value-added but necessary (NVAN) activities, and non-value-added (NVA) activities responsible for performance in the setup operation.

Step- 3 evaluates the setup operation. Once the category of the setup operation is clearly identified, the information will be used to analyze the overall performance of the setup activities. The developed performance measurement, namely, OPE, originated from the concept of overall effectiveness equipment (OEE). OPE considers two measurement elements.

Step- 4 identifies improvement opportunities. In Step **4**, the improvement opportunity lies in the setup operation. It is carried out by investigating and analyzing the activities that have been categorized under (Step 3). From the opportunity determination, the cause of the occurrence will be brainstormed, and alternatives for setup improvement will be generated.

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. Over all Equipment Effectiveness (OEE) is defined as a measure of total equipment performance …?(2pts)
2. Quality defects and rework are losses in quality caused by malfunctioning production equipment (2pts)

Test II: Choose the best answer

1. Which of the following is one of the big losses of equipment performance…? (3pts)

A. Quality Losses
B. Speed losses
C. Downtime Losses
D. All

2. Which of the following is steps for adjusting equipment performance ?(3pts)

A. Identifies improvement opportunities
B. Study current setup.
C. Categorizes setup
D. Evaluates the setup operation

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

Note: **Satisfactory rating - ≥ 5 points** **Unsatisfactory - below 5 points**

Information Sheet 7- Carrying out pre-start checks fractionation equipment

7.1 Carrying out pre-start checks fractionation equipment

This is where you find out how prepared you really are. Adequate space, light and administrative assistance may not always be available, but establishing the resources that are available will help ensure a successful completion of the process.

- **Keys to pre-start checks including:-**

a) Mechanical:

All workers must have adequate PPE (Personal Protection Equipment). Generally, this includes, as a minimum, safety shoes, safety glasses, a hard hat, and work gloves.

b) Electrical:

Review the wire wiring specification with the electrical contractor to ensure it follows the provided cabling and conduit-run instructions. Make sure all power is “locked out/tagged out” while the electrical work is being done.

Think through which machines are fixed and which are movable. Do not apply power to the main panel or any other parts of the system until the appropriate technician is on-site and has inspected the installation.

c) Filling and checking fluids

Confirm that gear box in the system is filled with the correct grade of oil.

d) Safety checks

A safety team must evaluate the installation for potential hazards and confirm that issues that being addressed systematically by the site’s safety/health program. Categories concerns as they apply to the relevant regulations and suggest remedies as required. Categories may include:

- Walking and working surfaces

- Fire safety
- Hazardous-material storage/handling
- Confined-space entry (vessels and crawl spaces)
- Machine guards
- Lock out/tag out

e) Start-up phase

Before any production, a preliminary evaluation of the equipment is conducted.

f) Installation qualification:

The first thing the technician should do upon arriving on-site is to inspect the installation work.

- Visual inspection and identification of system components
- Verification of all utility connections
- Inspection of electrical devices and corresponding wirings
- Heat –zone check out
- Overview and demonstration of power-up procedure

g) Operational Qualification:

Training is the final step in starting up a new system. Once the system is working properly it's time to tackle operator training. Operator training is best handled independently after the system is up and running.

h) Review the startup procedure:

- The main disconnect
- Temperature settings and heat soak times
- Turn on downstream equipment
- Fill the feeders
- Start the main drive at low rate
- Start the feeders at low rate
- Ramp up extruder and feeders to appropriate rate
- Increase the pelletizer speed to match rates.

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. All workers must have adequate PPE (Personal Protection Equipment)…?(2pts)
2. Training is the final step in starting up a new system (2pts)

Test II: Choose the best answer

1. **Which of the following is one of Keys to pre-start checks…? (3pts)**

A) Mechanical C) safety checks

B) Electrical D) All

2. **Which of the following is first thing the technician should do upon arriving on-site…? (3pts)**

A) Visual inspection and identification of system components

B) Verification of all utility connections

C) Inspection of electrical devices and corresponding wirings

D) Heat –zone check out

E) All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 10 points**

Operation Sheet 1- Checking and adjusting fractionation equipment performance

Objective of adjusting equipment

- To initiate the setup realization process, understanding the production floor is a must
- From the opportunity determination, the cause of the occurrence will be brainstormed, and alternatives for setup improvement will be generated

Procedure of adjusting equipment performance

Step 1 Identifies improvement opportunities

Step 2 Study current setup

Step 3 Categorizes setup

Step 4 Evaluates the setup operation

Operation Sheet –2	Separation of stearin by using detergent

Objective

- Helps break up the surface tension between oil and water because it is amphiphilic: partly polar and partly nonpolar.
- As a result, detergents can bind to both water and **oil** molecules.

Procedure of separating oil and water by using detergent

Step1 Detergent as much as 0.2 grams then dissolve with 0.8 grams of water

Step2 Input into beaker glass then adds 100 grams of CPO (crude Palm Oil) to homogeneous stir.

Step3 Then place the CPO mixture into the water bath containing the pieces of ice

Step4 Mix the CPO mixture with a temperature of 10 °C for ± 2 hours until the crystal is formed.

Step5 After that heat up, to form 2 layers

Step6 Then put on for 15 minutes

Step7 After centrifying process will form 3 layers

Step8 After separated weigh each layer is done density identification test, to be known at which layer there is stearin.

Step9 After stearin is identified, wash with hot water then input into separating funnel

Step10 Remove the bottom layer

Step11 Recalculate the saponification number and do test density test and melting point.

Materials and equipment

- Glass Beaker
- Filtering Funnel
- Water Bath
- Weighing Balance
- RBD Oil

LAPTEST	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 Adjust Equipment Performance
Task-2 Use Detergent to separate stearin

LG #45	LO#2- Operate and monitor the fractionation process

Instruction sheet

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

- Starting and operating the process to achieve required outcomes
- Workplace policies and procedures.
- Monitoring operation of equipment to identify variation
- Identifying variation in equipment operation
- Reporting maintenance requirements.
- Monitoring the fractionation process to confirm that bleached oil meets color specifications.
- Monitoring the fractionation methods to confirm that fractionation product meets melting point specifications.
- Identifying, rectifying and/or reporting out-of-specification product/process outcomes.
- Maintaining the work area according to housekeeping standards.
- 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:

- Start and operating the process to achieve required outcomes
- Workplace policies and procedures.
- Monitor operation of equipment to identify variation
- Identify variation in equipment operation
- Report maintenance requirements.
- Monitor the fractionation process to confirm that bleached oil meets color specifications.
- Monitor the fractionation methods to confirm that fractionation product meets

melting point specifications.

- Identify, rectify and/or report out-of-specification product/process outcomes.
- Maintain the work area according to housekeeping standards.
- 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- Starting and operating the process to achieve required outcomes

1.1 Starting and operating the process to achieve required outcomes

Fractionation processes are processes of separation of mixtures of liquids, gases or solids into their components. Fractional separation is based on differences in a specific property of the individual components. Fractionation processes are physical processes, where phase transition is involved.

In edible **oil** processing, a **fractionation** process consists of a controlled cooling of the **oil**, thereby inducing a partial, or 'fractional', crystallization. The remaining liquid (olein) is then separated from the solid fraction (stearin) by means of a filtration or centrifugation.

The **palm oil fractionation** process is designed to separate **palm oil** into two fractions, Olein and Stearine without the addition of any chemical or solvent. **Fractionation** plants can be counted upon to produce stable and filterable crystals giving you a product that fits your standard and quality requirements.

