Oil Seed and Pulse Processing

Level II

Based on October 2019, Occupational standards (OS) Version 2

Module Title: Operating Solvent Extraction Process

LG Code: IND OSP2 M14 LO (1-3) LG (44 – 46)

TTLM Code: IND OSP2 TTLM 1020v1

October 2020

United Nations
Educational, Scientific and
Cultural Organization

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LG # 44	LO #1- Prepare solvent extraction 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, preparing and blending materials
- Identifying and following workplace documentation
- Confirming addition of ingredients and services
- Requiring equipment facilities, and storage
- Occupational Health and Safety (OHS)
- Carrying out line clearance procedures
- Following policies and procedures to control cross contamination
- Carrying out pre-start checks

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, prepare and blend materials
- Identify and follow workplace documentation
- Confirm addition of ingredients and services
- Require equipment facilities, and storage
- Occupational Health and Safety (OHS)
- Carry out line clearance procedures
- Follow policies and procedures to control cross contamination
- Carry 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

Information Sheet 1 - Confirming, preparing and blending materials

1.1 Introduction

This module covers the skills and knowledge required to operate, adjust and shut down processes used to extract crude oil from oil seeds using solvent extraction methods. Oilseed solvent extraction is a process of solid-liquid extraction, by means of non-polar solvents. Solvent extraction process is widely applied in oil extracting for low oil content materials and pre-pressed oil cakes of high oil content materials. Solvent extraction plant is featured of high yield of oil recovery.

Solvent extraction is the preferred method for the final separation of oil from oleaginous materials containing less than 30% oil by weight. The oil content in the spent solids can be reduced to approximately 1% by weight, making maximization of oil yield the primary economic driver for the solvent extraction process. Solvent extraction can be employed for a variety of oleaginous materials. For oleaginous materials with less than 30% oil by weight, such as soybeans, cottonseed, dry process corn germ and rice bran, the material is mechanically and thermally prepared and then sent to the solvent extraction process for oil separation. The solvent extraction process dates back to 1855, when Deiss of Marseilles, France was the first to employ it, using carbon disulfide to dissolve olive oil retained in spent olive cakes (Kirschenbauer, 1944). This technology utilised batch solvent extraction, wherein the material was held in a common kettle for both the extraction process and the subsequent meal desolventising process. Deiss obtained a patent for batch solvent extraction of olive oil in 1856 (Kirschenbauer, 1944). In the early 1920s, with the availability of petroleum-based solvents, the German inventor Hildebrandt created the continuous countercurrent immersion extractor and the German inventor Bollman created the continuous two-stage percolation extractor. The first commercial-scale continuous solvent extraction plants were installed in Germany in the late 1920s, with the Hansa-Muhle facility in Hamburg, using Hildebrandt extractors, being the largest (Wan & Wakelyn, 1997).

1.2 Confirming, preparing and blending materials

There are different raw materials to be blended in oil processing industry.

During oil processing, we have different blending possibilities. The raw materials for blending process include:

- Conditioned seed and cake of Niger seed
- Conditioned seed and cake of Rape seed
- Conditioned seed and cake of Lin seed
- Conditioned seed and cake of Cotton seed
- Conditioned seed and cake of Ground nut
- Conditioned seed and cake of Soya bean
- Conditioned seed and cake of sunflower seed
- Conditioned seed and cake of sesame seed.

1.3 Preparing materials

The first step of the process, common to all technologies, is the preparation of raw material. The main unit operations used are shown in Figure 1: scaling, cleaning, dehulling (or decorticating), cracking, drying, conditioning (or cooking), and flaking (Anderson, 2005). Although cooking operation is not included in the flowchart, it is a very important step in the processing of oilseeds. The flowchart below may be altered depending on raw material to be processed. Initially the oilseeds are weighed and sent to the cleaning step. A good quality oilseed has around 2% of impurities when it comes from the field. These foreign materials are removed when the oilseeds reach the storage unit and also before starting the extraction of oil. Some examples of foreign materials are a combination of weed seeds, sticks, pods, dust, soil, sand, stones, and tramp metal. Tramp metal is considered hazardous to storage facilities and also for the oil processing operations, so it is the first impurity to be removed, using a magnetic force that pulls these metals from the mass of grain. Sticks and pods are larger and lighter than the oilseeds and can easily be removed by airflow equipment. Weed seeds, sand, and soil are smaller than the oleaginous materials, so those materials can be removed by screening equipment. In the case of peanuts, there are large amounts

of stones in grains, and these foreign materials have similar geometry, being necessary to use a gravity separation system to remove impurities (Kemper, 2005). Due to the high oil content in its composition, oilseeds must have a low moisture content in order to prevent deterioration during storage and also to ensure that downstream unit operations are efficient. This operation is conducted in a dryer (Kemper, 2005). The main goal of size reduction operation is to increase surface area to facilitate oil removal from the seed inside. This operation must be conducted at proper moisture content. If the moisture level is too low, the seeds are “conditioned” with water or steam to raise the moisture to about 11%. Another unit operation is dehulling because some oilseeds present outer seed coat known as hull, rich in fiber and poor in oil and protein. The removal of these hulls will produce a better cake with high protein content by weight (Kemper, 2005). Another problem observed with hulled seeds is that the hull will reduce the total yield of oil by absorbing and retaining oil in the cake (Wakelyn & Wan, 2006). Dehulling process removes the lighter hull fraction by aspiration and also the fines, separated from the hulls through various means of hull agitation and screening. A dehulling process can be considered effective if the levels of residual fiber content (from hulls) and residual oil content in the meal fraction were low (Kemper, 2005).

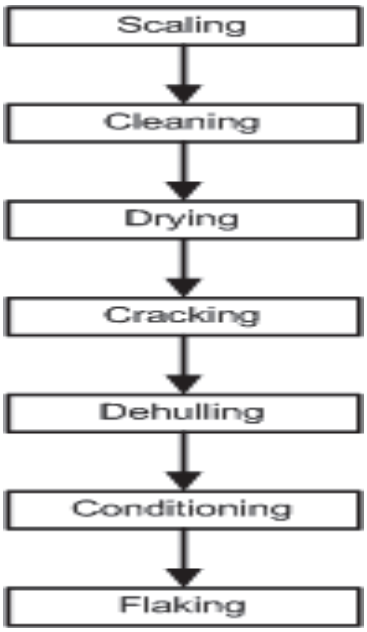

Fig. 1. Unit operations for raw materials preparation (adapted from Anderson, 2005).

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write raw materials needed for blending in oil processing (5pts)
2. Explain when did oil extraction process started (5pts)
3. Draw unit operations for raw materials preparation(10pts)

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

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

Information Sheet 2- Identifying and following workplace documentation

2.1 Identifying and following workplace documentation

May include but not limited to:

- Specifications
- manufacturing formulae
- processing instructions
- continuous production records
- Standard Operating Procedures (SOPs)
- OHS information, including Material Safety Data Sheets (MSDS)

2.1.1 Specification

A specification is exact statement of the particular need to be satisfied, or essential characteristics that customer requires (in a good, material, methods, process, service, or work).

2.1.2 Standard Operating Procedures (SOP)

SOP is a process document that describes in detail the way that an operator should perform a given operation. SOPs involve the purpose of the operation, the equipment and materials required, how to perform the set-up and operations required for the process, how to perform the maintenance and shutdown operations carried out by the worker, a description of safety issues, trouble-shooting, a list of spare parts and where to find them, illustrations, and checklists. In addition, SOPs are frequently used as checklists by inspectors when auditing procedures. Ultimately, the benefits of a valid SOP are reduced work effort, along with improved comparability, credibility, and legal defensibility.

2.1.3 Materials Safety Data Sheets (MSDS)

A material safety data sheet is a technical document which provides detailed and comprehensive information on a controlled product related to:

- Health effects of exposure to the product
- Hazard evaluation related to the product's handling, storage or use
- Measure to protect workers at risk of exposure
- Emergency procedures.

The data sheet may be written, printed or otherwise expressed, and must meet the availability, design and content requirements of WHMIS legislation. The legislation provides for flexibility of design and wording but requires that a minimum number of categories of information be completed and that all hazardous ingredients meeting certain criteria be listed subject to exemptions granted under the Hazardous Materials Information Review Act.

Self-Check 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write and explain what SOP mean in detail (4pts)
2. Define specification (4pts)
3. Define MSDS (2pts)

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

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

Information Sheet 3 - Confirming addition of ingredients and services

3.1 Confirming addition of ingredients and services

In oil seed processing there are different ingredients added to in oil which provides different functions to the oils. During addition of these ingredients you have to confirm that all the ingredients meet the specified condition, quality, and availability. Different ingredients that used in oil processing include:

- Water
- Salt
- white sugar
- Aerated sugar
- Emulsifier
- Flavors /citric acid

3.1.1 Emulsifier

An emulsifier acts in the following ways

- It adsorbs at the interface between two immiscible liquids such as oil and water.
- It reduces the interfacial tension between two liquids, enabling one liquid to spread more easily around the other.
- It forms a stable, coherent, viscoelastic interfacial film, which prevents or delays coalescence of the dispersed emulsion droplets.

Molecules that can act as emulsifiers contain both a polar, hydrophilic (water loving) section, which is attracted to water, and a hydrophobic (or water-hating) section, which is attracted to hydrophobic solvents such as oil. Good emulsifiers are able to interact at the interface to form a coherent film that does not break easily. The best emulsifiers are proteins, such as egg yolk (lipoproteins) or milk proteins, because they are able to interact at the interface to form stable films, and hence to form stable emulsions. However, many other types of molecules are used as emulsifiers. In some cases, finely divided powders such as dry mustard or spices are used to act as emulsifiers in oil-in-water mixture. The mustard and spices adsorb at the interface and reduce interfacial tension.

A temporary emulsion separates upon standing. The emulsion is not permanent because the hydrophobic oil and hydrophilic water components separate upon standing. A permanent emulsion is formed when two ordinarily non miscible phases, such as water and oil, are combined with an emulsifier.

Thus, the time of separation of oil and water is dependent upon the effectiveness of an emulsifier and the degree of agitation.

Factors Affecting Emulsion Stability

- Type of emulsifier
- Concentration of emulsifier
- Droplet size
- Changing pH or ionic strength
- Viscosity
- Addition of stabilizers
- Heating, cooling, freezing, and/or shaking

3.1.2 Citric acid

Citric or lemon juice may be used to increase foam stability. Addition of acid reduces the pH, which reduces the charge on the protein molecules and usually brings them closer to their isoelectric point. This generally results in a stronger, more stable interfacial film

Foams make a vital contribution to the volume and texture of many common food products. They give volume and a distinctive mouth feel to products such as whipped cream and ice cream and they give a light, airy texture to baked goods.

3.1.3 Sugar and salts

Sugar and salts acts as preservative which improve shelf life of an oils.

3.1.4Water

Water facilities the extraction of oil from oil seeds. It makes some fatty compounds soluble.

Self-Check # 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List some ingredients which are added in oil processing (5pts)
2. Explain some ingredients that used in oil seed processing process (6pts)

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

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

Information Sheet 4 - Requiring equipment facilities, and storage

4.1 Requiring equipment facilities, and storage

In an industry different machines, equipments and facilities are required to perform different activities in order to produce products. Equipment which are used for oil extraction and storage may include:

- Magnetic separator
- Cake breaker
- Percolators or extractor
- Circulation pumps
- Extraction vessel, desolventizer and Toaster
- Condenser
- Distillation apparatus
- Exchangers
- Conveyors(belt, chain)
- Hydro cyclone
- Hexane water separator
- Working tank
- Hexane storage tank

4.2. Oil Extraction equipment and their uses

4.2.1. Percolators or Extractor: Includes batch extractor (oil extractor) and continuous extractor (rotary extractor, loop type extractor, crawler type extractor). It is used to extract oils from different oil seeds.

Fig.2. Rotary Extractor

4.2.2 Magnetic separator

Magnetic separator are used to separate magnetic materials in the oil seed

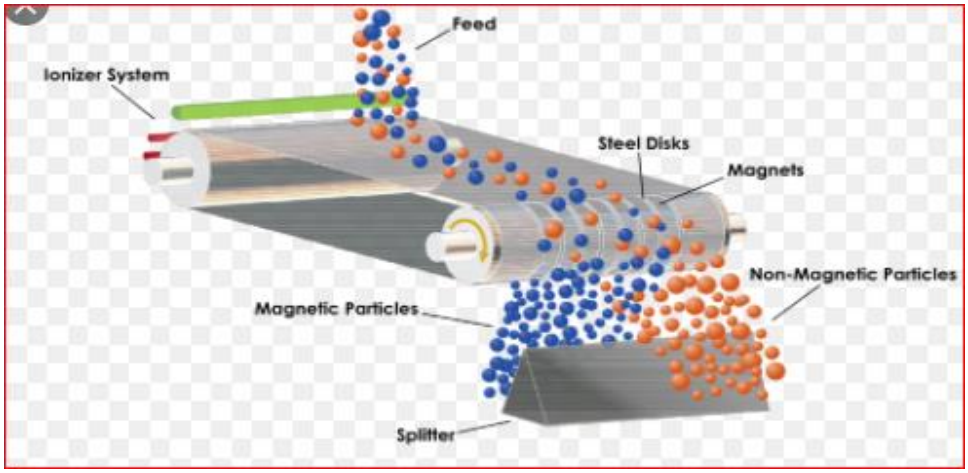

Fig.3. Magnetic separator

4.2.3 Desolventizer: Separating solvent from wet meal.

Fig.4. Desolventizer

4.2.4 Evaporator: Separating the solvent from miscella by evaporating the solvent or water.

Fig.5. Evaporator

4.2.5 Condenser: condersers are used to condense or cool the heated oils which passes through heater or heat exchangers.

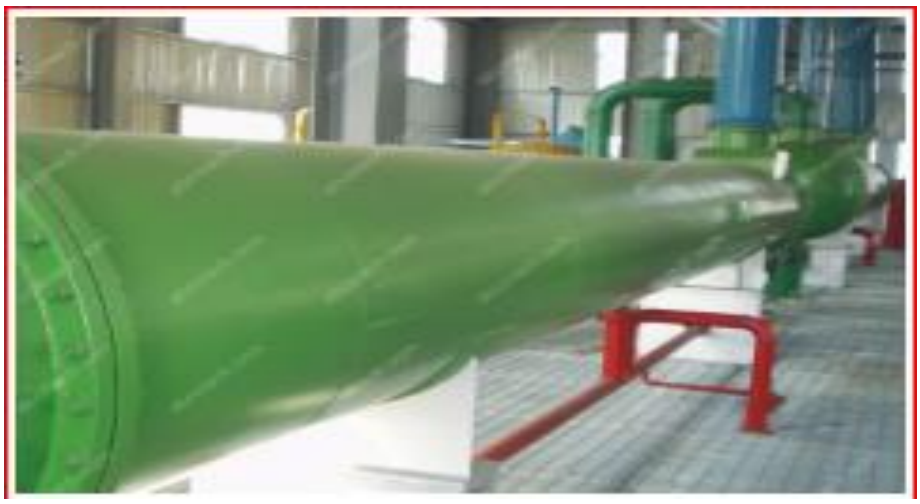

Fig.6. Horizontal Tubular Condenser

4.2.6 Hexane storage tank: As the name indicates that its used for hexane storage.

Fig.7. Hexane storage tank

4.2.7 Hexane water separator: Are an equipment used to separate solvent or water from oils.

Fig.8. Hexane water separator

Solvent or water recovery process are shown in the diagram below.