Process

1. Heating the feed oil.
2. Formation of crystals by controlled cooling
3. Crystal growth.
4. Maturation of crystals.
5. Filtration to separate Olein and Stearine

The fact that oil is a mixture allows it to be considered as a heterogeneous system of at least two separable fractions – a solute and a solvent – at a given temperature.

There are three variables that can be used to consider whether a certain triglyceride will remain in the melt (behave like solvent) or crystallize (behave like solute):

- The absolute melting temperature of the triglyceride
- The concentration of the triglyceride and
- The bulk temperature.

Removing from palm oil by solvent fractionation one or more olein fractions to provide a first stearine fraction

1. Providing a melted mixture of acetone and palm oil in a weight ratio of from about 3:1 to about 7:1
2. Slowly cooling the melted mixture to crystallize out fat crystals;
3. Holding the cooled mixture at a temperature of from about -6° to about 7°C for about 0.5 to about 2 hours after step (b);
4. Separating the fat crystals from the cooled mixture after step (c);
5. Melting a mixture of acetone and the separated fat crystals in a weight ratio of from about 4:1 to about 7:1;
6. Slowly cooling the melted mixture of step (e) to crystallize out a second portion of fat crystals;
7. Holding the cooled mixture of step (f) at a temperature of from about 4° to about 7°C for about 0.5 to about 2 hours after step (f); and
8. Separating the second portion of fat crystals from the cooled mixture after step

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: Say true or false

1. In edible **oil** processing, a **fractionation** process consists of a controlled cooling of the **oil**, thereby inducing a partial, or 'fractional', crystallization?**2pts**

Test II: Choose the best answer

1. Which of the following is one of variables that can be used to consider whether a certain triglyceride will remain in the melt?**4pts**

A. The absolute melting temperature of the triglyceride

B. The concentration of the triglyceride and

C. The bulk temperature

D. All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 6 points**

Information Sheet 2- Workplace policies and procedures

2.1 Workplace policies and procedures

A workplace policy is a set of rules and principles that aims to guide managers and workers in how to behave in the **workplace**. You can have them in place for numerous different issues – bullying, harassment, internet use, health and safety, and social media are just a few

Policies set some parameters for decision-making but leave room for flexibility. They show the "why" behind an action. **Procedures**, on the other hand, explain the "how." They provide step-by-step instructions for specific routine tasks. They may even include a checklist or process steps to follow.

Having well-developed policies and procedures can provide the following benefits to your workplace:

1. They help employees know what is expected of them with respect to standards of behavior and performance.
2. They set rules and guidelines for decision-making in routine situations so that employees and managers do not need to continually ask senior managers what to do.
3. They help you to adopt a consistent and clear response across the company to continually refer to situations involving employee interaction.
4. They allow you to demonstrate good faith that employees will be treated fairly and equally.
5. They allow you to have an accepted method of dealing with complaints and misunderstandings in place to help avoid favoritism
6. They set a framework for delegation of decision-making
7. They give you a means of communicating information to new employees
8. They offer you protection from breaches of employment legislation, such as equal opportunity laws

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

1. Define workplace policy**?4pts**

Test II Choose the best answer

1. Which of the f0llowing is true about well-developed policies and procedures can provide the following benefits to your workplace?**4pts**

A. They help employees know what is expected of them with respect to standards of behavior and performance.
B. They set rules and guidelines for decision-making in routine situations so that employees and managers do not need to continually ask senior managers what to do.
C. They help you to adopt a consistent and clear response across the company to continually refer to situations involving employee interaction.
D. They allow you to demonstrate good faith that employees will be treated fairly and equally.

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 8 points**

Information Sheet 3- Monitoring operation of equipment to identify variation

1.1 Monitoring operation of equipment to identify variation

Monitoring equipment is the act of detecting the presence of signals, such as sound or visual signals, and the measurement there of with appropriate measuring instruments**.**

Advantage of equipment monitoring

a) Monitoring provides a wireless sensors solution that will allow you to:

- Monitor machines
- Motors and other equipment for run times
- Voltage fluctuations
- Monitor or mechanical failure
- Temperature issues, current usage over time and much more.

b) Monitor machines, motors and equipment for critical issues

- Ensure that equipment is functioning properly and catch critical issues before they costly repairs.

c) Save Time and Money

Automated system tracks sensor data for you and alerts you when there is an issue, so no more manual checking.

Figure14 set up of up monitoring machine

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: Say true or false

1. Monitoring equipment is the act of detecting the presence of signals, such as sound or visual signals, and the measurement there of with appropriate measuring instruments.…? (2pts)

Test II: Choose the best answer

1. **Which of the following is advantage of equipment monitoring? 4pts**
   A. Monitoring provides a wireless sensors solution that will allow you to:
   B. Monitor machines, motors and equipment for critical issues
   C. Save money and Time
   D. All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 6 points**

Information sheet 4	Identify variation in equipment operation

4.1 Identifying variation in equipment operation

4.1.2 Equipment Variation

Variation is the act or state of varying; a partial change in the form, position, state, or qualities of a thing

It measures one appraiser has when measuring the same part using the same gage more than one time. This variation is usually referred to as equipment variation (EV) in the gage.

Sources of variation in measurements

a) Subject Variation

Difference made on the same subject occasions may be due to several factors, including:

- Physiological changes
- Factors affecting response
- Changes because of awareness

b) Observation Variation

Variations in recording observations arise from several reasons including: Bias, errors, and lack of skills or training.

c) Technical Limitations

Technical equipment may give incorrect results for several reasons, including:

- The method is unreliable
- Faults in the test system
- Absence of an accurate test

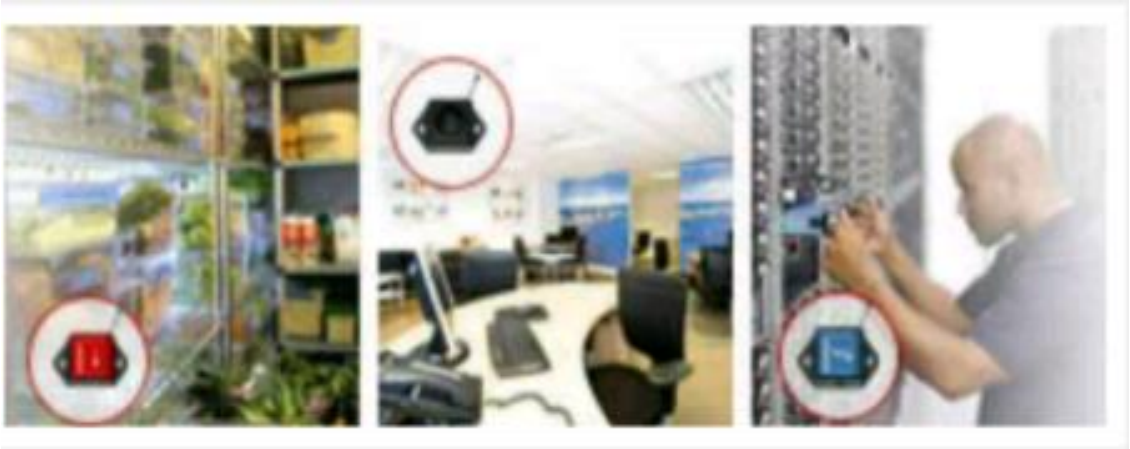

Figure15 Monitoring machines, motors and equipment

- **Variations when operating an Fractionation Equipment**

In order to prevent personal accidental injury:-

- ✓ Safety shields shall be installed on the transmission parts of all machines
- ✓ Safety doors shall be provided when the products are removed from the equipment
- ✓ The heating zone of the machine shall have safety and thermal insulation cover
- ✓ The crusher shall prevent the steel from falling in and prevent the operators hand is extended into the internal protection device
- ✓ Emergency brake buttons and alarms shall be installed at key parts of the equipment
- ✓ Hydraulic pressure tests shall be carried out regularly for all pressure vessels.

In the fractionation operation, if there is two or more operation, the division of labor must be clearly defined; when the equipment is unloaded, the power supply and air source should be cut off and the “maintenance” mark should be hung at the repair place.

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: Say True or False

1. Variation is the act or state of varying; a partial change in the form, position, state, or qualities of a thing**…?(2pts)**
2. The rotating action of the screw conveys the material to the transition section**?(2pts**)

Test I: Choose the best answer

1. **Which of the following is true about to prevent personal accidental injury? 3pts**
   A) Safety shields shall be installed on the transmission parts of all machines
   B) Safety doors shall be provided when the products are removed from the equipment
   C) The heating zone of the machine shall have safety and thermal insulation cover
   D) All

2. **Technical equipment may give incorrect results for several reasons**

A. The method is unreliable
B. Faults in the test system
C. Absence of an accurate test
D. All

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 10 points**

Information Sheet 5- Reporting maintenance requirements

5.1 Reporting maintenance requirements

Maintenance requirements are dependent on the size and type of mechanical equipment, transportation of equipment parts, as well as access requirements for tool and lifting clearances.

Maintenance requirements fall into the following categories.

1. Operational checks to simulate automatic start-up, shut-down and emergency shutdown.
2. Inspection and maintenance.

The resources required include labor, parts, materials, and tool costs. If **maintenance** is contracted, then all of these costs are often rolled into one by the contractor, although with some contracts, parts costs might be kept separate.

- **Activity Description**

1. Reporting Operation

Report when the actual work or inspection has been performed. When you report, you enter information about the operation. This information includes details about the time spent on the operation, materials used and inspection results.

The details about the programs used for these activities are described in the process document below this level.

2. Approving Work Order Operation

Approve work order operations when the operations have been reported. Operations may be automatically approved, as is the case for inspection operations. When an operation requires manual approval, the approval is likely to be done by a supervisor who makes sure that the work has been performed according to the original requirements.

Work order operations are approved in 'Work Schedule. Open Toolbox' (MOS195).

3. Closing Work Order Operation

Close the operations when they are reported and approved. It is possible to close an entire work order when all operations are closed. When you close an operation, you also make sure that there are no outstanding materials or purchases connected to the operation.

Work order operations are closed in 'WO Operation. Report' (MOS070).

4. Closing Work Order

Close the work order header when all operations contained within the work order are completed and closed. This step can be automated, allowing the work order header to be automatically closed when the last operation is closed.

- **How to make a maintenance report form?**

1. Plan what you want to place in the **form** first. ...
2. Include photographs. ...
3. Write things down. ...
4. Create a complete list of parts. ...
5. Create complete lists for experts, supplies, and tools. ...
6. Include diagrams and drawings.

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: Say true or false

1. Maintenance requirements are dependent on the size and type of mechanical equipment, transportation of equipment parts, as well as access requirements for tool and lifting clearances ….? (**3pts)**

Test II: Choose the best answer

1. **Which of the following are categories of Maintenance requirements?5pts**
   A. Operational checks to simulate automatic start-up
   B. Shut-down and emergency shutdown.
   C. Inspection and maintenance.
   D. All

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 8 points**

Information Sheet 6- Monitoring the fractionation process to confirm that bleached oil meets color specifications

6.1 Monitoring the fractionation process to confirm that bleached oil meets color specifications

6.1.1. Fractionation process

In edible **oil** processing, a **fractionation** process consists of a controlled cooling of the **oil**, thereby inducing a partial, or 'fractional', crystallization. The remaining liquid (olein) is then separated from the solid fraction (stearin) by means of a filtration or centrifugation.

a) Continuous fractional

Mainly in the final decade of the 20th century, the possibilities of continuous fat fractionation on anhydrous milk fat were studied, with results that resembled those obtained by traditional batch dry fractionation (Illingworth, 2002). Quite atypically for dry fractionation purposes, a scraped-surface heat exchanger (SSHE) can be used as a plug-flow reactor (PFR). In all such designs, however, a batch membrane press filtration is still recommended, in order to reduce the entrainment of olein within the stearin cake. Therefore it is more correct to define them as continuous crystallizations techniques rather than complete continuous fractionation systems. A vacuum belt filter or hyperbaric filters can be considered to meet this objective of total continuity of the process, although they yield less thorough phase separation compared to membrane press filters.

Continuous fractionation of palm oil is regarded as probably the most promising pathway for future dry fractionation. An important challenge in continuous fractionation is to avoid complete mixing while maintaining adequate heat and mass transfer in a low viscous suspension. In order to achieve this, contemporary batch crystallizers with the desired homogeneous mixing should be redesigned to function as PFRs, allowing minimal back-mixing and ensuring uniform residence time upon continuous product throughput. A good continuous fractional crystallizations technique has considerable advantages for plant operation: it can increase throughput, it will reduce inter batch variability, it can improve the homogeneity of the particle size distribution in the slurry leaving the crystallizer and it offers a

substantial energy saving. This economy exists because the long era crystallizer can run at a temperature, the more equivalent‘ batches’ it can produce without reheating or re cooling of the crystallizer’s steel and water.

b) Batch Fractionation

Batch Fractionation refers to the use of fractionation in batches, meaning that a mixture is fractionated to separate it into its component fractions before the Fractionation still is again charged with more mixture and the process is repeated

- **The oil can be cooled according to:**
  - ✓ Water profile: T water = f (T oil) i.e. (T water-temperature of water)
  - ✓ With Conventional Crystallizers
- **Fixed water cooling**
  - ✓ profile: T oil = f (T water) i.e. (T oil-Temperature of Oil)
  - ✓ High preferment Crystallizers

Color is one of the physicochemical properties that represents the level of oil refining, which can affect consumer choice at somewhat. Carotenoids and chlorophyll are the main color pigments in vegetable oils. Oxidation of these compounds or reaction of oxidized triglycerides with carotenoids could cause oil darkening.

Figure16 color pigments in vegetable oils

The lightness increased from 90.35–91.58 to 99.54–102.19, the redness decreased from 2.77– 5.48 to 2.46–4.93 and yellowness decreased from 126.49–133.93 to 6.95–18.25 in the whole refining process. However, the yellowness of oils of Huyou 4 (18.25) and Zhongshang

11 (15.69) after deodorization was higher than that of other 3 kinds oils (9.16–6.95). This could be attributed to the different varieties of seeds.

Bleaching is the most important step for removing color because of activated bleaching earth In current research, the color of all oils could be removed completely after deodorization, probably owing to degradation of highly unsaturated carotenoids during deodorization.