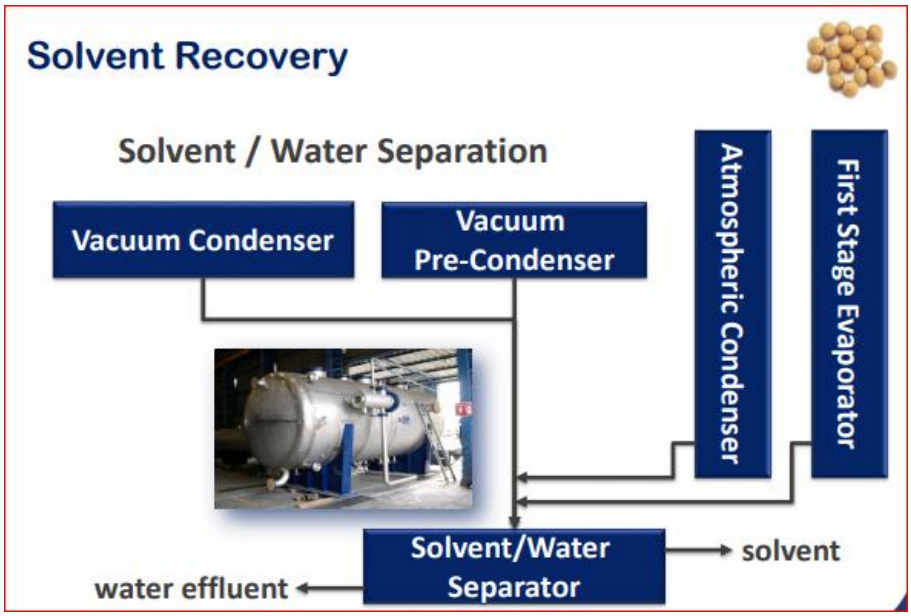

Fig.9. Solvent or water recovery process flow diagram

4.2.8 Hydro cyclone - Analogous devices for separating particles or solids from liquids are called hydrocyclone or hydroclones.

Hydrocyclone is a devices to classify, separate or sort particles in a liquid suspensions based on the ratio of their centripetal force to fluid resistance.

Hydro cyclone also find application in the separation of liquid of different densities.

Fig.10. Hydro cyclone

4.2.9 Cake breaker- used to process or mill oil cakes

Fig.11. Cake breaker

4.2.10 Exchanger - Equipment that transfer heat from one vapor or liquid to another vapor or liquid**.** Heat exchangers are used to heat or boil crude oils which helps to evaporate solvent and water from the oils.

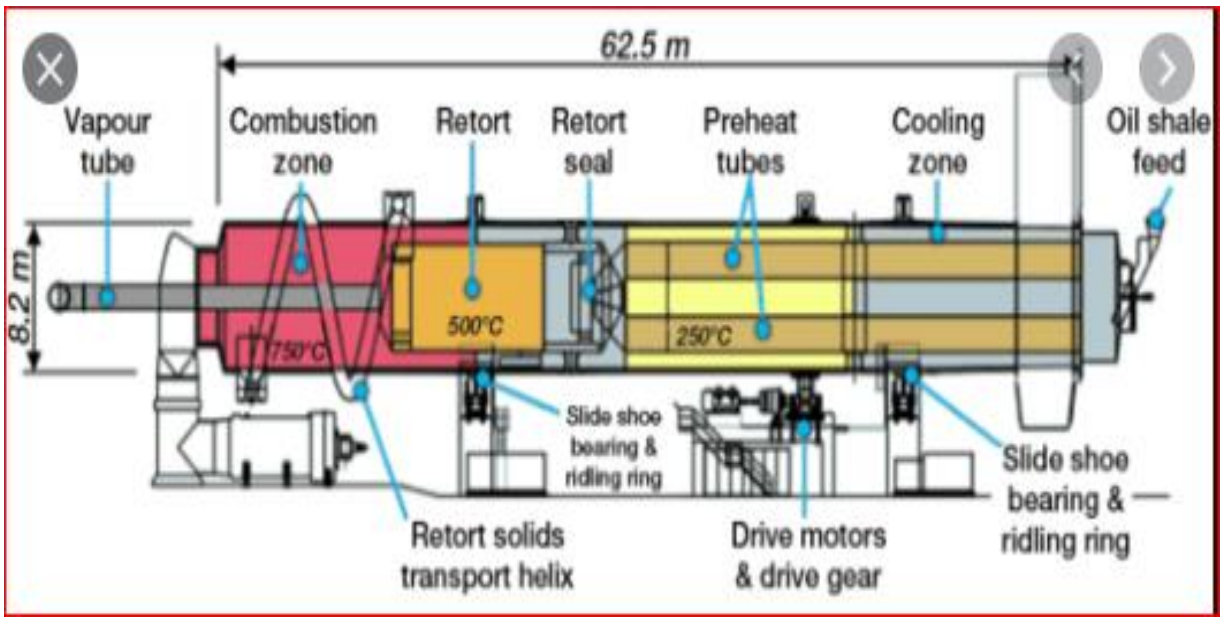

Fig.12 Shale oil extraction heat exchanger

Self-Check 4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List at list five equipments which are used to process oil seed in to oil (5pts)
2. Draw the process flow diagram for solvent or water recovery process (10pts)
3. Write the uses of extractor, condenser, Hydrocyclone and evaporators (8pts)

Note: **Satisfactory rating - 20 points** **Unsatisfactory - below 20 points**

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

Information Sheet 5- Occupational Health and Safety (OHS)

5.1 Introduction

Occupational health and safety is one of the oldest and most advanced social policy areas of the work. OHS is an integral part of everyday work. It is every Public service employee's responsibility to cooperate in practicing sound OHS principles in all work activities established minimum occupational safety and health requirements and stated that "particularly sensitive risk groups must be protected against the dangers which specifically affect them". It includes Information about key health and safety policies, standards of conduct, and associated issues.

Occupational health and safety in the work areas may include but not limited to:

- risks involved with the use of solvents, such as hexane, .
- limitations of protective clothing and equipment usage

5.2 Risks involved with the use of solvents

There are enourmous risks involved with the use of solvents and limitations of protective clothing and equipment usage in an oil processing industries. Exposure and health risks Hexane evaporates easily, so breathing contaminated air during the manufacture and use of the chemical is the most common form of exposure. People living near workplaces where hexane is manufactured or used, or near hazardous waste sites containing hexane, can be exposed when the solvent is released into the surrounding air. And anyone can be exposed when using the many household products that contain hexane. Workers using products that contain hexane without appropriate ventilation and protective equipment can be exposed to levels that cause nerve damage. Short-term exposures affect the central nervous system (brain) and can cause headaches, dizziness, confusion, nausea, clumsiness, drowsiness, and other effects similar to intoxication. If exposures are high and occur frequently over months or years, effects on the brain can be long-lasting and possibly permanent. High levels of exposure have been associated with a medical condition called peripheral neuropathy symptoms

include numbness and tingling in the feet and legs, and then in the hands. There also may be reduced ability to sense touch, pain, vibration, and temperature. Muscles may become weak. In severe cases, muscles may shrink or waste away and there may be paralysis. When combined with other solvents, such as acetone or methyl-ethyl ketone, hexane-related nerve damage is increased.

Self-Check 5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define OHS (5pts)
2. Write the risks that involved with the use of solvents; specially hexane (10pts)

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

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

Information Sheet 6 - Carrying out line clearance procedures

6.1 Carrying out line clearance procedures

Line clearance is useful to ensure clean lines of the manufacturing area. It is good manufacturing practices required to prevent mix up and cross contamination in the oil processing industries. The purpose was to lay down the procedure to ensure line clearance before starting the activity in manufacturing, filling and packaging area. If there are any non-compliances found during the Line Clearance check then these must be completed:

- Record in the Non-Compliance Table on the checklist
- Record in the Non-Compliance Logbook; and
- Report to and give non-compliance to the area Manager; and
- Communicate to the Team.

If a foreign product/material is found during a production run then these must be completed:

- Stop the line immediately,
- Record in the Non-Compliance Logbook;
- Report to and give to the area Manager immediately.
- Communicate to the Team.

6.2 Line clearance in the manufacturing area

- Ensure that the manufacturing area cleaned as per SOP
- Ensure that the drain area cleaned as per SOP
- Ensure that status board displayed with mentioning product, Batch No and status with sign and date of manufacturing area.
- Ensure that preventive maintenance of machines has been carried out as per the schedule.
- Ensure that raw materials and batch records required for the batch are taken in the manufacturing area.

- Ensure that (Heating ventilation and Air conditioning) HVAC system is functional and environmental condition are met as per SOP.
- Line clearance shall be done by production officer in the manufacturing area, cheked and signed by production excutive and verified by quality assurance (QA).

6.3 Line clearance in the filling area

- Gowning procedures is followed as per SOP.
- Ensure that earlier run up is completed and tube sand batch document are lying on or neat to machine.
- Ensure that primary packaging materials like; empty bottles remaining after batch completion are returned the warehouse.
- Ensure that the bottles filling machine and pipelines are cleaned as per SOP.
- Ensure that the filling area is cleaned as per SOP.
- Ensure that the drain is cleaned as per SOP.
- Ensure the primary packaging materials required for the batch are issued by the warehouse.
- Ensure that (Heating ventilation and Air conditioning) HVAC system is functional and environmental condition are met as per SOP.
- Line clearance shall be done by production officer in filling area, checked and signed by production excutive and verified and signed by QA.

6.4 Line clearance in the packaging area

- Gowning procedure is followed as per SOP.
- Ensure that earlier production run is completed and no bottles and carton, and batch documents are lying on or near the machine.
- Ensure that the secondary packaging materials like; carton, remaining after batch completion, are returned to the warehouse.
- Ensure that the cartonator or filling machine is cleaned as per SOP.
- Ensure that the packaging area is cleaned as per SOP.
- Ensure that (Heating ventilation and Air conditioning) HVAC system is functional and environmental condition are met as per SOP.
- Line clearance shall be done by production officer in packaging area, checked and signed by production excutive and verified and signed by QA.

Self-Check 6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What we have to do if a foreign product/material is found during a production (6pts)
2. Write are line clearance in the manufacturing area? (10pts)

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

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

Information Sheet 7- Following policies and procedures to control cross contamination

7.1 Introduction

Policies are a statement of purpose, which highlight broad guidelines on action to be taken to achieve that purpose. Policies act as a guiding frame of reference for how the organization deals with everything from its day- to-day operational problems or how to respond to requirements to comply with legislation, regulation and codes of practice. It is important that policies are reasonable, that employees are aware and clearly understand what the policy is trying to achieve. The statement of purpose should not be more than one page in length, but this will vary depending on the policy. Procedures explain how to perform tasks and duties. A procedure may specify who in the organization is responsible for particular tasks and activities, or how they should carry out their duties. To be effective, policies need to be publicized and provided to all existing and new employees. This includes casual, part-time and full-time employees and those on maternity leave or career breaks

7.2 Following policies and procedures to control the cross contamination

Policies and procedures followed to control the cross contamination include:

- Company policies and procedures,
- regulatory and licensing requirements,
- legislative requirements, and
- industrial awards and agreements

7.3 Benefits of Company policies and procedures

Well-written Company policies

- Are consistent with the values of the organization and employment legislation
- Demonstrate that the organization is being operated in an efficient and businesslike manner

- Ensure uniformity and consistency in decision- making and operational procedures
- Save time when a new problem can be handled quickly and effectively through an existing policy
- Foster stability and continuity
- Maintain the direction of the organization even during periods of change
- Provide the framework for business planning
- Assist in assessing performance and establishing accountability
- Clarify functions and responsibilities.

7.4 Policy checklist

A policy should:

- set out the aim of the policy
- explain why the policy was developed
- list who the policy applies to
- set out what is acceptable or unacceptable behavior
- set out the consequences of not complying with the policy
- Provide a date when the policy was developed or updated

Self-Check 7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

3. Define OHS (5pts)
4. Write the risks that involved with the use of solvents; specially hexane (10pts)

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

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

Information Sheet 8- Carrying out pre-start checks

8.1 Introduction

In an industry, there are many types of works to be operated using different machine and equipment. So before we are going to operate machine/lab equipment we have to inspect /check whether it was in a good operating condition or not. Before allowing someone to start using any machine you need to think about what risks there are and how these can be managed. So, you should:

- Check that it is complete, with all safeguards fitted, and free from defects. The term 'safeguard' includes guards, interlocks, two-hand controls, light guards, pressure-sensitive mats etc. By law, the supplier must provide the right safeguards and inform buyers of any risks ('residual risks') that users need to be aware of and manage because they could not be designed out.
- Produce a safe system of work for using and maintaining the machine. Maintenance may require the inspection of critical features where deterioration would cause a risk. Also look at the residual risks identified by the manufacturer in the information/instructions provided with the machine and make sure they are included in the safe system of work.
- Ensure every static machine has been installed properly and is stable (usually fixed down) and is not in a location where other workers, customers or visitors may be exposed to risk.
- Choose the right machine for the job.
- safe for any work that has to be done when setting up, during normal use, when clearing blockages, when carrying out repairs for breakdowns, and during planned maintenance;
- Properly switched off, isolated or locked-off before taking any action to remove blockages, clean or adjust the machine.

8.2 Pre-operational checks of equipment

Pre-operational checks of equipment include:

- Pre-start and safety checks including the service and maintenance system.
- Checking size of sieve, type machine with respective oil seed type, fuel, and lubricants needed, fan belts, lines, connections and transmission.
- Inspection of safety guards
- Checking and confirming equipment calibration settings and operating methods
- Observing and monitoring noise levels for correct operation.
- Preparation of independently powered tools may include cleaning, priming, tightening, basic repairs and adjustments.
- Identify and segregate unsafe or faulty equipment for repair or replacement.

8.3 Conduct pre-start checks

Conduct pre-start checks includes:

- Inspecting equipment condition (signs of wear)
- Selecting appropriate settings and/or related parameters
- Cancelling isolation or lock outs as required
- Confirming that required screens are fitted and related equipment is clean and correctly configured as per cleaning process requirements
- Positioning sensors and controls correctly
- Ensuring any scheduled maintenance has been carried out
- Confirming that all safety guards are in place and operational

Self-Check 8	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the pre-operational checks of equipment (5pts)
2. What we have to do during conduct pre-start checks on an equipments? (5pts)

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

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

LG #45 LO #2: Operate and monitor solvent Extraction process

Instruction sheet

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

- Monitoring solvent extraction process
- Identifying out-of-specification product
- Maintaining work area
- Monitoring operation of equipment and processes
- Identifying variation in equipment operation
- Reporting maintenance requirements
- Monitoring solvent extraction process
- Conducting a work according to legislative environmental standards
- Maintaining workplace documentation

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:

- Monitor solvent extraction process
- Identify out-of-specification of a product
- Maintain work area
- Monitor operation of equipment and processes
- Identify variation in equipment operation
- Report maintenance requirements
- Monitoring solvent extraction process
- Conduct a work according to legislative environmental standards
- Maintain workplace documentation

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 - Monitoring solvent extraction process

1.1 Introduction

A solvent is defined as “a liquid that has the property to dissolve, dilute or extract other materials without causing chemical modification of these substances or itself. Solvents are able to implement, apply, clean or separate products”. These compounds play an important role in great number of unit operations in chemistry and chemical engineering. In fact, nowadays there is no production process in perfume, cosmetic, pharmaceutical, food ingredients, nutraceuticals, and biofuel or fine chemicals industries without a solvation step. Solvents can be used as diluents or additives in paints and inks, as cleaning agents or solvents for syntheses and extractions.