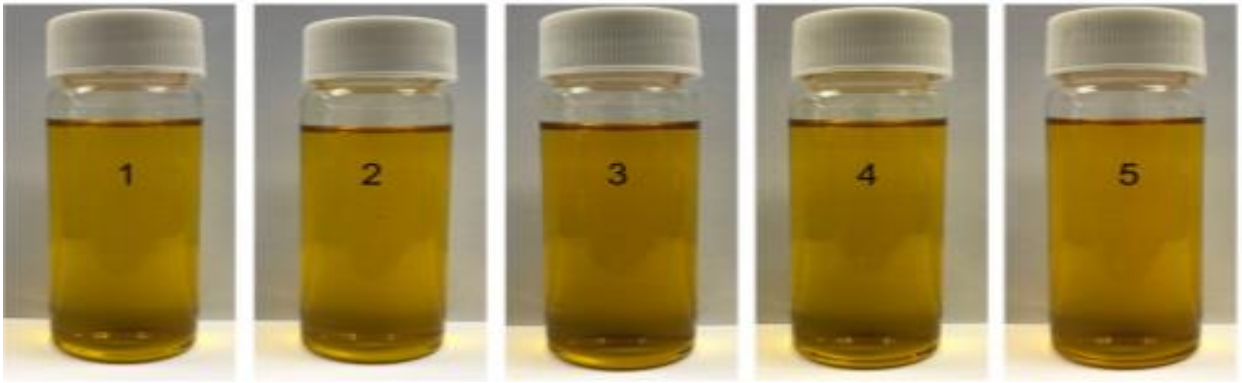

Figure17 color of oil Before Refining

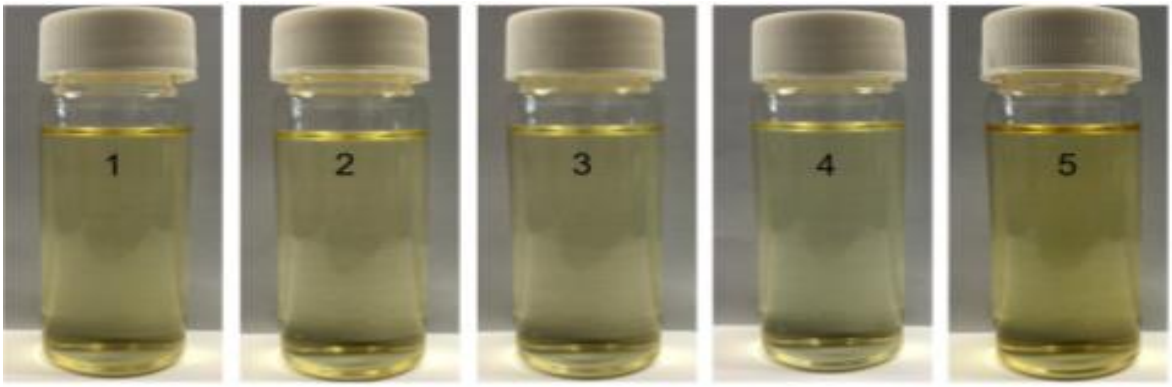

Figure18 Color of oil After Refining

Edible oil refining processes change from refinery to refinery, with lots of variations based on feedstock, scale of production, desired product and the exact methodology used by the plant. The key processes are shown below in a typical plant design, consisting of a degumming and neutralization step, washing and bleaching/de-odorizing.

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: Say true or false

1. **Fractionation** process consists of a controlled cooling of the **oil**, thereby inducing a partial, or 'fractional', crystallization.…? **(3pts)**
2. Color is one of the physicochemical properties that represents the level of oil refining, which can affect consumer choice at somewhat? **(3pts)**

Test I: choose the best answer

1. Which of the following is correct about refining process..? **(4pts)**

   A. The lightness increased from 90.35–91.58 to 99.54–102.19
   B. The redness decreased from 2.77– 5.48 to 2.46–4.93
   C. Yellowness decreased from 126.49–133.93 to 6.95–18.25
   D. All

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 10 points**

Information Sheet 7- Monitoring the fractionation methods to confirm that fractionation product meets melting point specifications.

7.1 Monitoring the fractionation methods to confirm that fractionation product meets melting point specifications.

7.1.1. Methods for Fractionation

There are three known methods for fractionating palm oil. They are:

1. Dry fractionation (slow cooling and rapid cooling),

2. Wet fractionation with detergent, and

3. Wet fractionation with solvent.

A) Dry fractionation

Dry fractionation is most commonly used in fractionation of palm oil. This is the simplest, least costly and very effective way of obtaining palm oil fractions of desired attributes.

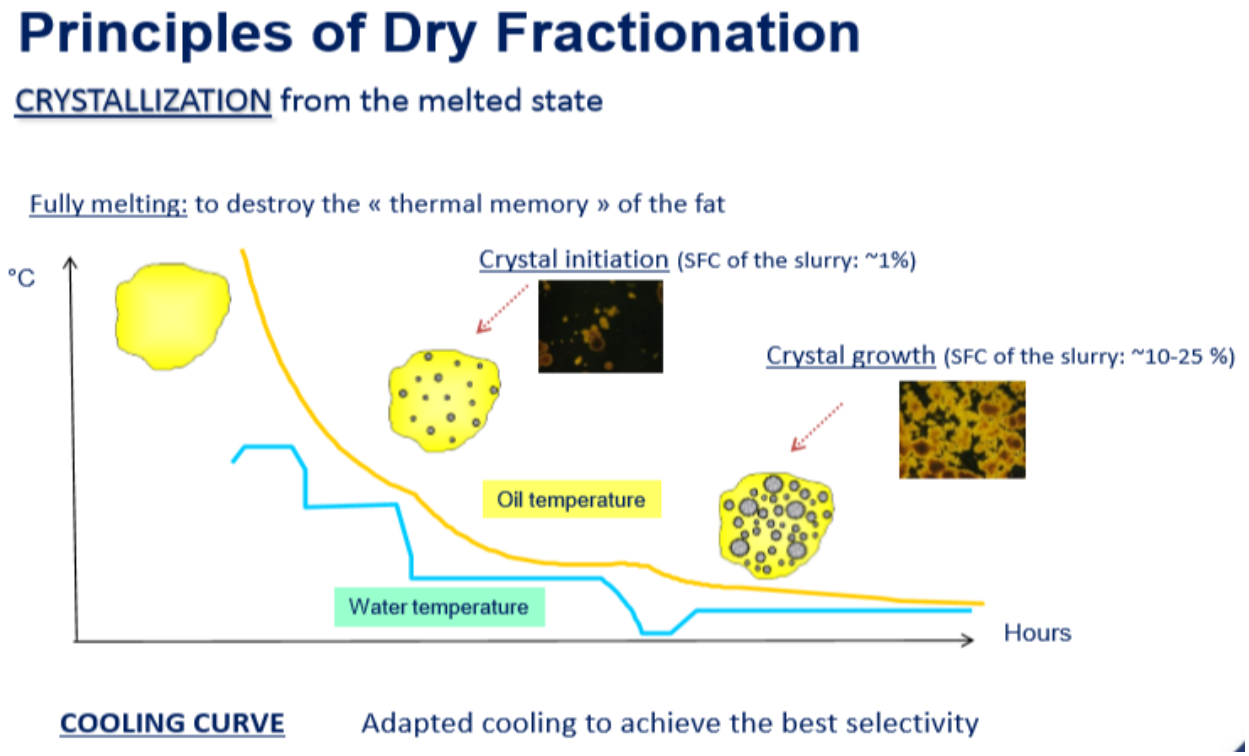

Figure19 Principles of dry Fractionation

There are fundamentally two steps involved in the dry fractionation process (1) crystallization of the solids and (2) separation of the solid and the liquid fractions.