Solvent extraction refers to preferential dissolution of oil by contacting oilseeds with a liquid solvent. This is the most efficient technique to recover oil from oilseeds. The efficiency depends on the oilseed preparation prior to extraction, temperature, mode of operation (batch vs. continuous and co-current vs. counter current operations) and equipment design. It is expected that residual oil in the meal to be less than 1 percent after commercial solvent extraction.

The choice of solvent type is based on solubility of oil in the selected solvent, cost and safety. Light paraffinic petroleum fractions, pentane (boiling point 88-97°F), hexane (boiling point 146-156°F), heptanes (boiling point 194-210°F) and octane (boiling point 215-264°C) can be used for oil extraction. Currently hexane is widely used for commodity vegetable oil extraction. The major disadvantage of these solvents is their flammability. Strict precautions have to be taken to avoid fires and minimize explosion risk in the extraction plants. The 1990 Clean Air Act listed hexane as a hazardous air pollutant. The oilseed processing industry is under pressure to switch to solvents that are considered benign such as alcohol or water. Low oil solubility and higher energy requirement for solvent recovery and meal drying are major disadvantages for using alcohols and water for oil extraction.

1.2 Monitoring solvent extraction process

Extraction with solvents is the most effective method for the recovery of oil (almost 98%), especially with materials with low oil content, like soybeans. This method is not indicated to oilseeds with high oil content, like peanut and sunflower, requiring a prior step of pressing of the seeds and then the cake produced is extracted with a solvent. When performed at low temperature, the solvent extraction has another advantage over screw-pressing: better quality of oil produced. This is because during expelling a sudden heating of the oil can occur, changing some parameters of its quality (Williams, 2005). Oil solubility in solvent increases with extraction temperature. High temperature also has a positive effect on viscosity and diffusivity of oil. Viscosity decreases while diffusivity increases as the extraction temperature increases, resulting in shorter extraction times. Energy required for solvent recovery decreases when higher operating temperature is used for extraction. However, high temperatures may cause deterioration and denaturation of some oil and meal components. Hence, temperature selection is based on type of oil and required specifications of the final product.

One of the disadvantages of the extraction is that the solvent extracts some nontriglycerides, which does not occur in the expelling (Williams, 2005). Another serious problem is the presence of volatile organic impurities in the final product, which can compromise the quality and go against the new profile of consumers who are seeking for natural products aiming to have a healthier diet (Michulec & Wardenki, 2005). The lowest levels of residual oil after pressing are 3-8%; exhaustive removal of the oil present in the cake by mechanical means alone is imposible. The residual oil in cake, therefore, only be removed by a different approach, this being solvent aided extraction.

1.3 Types of Extractors

Solvent extractors are of two types

- Batch
- Continuous

- ✓ **In batch processes,**
  - A certain quantity of flakes is contacted with a certain volume of fresh solvent.
  - The micella is drained off, distilled and the solvent is recirculated through the extractor until the residual oil content in the batch of flakes is reduced to the desired level.
  - The miscella is drained off, distilled and the solvent is recirculated through the extractor until the residual oil content in the batch of flakes is reduced to the desired level.

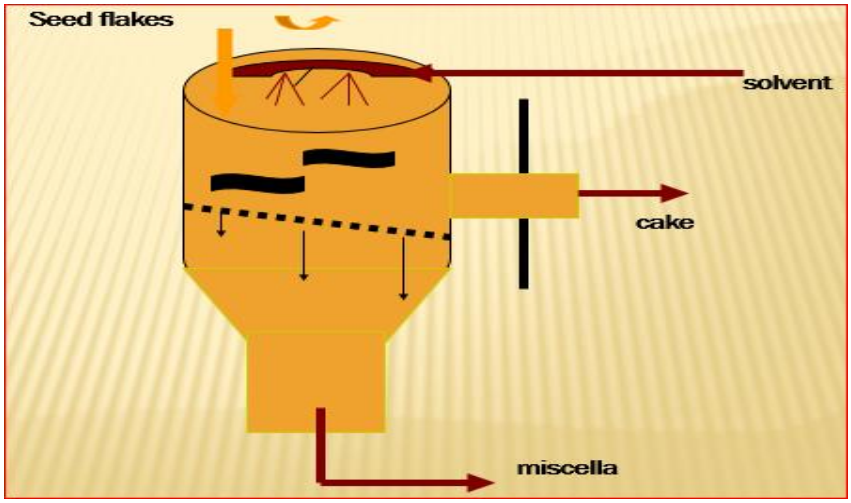

Fig.13 Batch extractor

- ✓ **In continuous extraction**
  - Both the oilseeds and the solvent are fed into the extractor continuously.
  - The different available types are characterized by their geometrical configuration and the method by which solids and solvents are moved one in relation to the other, in counter-current fashion.

Two different methods can be used to bring the solvent to intimate contact with the oilseed material:

- **Percolation**

Percolation were basket-type extractors in which flaked seeds were placed in baskets with perforated bottoms. These systems look like an enclosed bucket elevator.

- ✓ The solvent trickles through a thick bed of flakes without filling the void space completely.
- ✓ A film of solvent flows rather rapidly over the surface of the solid particles and efficiently removes the oil which has diffused from the inside to the surface.
- ✓ This mode of contact is preferable whenever the resistance to diffusion inside the flake is relatively low (thin flakes with large surface area, open tissue structure).

- **immersion**
  - ✓ The solid particles are totally immersed in a slowly moving, continuous phase of solvent.
  - ✓ Immersion works better with materials offering a greater internal resistance to oil transfer (thick particles, dense tissue structure).

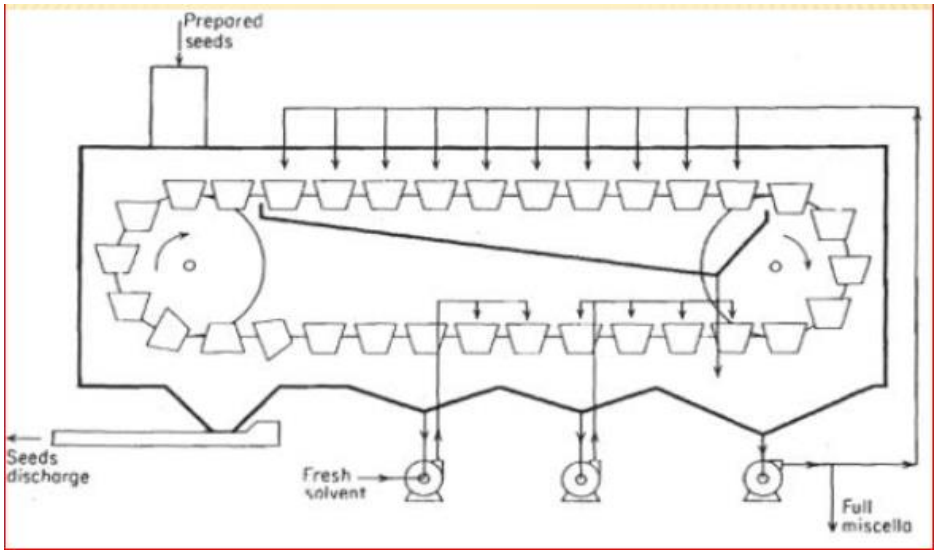

Fig.14 Continuous horizontal extractor

1.4 Refining of crude oil

- Crude oils as received from the extraction plant contain several non-triglyceride components which must be removed.
- Refining consists of several processes which accomplish this aim.