The aim of dry fractionation is to separate high-melting triglycerides from low-melting triglycerides. This is achieved by cooling the oil to below the crystallizations temperature of the high-melting triglycerides. In a subsequent filtration, the crystallized triglycerides are removed from the non-crystallized triglycerides, creating the stearin and olein fractions, respectively.

In the dry fractionation process, the palm oil feed is heated to 155–165°F (68–73°C) to completely melt all solids in the oil. The oil is then cooled very slowly under controlled conditions to obtain the desired crystal structure for the solid fraction. The temperature is almost at the equilibrium condition, so there is little or no super cooling of the solids, and the crystals formed have the proper characteristics for filtration. The oil is filtered to separate the liquid fraction (olein) from the solid fraction (stearin).

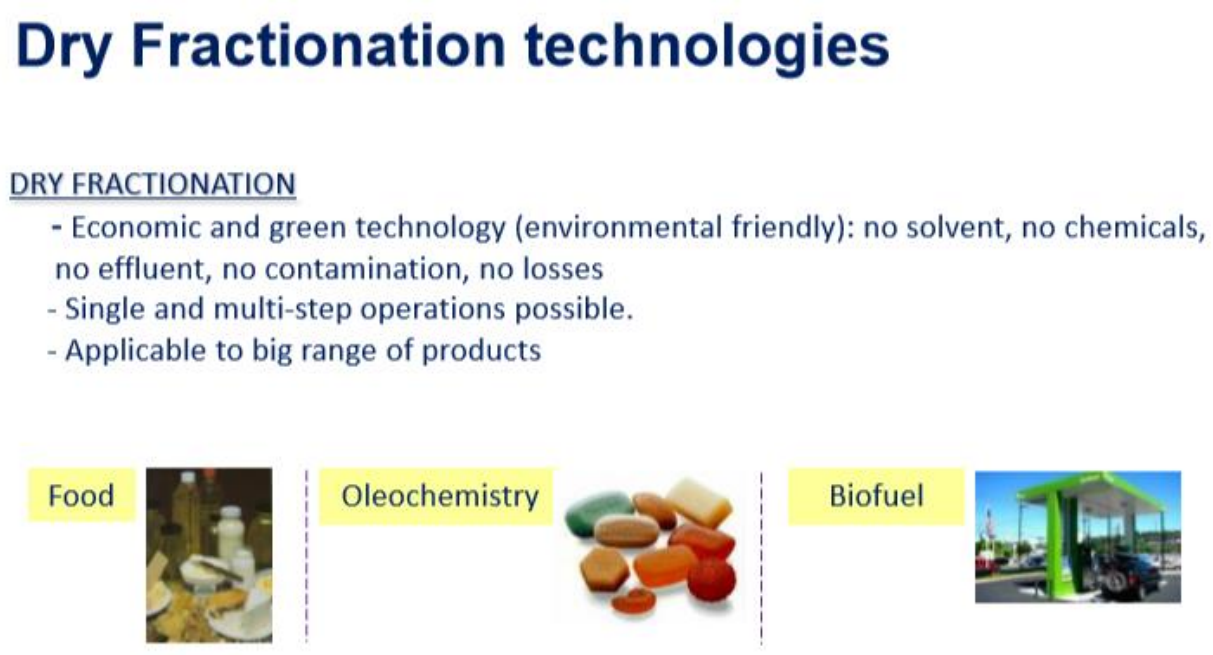

Figure20 Dry fractionation technologies

B) Wet fractionation with detergent (lanza process)

Detergent fractionation is carried out with only crude palm oil (CPO). The process involves cooling, crystallization, and separation of the crystals with the help of a detergent, sodium lauryl sulfate solution, and an electrolyte (magnesium sulfate or sodium sulfate) to aid the separation.

The chilled oil is mixed with a mixture of detergent and electrolyte that has been chilled to the same temperature as the oil. The detergent wets the stearin crystals and releases the olein occluded in the crystals. The crystals and the olein fraction are separated in a centrifuge. The olein fraction is washed to remove the detergent, dried and stored.

C) Solvent fractionation process

The solvent method is very similar to what was described for fractionation of partially hydrogenated soybean oil, except the solvent used in this process is acetone, while the solvent used in soybean oil fractionation is normal hexane. The typical ratio between solvent and the oil is 1:3 or 1:4. The oil and solvent mixture is chilled, the crystals are filtered, and the solvent is stripped and recovered from both fractions.

As in the case of soybean oil fractionation, the solvent process is not used in the palm oil industry because of the:

- High investment cost
- High operating cost
- The risk for explosion
- and loss of solvent.

The membrane press, combined with the multiple dry fractionation technique, has allowed the industry to improve both yield and quality of both olein and stearin fractions.

However, solvent fractionation is still very useful in making high value mid fractions of palm oil. This process is especially useful where the triglycerides containing long chain fatty acids

tend to become very viscous at the very low temperatures required for making certain products.

Solvent fractionation (acetone/hexane) - crystallization: continuous or batch - separation: mostly; vacuum belt filter

- ✓ Today used for specialty fats, ex. HPMF and Shea butter Still new installations are built/ serious lack of cocoa butter expected