1.4.1 Composition of oils and fats

- Major Component (95-99%)
  - ✓ Triglycerides
- Minor Component (1-15%)
  - ✓ Triglyceride Derivatives
    - Glycerol
    - Free Fatty Acids
    - Mono- and Diglycerides
  - ✓ Non-Triglyceride Derivatives
    - Phospholipids
    - Sterols
    - Pigments
    - Vitamins
    - Antioxidants
    - Oxidation Products
    - Trace Metals
    - Hydrocarbo

Triglyceride

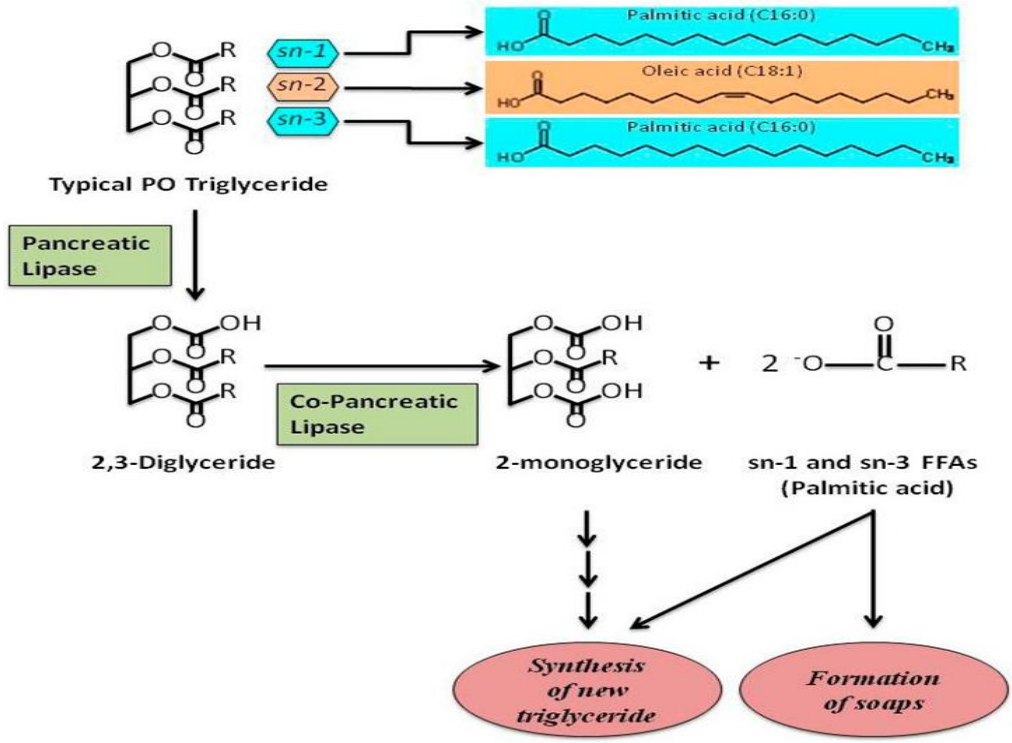

Fig.15 Schemic diagram for Hydrolysis of typical tryglyceride

1.4.2Objectives of Refining

- Removal of undesired products from crude oils
  - ✓ Free fatty acids (FFA)
  - ✓ Phospholipids (gums)
  - ✓ Oxidized products
  - ✓ Metal ions
  - ✓ Molour pigments
  - ✓ Other impurities
- Preservation of valuable vitamínes (vitamin E or tocopherol–natural anti-oxidants)
- Minimize oil losses
- Protection of the oil against degradation

1.4.3 Refining Methods

Refining **-** Oils extracted by the above methods are crude and contain many other constituents like free fatty acids, unsaponifiable matter, gums, waxes, variety of coloring matter, undesirable odoriferous constituents etc. In refining the suspended particles are removed by filtration or centrifugation.

The free fatty acids are removed by alkali treatment. When the free fatty acid content is high as in palm oil (5%), it is removed by blowing steam through hot oil under vacuum. This results in both deacidification and deodorization. Any remaining free fatty acids are removed by neutralization. Pigments are removed by bleaching using adsorbents like activated earth or carbon or, in special cases, chemical bleaching agents. Finally, the oil is deodorized by injecting steam through the heated fat kept under reduced pressure. Sealed glass or plastic bottles are adequate. Colored containers in a dark box help to increase shelf life. Seed cake is a valuable by-product of pressing and makes a good chicken, pig, or cattle feed. Oil finds wide uses as food, skin care products, aromatherapies, biodiesel fuels, and industrial lubricants.

- Chemical Refining (alkaline refining)
  - ✓ Degumming
  - ✓ Neutralizing
  - ✓ Bleaching
  - ✓ Deodorization
- Physical Refining (steam refining)
  - ✓ Degumming
  - ✓ Bleaching
  - ✓ Steam distillation

- **Degumming**
  - ✓ Removes phosphatides and other materials that may be precipitated or dissolved from the crude oil by hot water.
  - ✓ Degumming is accomplished by introducing hot water at a level of 1 to 3 percent of oil volume, or by injecting an equivalent amount of steam to hydrate the phosphatides
  - ✓ The phosphatides, together with certain other materials, absorb water and
  - ✓ Precipitate from the oil as a heavier phase, which is removed by centrifuge Separator.

- **Neutralization**

- ✓ Free fatty acids are neutralized by treatment at 82- 100 degree with a small amount of concentrated sodium hydroxide solution.
- ✓ Alkali refining reduces color and also removes other non-triglyceride substances, which are separated along with the neutralized free fatty acids and hydrated phosphatides, by centrifugation

- **Bleaching**
  - ✓ The oil is then decolorized by treatment with acid-activated clays that bleach by adsorbing color bodies, residual soaps and metal complexes from the oil.
  - ✓ The major purpose of bleaching is the removal or undesired color materials in the oil.
  - ✓ Heated oil (~85^{o}C) may be treated with various bleaching agents such as fuller's earth, activated carbon, or activated clays.
  - ✓ Many impurities, including chlorophyll and carotenoid pigments, are adsorbed onto such agents and removed by filtration.
  - ✓ However, bleaching also promotes lipid oxidation since some natural antioxidants are removed together with the impurities.

Bleaching agent

- ➢ Activated bleaching
- ➢ Bentonite
- ➢ Activated carbon

Fig.16. Bleaching agents

- **Deodorizing**
  - ✓ Deodorization is an absolute necessity in processing edible fats and oils.
  - ✓ How efficiently it is done determines what you can achieve in your processing operations as a whole, in terms of removing odours, pigments and volatile substances.
  - ✓ When processing edible vegetable oils and animal fats, it is crucially important to remove any undesirable compounds that can affect flavour, odour, stability and colour.
  - ✓ Deodorization is a vacuum steam distillation process in which steam is passed through such oils at very low pressure and relatively high temperature in order to remove any such substances still present after the preceding processing stages.
  - ✓ The oil produced is referred to as "refined oil" and is ready to be consumed or for the manufacture of other products.
  - ✓ About 0.01 percent of citric acid is often added during this step to inactivate pro-oxidant metals such as iron or copper.
  - ✓ Deodorization is the final step in the refining of oils.
  - ✓ Deodorization involves the use of steam distillation under reduced pressure.
  - ✓ In Europe, a deodorization temperature of 175 - 205º C is common, but in the United States, higher temperatures of 235 - 250º C are usually employed.
  - ✓ Volatile compounds with undesirable odors and tastes can be driven off, resulting an odorless product.