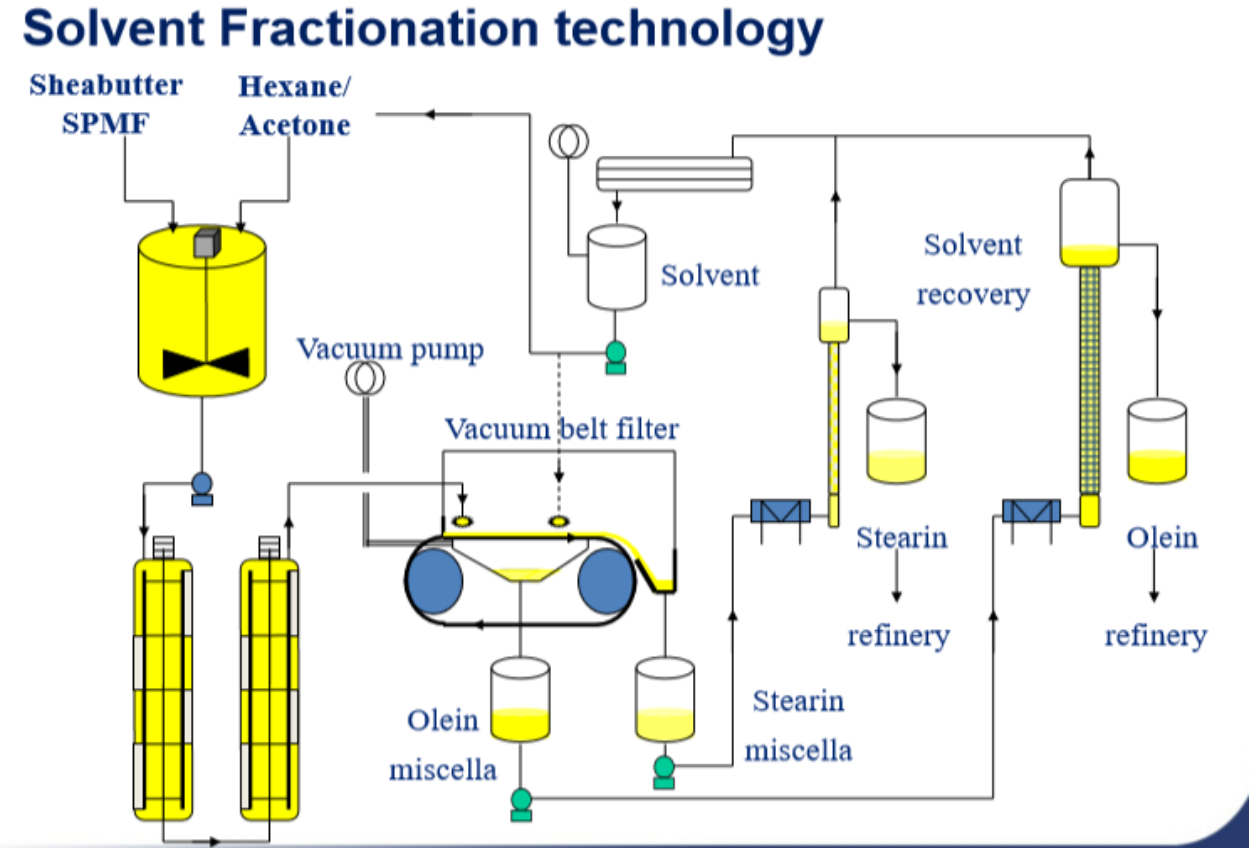

Figure21 Solvent fractionation (acetone/hexane)

- ✓ **Reason for Fractionate and using Solvent**

We all generally like the snap of chocolate, the creaminess of a biscuit filling, the pour ability of cooking oil and the texture of pastries. All these products depend on the melting or solid and liquid characteristics at the various temperatures of the oil or fat used in the particular product.

In naturally occurring edible oils and fats there are a range of fatty acids involved with the triglycerides. These fatty acids can be saturated, unsaturated, long-chain or short-chain and in themselves have different melting points. When these fatty acids are combined on the

glycerol backbone they introduce a range of melting points into the triglyceride molecules in the oil or fat. A good example of this is in palm oil where the major fatty acids are a saturated palmitic C16:0 (P) and oleic acid C18:1 (O) followed by lesser amounts of linoleic acid C18:2

Figure22 shows a typical indexing flat band filter.

- ✓ **Comparison between the Three Methods of Fractionation**

The three methods—dry, detergent, and the wet fractionation process—produce both olein and stearin fractions that are distinct from each other. Even the slow versus rapid chilling under dry fractionation produces distinct products. It must be recognized that these methods cannot be applied in a plant interchangeably.

Therefore, careful considerations must be given to the type of product to be made before a specific process can be chosen for the plant. Owing to the development made in the dry fractionation process, the newer installations mostly use the dry fractionation process. As mentioned earlier, the wet fractionation method is chosen only when very high value specialty products are to be made.

- **Method of measuring melting point**

Heat the sample in a water bath and measure the temperature at which the stearin begins to melt

✓ **Slip Melting Point (SMP)**

SMP were determined according to AOCS (method Cc. 3.25). Capillary tubes filled with 1 cm high column of fat were chilled at 10+1oC for 16 h before being immersed in a beaker of cold distilled water. The water bath was stirred and heated, and the temperature was recorded when the column of fat in the capillary tubes rose in the tube.

✓ **Mettler Cloud Point (CP)**

Cloud points were determined with the FP-90/FP81HT apparatus, supplied by Mettler Toledo. The procedure recommended by Mettler for edible oils and fats (cooling rate: -1oC/min, starting at approximately 10 oC above the suspected cloud point) was used.

✓ **Determination of Melting Behavior By DSc**

DSC analyses were carried out using a Q1000 DSC (TA Instruments, New Castle, USA) with a refrigerated cooling system (TA Instruments) using aluminum SFI pans. Calibration was made with indium and n-dodecane standards. Nitrogen was used as purge gas in order to prevent condensation in the cells. An empty aluminum SFI pan was used as reference. The samples were fast cooled to -80oC at cooling rate -25oC /min and kept for 1 min in order to ensure complete solidification.

✓ **Melting Behavior as Measured by Differential Scanning Calorimetry (DSC)**

The DSC melting curve of RBD-palm oil was presented at Figure 2. In spite of the compositional complexity of RBD palm oil, only two major peaks were displayed. The presence of two main groups of peaks in the thermo gram was evidence for illustrating the easy separation of olein and stearin during the dry fractionation process.

Note: a) VIDEO1 ..\1-10tpd palm oil fractionation plant, machine to separate palm olein and palm stearin(1).mp4 b) video2

.

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: say true or false

1. In the dry fractionation process, the palm oil feed is heated to 155–165°F (68–73°C) to completely melt all solids in the oil? **4pts**

Test II: Choose the best answer

1. **Which of the following are methods for fractionating palm oil**? **3pts**
   A. Dry fractionation (slow cooling and rapid cooling)
   B. Wet fractionation with detergent
   C. Wet fractionation with solvent
   D. All
2. **Which of the following is main reason for solvent process is not used in the palm oil industry ?3pts**
   A. High investment cost
   B. High operating cost
   C. The risk for explosion
   D. All

.

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 10 points**

Information Sheet 8- Identifying, rectifying and/or reporting out-of-specification product/process outcomes.

8.1 Identifying, rectifying and/or reporting out-of-specification product/process outcomes

8.1.1 out-of-specification outcomes in Fractionation process

a) Edible Oils Degradation

During the production, storage and processing of fruits or oilseeds, hydrolysis (chemical or enzymatic) and oxidation are the main pathways of lipid alteration. In addition, there is thermal weathering by heating at temperatures above 100 or even 180 °C with formation of polymers and cyclic compounds. All fatty substances undergo during their conservation or their use of oxidative alterations.

b) Edibles Oils Contaminants

Thus, food contaminants are substances of very varied nature that are present in the diet because of either a natural contamination by an organism (mycotoxins) or an anthropogenic contamination related to the production of food (pesticides), food modification processes (cooking and smoking with the example of polycyclic aromatic hydrocarbons) or transfer processes between the containers and the content

- **Feeding products**

Any product derived directly or indirectly from crude or recovered oils and fats by oleo chemical or biodiesel processing or distillation, chemical or physical refining, other than:

- ✓ refined oils
- ✓ products derived from refined oils
- ✓ feed additives; to be used in feed

- **Parameters to be analyzed**
  - ✓ Fatty Acid profile
  - ✓ Moisture and impurities
  - ✓ Free Fatty Acid
  - ✓ Melting point

8.1.2 Reporting product/processes outcomes.

When a quality defect is found and documented, the technician assumes the role of quality control, which is to report the defect.

- This function usually contains four parts:
  - ✓ Notification to others of the defect
  - ✓ Follow-up to make sure the defect does not occur again,
  - ✓ Documenting how the problem was fixed
  - ✓ Changing the processing specification as needed.

- Notification to others of any defect can be simple or complicated.
  - ✓ For instance, if the defect is just a matter of the slow speed of die, then a simple notification to the line operator will suffice (although if this is a constant occurrence, a different and elevated reporting procedure should be used).
  - ✓ On the other hand, if the defect is a microbiological problem that has reached the customer, then multiple parts of the company must be notified, including ownership and top management.

Who and how to notify are defect specific and care should be taken by the technician to notify those people with a need to know but to limit the open discussion of product defects as a means to protect the brand.