1.5 Basic Steps of Edible Oil Refining Process

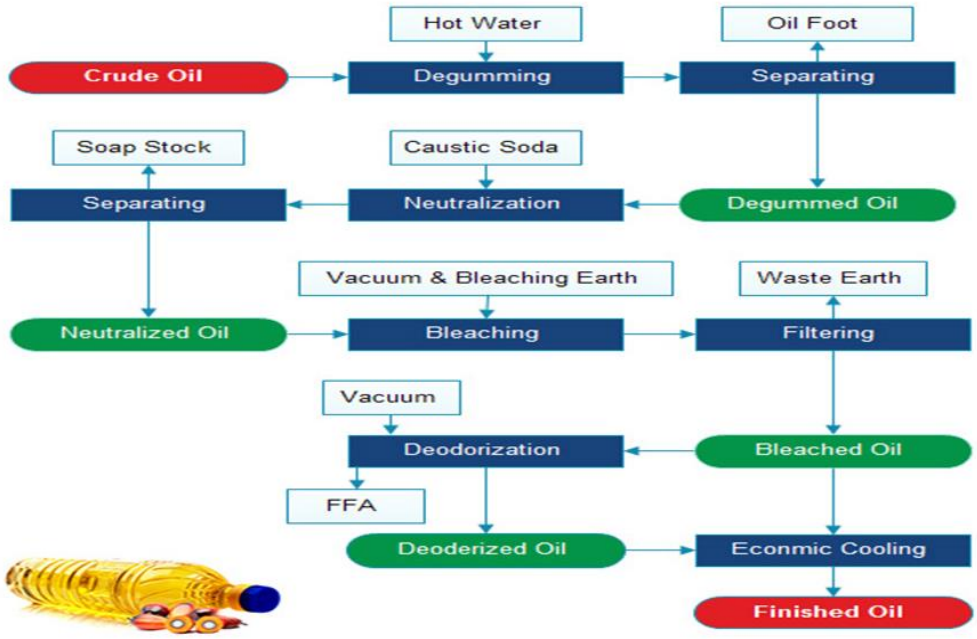

Fig.17. Flow Diagram of Edible Oil Refining Process

1.6 Basic principles of solvent extraction:

- The extraction of oil from oilseeds by means of non-polar solvents is, basically, a process of solid-liquid extraction.
- The transfer of oil from the solid to the surrounding oil-solvent solution (miscella) may be divided into three steps:
  - ✓ diffusion of the solvent into the solid
  - ✓ dissolution of the oil droplets in the solvent
  - ✓ diffusion of the oil from the solid particle to the surrounding liquid
- The driving force in the diffusional processes is, obviously, the gradient of oil concentration in the direction of diffusion.
- Yet, the raw material cannot be ground to a fine powder, because this would impair the flow of solvent around the particles and would make the separation of the miscella from the spent solid extremely difficult.

- The oilseeds are rolled into thin flakes, thus reducing one dimension to facilitate diffusion, without impairing too much the flow of solvent through the solid bed or contaminating the miscella with an excessive quantity of fine solid particles.
- The rate of extraction can be increased considerably by increasing the temperature in the extractor.
- Higher temperature means higher solubility of the oil, higher diffusion coefficients and lower miscella viscosity.
- An open, porous structure of the solid material is preferable, because such a structure facilitates diffusion as well as percolation.
- A number of processes have been proposed for increasing the porosity of oilseeds before solvent extraction
- Although most of the resistance to mass transfer lies within the solid,
- The rate of extraction can be increased somewhat by providing agitation and free flow in the liquid phase around the solid particles.
- Too much agitation is to be avoided, in order to prevent extensive disintegration of the flakes.

1.7 Choice of solvents

The selection of solvent for oil extraction from oil seed is an important factor. The solvent should have good extraction capacity, low viscosity and higher solubility with oil. Proper penetration of the solvent inside the oil seed is necessary to extract oil effectively with nearly equal polarity of the solvent and the oil. Generally, organic solvents possess all the above criteria and are used for oil extraction since long years. Hexane, ethanol, petroleum ether, isopropanol and carbon tetrachloride were used as organic solvents in this study to find the best solvent for oil extraction. It was observed that amongst all the organic solvents used, hexane is the best extracting solvent with a 10.6% yield.

An ideal solvent for the extraction of oil from oil seeds should possess the following properties:

- Good solubility of the oil.
- Poor solubility of non-oil components.
- High volatility (i.e. low boiling point), so that complete removal of the solvent from the miscella and the meal by evaporation is feasible and easy.
- Yet, the boiling point should not be too low, so that extraction can be carried out at a somewhat high temperature to facilitate mass transfer.
- Low viscosity.
- Low latent heat of evaporation, so that less energy is needed for solvent recovery.
- Low specific heat, so that less energy is needed for keeping the solvent and the miscella warm.
- The solvent should be chemically inert to oil and other components of the seed flakes.
- Absolute absence of toxicity and carcinogenicity, for the solvent and its residues.
- Non-inflammable, non-explosive.

- Non-corrosive
- Commercial availability in large quantities and low cost

1.8 Hexane extraction process

There are three major steps in traditional solvent extraction (Figure 1): oil extraction, meal and oil desolventizing, and meal toasting.

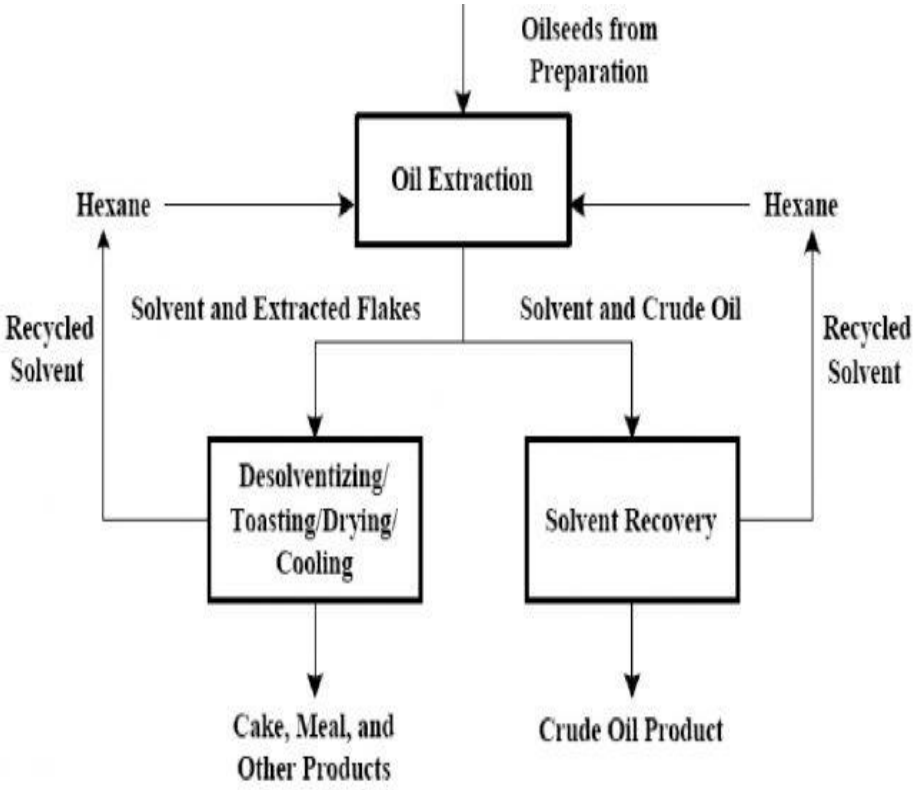

Figure 1: Simplified flow diagram of a hexane extraction process

1.9 Oil recovery and oil yield

In terms of oil recovery and oil yield, the old traditional or informal wet extraction methods used by rural communities around the globe is regarded as inefficient, often yielding below the range of plant oil content found in literature (Alonge and Olaniyan, 2006; Olaniyan, 2010). Olaniyan (2010) has outlined three major means of recovering oil from oleaginous materials of plant origin as wet extraction (hot water or steam extraction), solvent extraction and mechanical expression. With regard to the wet extraction method, Oluwole *et al*. (2012) proffered nine major operations that are involved in the extraction of castor oil by the old traditional method namely, collection of

seed pods, shelling of the pods/winnowing, boiling the seeds to reduce moisture, grinding of seeds to form paste, mixing the paste with water/boiling to extract oil, scooping of oil and drying the oil by heating. They evaluated the percentage yield (19.42) and percentage oil recovery (38.84) using the expressions.