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: Choose the best answer

1. **Which of the following is edible oil out-of-specification outcomes 5pts**
   A. Edibles Oils Contaminants
   B. Edible Oils Degradation
   C. A & B
   D. All

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

Note: **Satisfactory rating – Answer all Unsatisfactory - below 5 points**

Information Sheet 9 - Maintaining the work area according to housekeeping standards

9.1 Maintaining the work area according to housekeeping standards

9.1.1 Housekeeping

Employees should be aware of hazards arising from poor housekeeping. Good housekeeping improves safety, efficiency and quality at the same time.

Plus bonus, it's easier to find things!

Good housekeeping is a day to day activity and should not be viewed as a separate task or something to do after the shift. Clean up time is all the time! You'll never know if the trap has been set.

- **Housekeeping Guidelines**
  - ✓ Keep work areas neat and clean.
  - ✓ Place tools, equipment and supplies in their correct places.
  - ✓ Keep stairways and other walkways free of debris, hoses and other obstructions. Put trash in approved containers.
  - ✓ Remove protruding objects such as nails, spikes, wire or other sharp points.•Keep workbenches and stations free from items that are not being used or worked on at present.
  - ✓ Place oily rags in the metal containers provided.
  - ✓ Paper cups, plates, and lunch debris, including trash must be thrown in the appropriate trashcans.
  - ✓ To avoid skin irritations, wash frequently, using soap and water. Wear gloves when handling substances that may cause irritation.
  - ✓ Cigarette butts belong in containers provided.
- Mess can cause slips, trips and falls. Avoid injuries by:
  - ✓ Keeping work areas, walkways and other paths clear and clean
  - ✓ Clearly marking walkways and no-go areas

✓ Preventing spills, which can cause slips

9.1.2 Maintaining the work area

Work area is the place where a person or people work.

- **The elements of an effective maintaining the work area program are:**

a) Dust and Dirt Removal

In some jobs, enclosures and exhaust ventilation systems may fail to collect dust, dirt and chips adequately. Vacuum cleaners are suitable for removing light dust and dirt. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt may accumulate.

Compressed air should not be used for removing dust, dirt or chips from equipment or work surfaces.

b) Employee Facilities

Employee facilities need to be adequate, clean and well maintained. Lockers are necessary for storing employees' personal belongings. Washroom facilities require cleaning once or more each shift. They also need to have a good supply of soap, towels plus disinfectants, if needed.

c) Surfaces

Floors: Poor floor conditions are a leading cause of accidents so cleaning up spilled oil and other liquids at once is important. Allowing chips, shavings and dust to accumulate can also cause accidents. Trapping chips, shavings and dust before they reach the floor or cleaning them up regularly can prevent their accumulation. Areas that cannot be cleaned continuously, such as entrance ways, should have anti-slip flooring. Keeping floors in good order also means replacing any worn, ripped, or damaged flooring that poses a tripping hazard.

Walls: Light-colored walls reflect light while dirty or dark-colored walls absorb light. Contrasting colors warn of physical hazards and mark obstructions such as pillars. Paint can highlight railings, guards and other safety equipment, but should never be used as a substitute for guarding. The program should outline the regulations and standards for colors.

d) Maintain Light Fixtures

Dirty light fixtures reduce essential light levels. Clean light fixtures can improve lighting efficiency significantly.

e) Aisles and Stairways

Aisles should be wide enough to accommodate people and vehicles comfortably and safely. Aisle space allows for the movement of people, products and materials. Warning signs and mirrors can improve sight-lines in blind corners. Arranging aisles properly encourages people to use them so that they do not take shortcuts through hazardous areas.

f) Spill Control

The best way to control spills is to stop them before they happen. Regularly cleaning and maintaining machines and equipment is one way. Another is to use drip pans and guards where possible spills might occur. When spills do occur, it is important to clean them up immediately. Absorbent materials are useful for wiping up greasy, oily or other liquid spills. Used absorbents must be disposed of properly and safely.

g) Tools and Equipment

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide orderly arrangement, both in the tool room and near the work bench.

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: Say true or false

1. Good housekeeping is a day to day activity and should not be viewed as a separate task or something to do after the shift ?**3pts**
2. Poor floor conditions are a leading cause of accidents so cleaning up spilled oil and other liquids at once is important? **3pts**

Test I: Choose the best Answer

1. **Which of the following is Housekeeping Guidelines? 4pts**

A. Keep work areas neat and clean.

B. Place tools, equipment and supplies in their correct places.

C. Keep stairways and other walkways free of debris, hoses and other obstructions.

D. All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 10 points**

Information Sheet 10- Maintaining Workplace records

10.1 Maintaining Workplace records.

Documentation requirements procedure for control of documents

To ensure controlled and consistent preparation, dissemination and retrieval of documents relating to the Organization's Food Safety Management System (FSMS).

10.1.1 Kinds of documents

- **Food Safety Management System manual** - This manual is the primary document which defines the authority's definition on requirements of FSMS to be implemented by an organization.
- **Standard operating Procedures (SOP)** - It is a procedure specific to policies and standards needed in the operation. Forms and Formats- They are a kind of documents needed to record the implementation of a standard operating procedure.
- **Work Instructions (WI)** – It is a step by step process in which the instructions for performing any procedure are directed.
- **Specifications Manual-** It specifies the conditions of a system such as temperature, humidity, hygiene etc. and standards for individual food commodity like finish products i.e. oil, raw materials, ingredients etc.
- **Testing Manual** – A manual which contains testing method or procedure to perform the test such as free fatty acid & Vitamin A detection in fortified oil.

Note: A unified numbering system is followed for the entire documented FSMS. Document Preparation and Identification Documents except the System Manual; originate from their respective functional heads. The documents are prepared on a prescribed format by those who perform the activities. Thus, the ownership of the document rests with the concerned functional heads

- The key elements of any document are
  - ✓ Document name
  - ✓ Document number
  - ✓ Revision number

- **Purpose records**
  - ✓ To provide evidence of conformity to requirements.
  - ✓ Evidence of the effective operation of the food safety management system.
  - ✓ Ensure proper identification, up gradation, storage, protection, retrieval, retention time and disposition of records.

- **Procedure for managing records**

a) Identification

Records shall be maintained to demonstrate effective operation of the activities. All records /formats are identified and a master list of records is prepared.

While master list of all records/formats is maintained by FSTL, concerned records are maintained in the sections.

b) Storage

Records are stored in appropriate locations. They are segregated and placed on identified places. Electronic copies of records, if maintained are backed up regularly.

While current records remain in the section, old records are centrally maintained with due identification for easy retrieval when needed.

c) Protection

The records are preserved in such a way that they are readily accessible and do not get damaged. They are protected from insect pest damage, dampness and seepage. Record room is inspected to check that they are not damaged.

d) Retrieval

Records are identified, indexed and stored in such a way that they are easily retrieved when needed.

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: Say true or false

1. Standard operating Procedures (SOP) is a procedure specific to policies and standards needed in the operation …? **(2pts)**
2. Records shall be maintained to demonstrate effective operation of the activities..? **(2pts)**

Test I: Choose the best answer

1. **One of the following is key elements of any document?4pts**
   - **A.** Document name
   - **B.** Document number
   - **C.** Revision number
   - **D.** All

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 8 points**

Operation Sheet 1	Separating stearin by solvent Fractionation

Procedure for removing stearin fraction from palm oil by solvent fractionation

Step 1 Providing a melted mixture of acetone and palm oil in a weight ratio of from about 3:1 to about 7:1;

Step 2 Slowly cooling the melted mixture to crystallize out fat crystals;

Step 3 Holding the cooled mixture at a temperature of from about -6° to about 7°C for about 0.5 to about 2 hours after step (b);

Step 4 Separating the fat crystals from the cooled mixture after step (c);

Step 5 Melting a mixture of acetone and the separated fat crystals in a weight ratio of from about 4:1 to about 7:1;

Step 6 Slowly cooling the melted mixture of step (e) to crystallize out a second portion of fat crystals;

Step 7 Holding the cooled mixture of step (f) at a temperature of from about 4° to about 7°C for about 0.5 to about 2 hours after step (f); and

Step 8 Separating the second portion of fat crystals from the cooled mixture after step

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 Remove stearin fraction from palm oil by solvent fractionation

LG #46	LO #3- Shut down the fractionation process

Instruction sheet

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

- Identifying the appropriate shutdown procedure.
- Shut down the fractionation process
- Identifying and reporting maintenance 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**:

- Identifying the appropriate shutdown procedure.
- Shut down the fractionation process
- Identifying and reporting 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 the appropriate shutdown procedure

3.1 Identifying the appropriate shutdown procedure

- **Seven steps for a successful shutdown**

Step 1: A comprehensive list

A checklist with every piece of equipment involved in the outage should be available for review. Every stakeholder should examine this list to ensure nothing is missing.

This checklist should be periodically updated to add equipment installed since the last shutdown. It should also note:

- Equipment difficult to take offline in the past
- Bad actor assets since the last outage
- Special equipment such as cranes or generators needed to complete the required work.

This information should be included in the job plan for each equipment type.

Step 2: Have it in inventory

Ensure that all replacement parts, accessories and rebuilt equipment are in stock before the shutdown. The last thing any team needs is to have staff on hand to conduct maintenance, replacements and new installations only to be held up waiting for rebuilt equipment to return from a shop.

Step 3: Safety first

Safety should be the top priority during any outage. Before beginning work, all lock out/tag out (LOTO) procedures should be followed and personnel must wear all required personal protective equipment (PPE)

Step 4: Within current specifications

Double check that all equipment (new and rebuilt) is within current operating parameter specifications. When assets were specified, they met the requirements of the process at that time. Condition changes, such as fluid temperature, flow requirement or process fluid pH must be considered. Different parts or different equipment may need to be used.

.

Step 5: Inspect before installation

Personnel should inspect all equipment before anything is installed; look for wear or damage. Installing new components into a worn piece of equipment is almost always counterproductive. Demise of the new components begins immediately. Examples of this include:

- Packing installed in a pump with a worn shaft or sleeve or a damaged stuffing box wall will immediately begin to wear.
- With extreme damage, successful installation may not be possible.
- Installing a new mechanical seal into a system with a failing bearing or bearing isolator means the mechanical seal's life will be shortened.
- Installing a new impeller on a worn shaft or with improper clearances because of casing wear or damage will result in poor operation and incorrect flow.

Step 6: Precise installation

While this step seems obvious, improper installation happens all the time. Reliability begins with the asset selection and correct installation. If installed imprecisely, failure begins at startup.

Properly following job plans help prevent premature failure because of installation problems. An example of ways to properly install components is to use tools to install compression packing. Using tools and carefully following the correct job plan steps every time results in precise installation and provides the longest life for each component or asset

Step 7: Inspection before restart

The plant team should give everything one more look before restarting the plant or process. Even when every step is taken and every job plan is followed, stuff happens. A motor is bumped during work on another piece of equipment, causing misalignment. Housekeeping staff accidentally hits a piece of equipment. A wrench left on an asset may have fallen.

Figure Ensuring that all steps on a job plan are carried out, safety/PPE equipment is worn and LOTO procedures are followed is essential during a shutdown

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: Short Answer

1. Write down the steps to identify successful shutdown?**4pts**

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

Note: **Satisfactory rating – Answer all** **Unsatisfactory - below 4 points**

Information Sheet 2- Shut down the fractionation process

2.1 Shut down the process

Shutting down process is the act of closing a factory or business or stopping a machine/Equipment either temporarily or permanently.

According to manufactures or operational procedures and specification, workers should apply:

- Make sure power tools are properly grounded or are double insulated
- Switch off and unplug power tools before changing blades or servicing and repairing
- Wear appropriate personal protective equipment (PPE), such as glasses, goggles, dust masks, face shields, hearing protection, etc.
- Keep bystanders at a safe distance
- Keep all guards and shields in place
- Unplug and store tools after use
- Consider keeping power tools locked up to prevent unauthorized use
- Cleaning and other activities by turning off the equipment by unplugging a power or by pressing emergency button.
- In addition, after any cleaning and maintenance activity, equipment has to be put on and checked its functionality and if any deviations against SOPs.

Procedure fractionation process

Step 1 Make sure power tools are properly grounded or are double insulated

Step 2 Switch off and unplug power tools before servicing and repairing

Step 3 Wear appropriate personal protective equipment (PPE), such as glasses, goggles, dust masks, face shields, hearing protection, etc.

Step 4 Keep bystanders at a safe distance

Step 5 Keep all guards and shields in place

Step6 Unplug and store tools after use

Step 7 Consider keeping power tools locked up to prevent unauthorized use

Step 8 Cleaning and other activities by turning off the equipment by unplugging a power or by pressing emergency button.

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

1. **List down the appropriate Extrusion shutdown process…(10)pts.**

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

Note: **Satisfactory rating - ≥ 5 points** **Unsatisfactory - below 5 points**

Information Sheet 3- Identifying and reporting maintenance requirements

3.1 Identifying and reporting maintenance requirements

- **Reporting Operation**

Report when the actual work or inspection has been performed. When you report, you enter information about the operation. This information includes details about the time spent on the operation, materials used and inspection results.

The details about the programs used for these activities are described in the process document below this level.

- **Steps to make a maintenance report form**

Steps1 Plan what you want to place in the form first.

Steps2 Include photographs

Steps3 Write things down.

Steps4 Create a complete list of parts.

Steps5 Create complete lists for experts, supplies, and tools.

Steps6 Include diagrams and drawings.

1.

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: short answer

1. Write the Steps to make a maintenance report ?**8pts**

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

Note: **Satisfactory rating - ≥ 5 points** **Unsatisfactory - below 8 points**

Operation sheet 1– Fractionation shutdown procedure

Procedure

Step1 Make sure power tools are properly grounded or are double insulated

Step2 Switch off and unplug power tools before servicing and repairing

Step3 Wear appropriate personal protective equipment (PPE), such as glasses, goggles, dust masks, face shields, hearing protection, etc.

Step4 Keep bystanders at a safe distance

Step5 Keep all guards and shields in place

Step6 Unplug and store tools after use

Step7 Consider keeping power tools locked up to prevent unauthorized use

Step8 Cleaning and other activities by turning off the equipment by unplugging a power or by pressing emergency button

Operation sheet-2	Techniques to make a maintenance report form

Procedure

Steps1 Plan what you want to place in the form first.

Steps2 Include photographs

Steps3 Write things down.

Steps4 Create a complete list of parts.

Steps5 Create complete lists for experts, supplies, and tools.

Steps6 Include diagrams and drawings.

Lap Test	Demonstration

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.

During your work: You can ask all the necessary tools and equipment
Lap Test Title: Produce Tool Shanks for Milling Machines

Task 1 Shutdown a Fractionation process
Task 2 Make maintenance report form

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TNX'S!!!