% oil yield = $Moi \quad /Mseed$ × 100 ---------- (equation.1)

% oil recovery = $Moil$ / $XMseed$ × 100 ---------- (eq.2)

Where Moil = mass of oil (kg)

Mseed = mass of oilseed (kg)

X = oil content of oil seed

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Write and explain the two types of oil extraction process in detail (10pts)
2 Define solvent means (4pts)
3 What are the objectives of oil Refining (6pts)
4 Draw the process flow diagram of a hexane extraction process(10pts)
5 What are the properties of solvents which enable chosen for the extraction of oil? (10pts)

Note: **Satisfactory rating - 35 points** **Unsatisfactory - below 35 points**

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

Information Sheet 2 - Identifying out-of-specification product

2.1 Identifying out-of-specification product

The main quality checks concern raw materials, processing conditions, product quality and packaging and storage conditions. Raw materials should be checked to ensure that there is no moulds growth, and that they are correctly dried, cleaned and sorted. During processing, the temperature and time of conditioning, the moisture content of the raw material, and the yield of oil should be routinely checked. Quality checks on the product include correct color, flavor, odour, clarity and fill weight.

Processed oil should be consistent in all aspects such as colour, taste and viscosity. In addition, the oil should be free of impurities and meet the demands placed upon it for use in cooking. Before being filled, the bottles that hold the oil are cleaned and electronically inspected for foreign material. To prevent oxidation of the oil (and therefore its tendency to go rancid), the inert (non-reactive) gas nitrogen is used to fill up the space remaining at the top of the bottle.

Self-Check 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 What are the indicators of out-of-specification oil products (6pts)

2 Why we need to check raw materials before processing it? (4pts)

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

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

Information Sheet 3 - Maintaining work area

3.1 Introduction

Maintaining the work area cleanness is playing the vital role of the organizational success. It includes keeping work areas neat and orderly; maintaining halls and floors free of slip and trip hazards; and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas.

It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of accident and fire prevention

A safe work environment Including facilities, Amenities and accommodation.

Facilities refer to toilets, washrooms, showers, lockers, dining areas, drinking water, etc. These facilities must be in good working order, clean, safe and accessible. When considering how to provide and maintain facilities that are adequate and accessible, a person conducting a business or undertaking must consider all relevant matters including

- The nature of the work being carried out at the workplace
- The nature of the hazards at the workplace
- The size, location and nature of the workplace
- The number and composition of the workers at the workplace.

3.2 Maintaining work area

During Conducting work in accordance with workplace guideline a person should ensure the following requirements.

3.2.1 Legislative Requirements

A person conducting a business or undertaking at a workplace must ensure so far as is reasonably practicable, the following:

- The layout of the workplace allows, and the workplace is maintained so as to allow, for persons to enter and exit and to move about without risk to health and safety, both under normal working conditions and in an emergency,

- Work areas have space for work to be carried out without risk to health and safety,
- Floors and other surfaces are designed, installed and maintained to allow work to be carried out without risk to health and safety,
- Ventilation enables workers to carry out work without risk to health and safety,
- Workers carrying out work in extremes of heat or cold are able to carry out work without risk to health and safety,

3.2.2 Responsibilities

- Facilities Management Division (or Equivalent)
  - ✓ Are designed and installed according to company legislative and requirements
  - ✓ Are inspected and maintained to ensure a safe level of hygiene.
- Company Management and Supervisors

Management and supervisors of faculties, divisions and units are to ensure that amenities and facilities in the workplace do not expose workers, or visitors to health and safety risks.

This includes:

- Employees

Employees are responsible for reporting any identified hazard in the work environment, facilities or amenities that they become aware of in accordance with factory or company guidelines.

3.2.3 Needs Assessment

The work environment, facilities and amenities are provided for basic health and welfare of employees. These include items such as:

- Toilets
- Rest rooms
- Shelter sheds
- Dining rooms
- Drinking water
- Accommodation
- Waste receptacles
- First aid facilities/rooms (refer to first aid guidelines).

3.2.4 Work Environment

Work environment includes/consider: work layout, work access, floors and other surfaces, work station, lighting, air quality, and heat and cold.

- **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.

- **Housekeeping**

Untidy workplaces may lead to injuries e.g. slips and trips, therefore good housekeeping practices are essential for all workplaces.

For 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.

- **Work Areas**

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

- **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, chemicals, and the need for cleaning.

- **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 a 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 Workplace Environment Guidelines
- ✓ Contrast
- ✓ Reflections.

- **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.

- **Heat and Cold**

Refer to the Thermal Comfort Guidelines for further information on managing health and safety risks associated to hot and cold environments.

3.2.5 Welfare Facilities

- **Access**

Workers, including those who have particular needs or disabilities, must have access to the facilities provided.

Workers are to be provided with:

- ✓ Adequate breaks to use the facilities
- ✓ Facilities which are within a reasonable distance from the work area
- ✓ Shift workers have similar access to those who work during the day
- ✓ A means of access which is safe.

- **Personal Storage**

Accessible and secure storage should be provided at the workplace for personal items belonging to workers. This storage should be separate from that provided for personal protective equipment in cases where contamination is possible.

- **Change Rooms**

Persons required to change clothes before and after work should be able to access a change room.

This includes workers who need to:

- ✓ Wear personal protective clothing or uniforms while they are working
- ✓ Leave their work clothing at the workplace.

- **Shower Facilities**

Where dirty, hot or hazardous work is undertaken showering facilities should be provided. Showers should have:

- ✓ Floor area of not less than 1.8m2
- ✓ A Slip resistant surface that is capable of being sanitized
- ✓ A Partitions between each shower that are at least 1650mm high and no more 300cm above the floor
- ✓ An adjacent dressing area for each shower containing a seat and hooks
- ✓ A Lockable door enclosing the shower and dressing cubicle

- **Shelter Facilities**

Where persons are required to be performing tasks offsite and can be exposed to environment elements appropriate shelter is to be provided.

3.2.6 Inspection and Monitoring

The work environment, facilities and amenities need to be periodically inspected to ensure they conform to relevant legislation, standards and codes of practice and are maintained and serviced appropriately. Any non-conformances identified throughout the inspection require a risk control assigned to an appropriate person.

Review of the work environment, facilities and amenities are required when:

- Work practices, equipment or workplaces are modified
- Employees numbers increase
- New work processes are introduced
- An incident impacting on the health, safety or welfare of employees occurs.

Where it is identified that the workplace environment, facilities or amenities pose a health and safety risk, the issue should be reported to the supervisor and recorded. Corrective actions may include a review of the area in relation to the information contained in guideline, WHS Regulation, Code of Practice or other information.

Self-Check 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the requirements a person should ensure during conducting work in accordance with workplace guideline(6pts)
2. Write at list five items that a work environment, facilities and amenities are provided for basic health and welfare of employees. (5pts)

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

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

Information Sheet 4 - Monitoring operation of equipment and processes

4.1 Introduction

Monitoring operation is a systematic process of observing, tracking, and recording activities or data for the purpose of measuring program or project implementation and its progress towards achieving objectives. Information gathered through monitoring is used to analyze, evaluate the all of the components of a project or a department in order to measure its effectiveness and adjust inputs where necessary. In any processing industry there must equipment and process monitoring and controlling system. So in oil seed industry there is equipment that needs monitoring and control of its processing parameters like temperature, pressure, and flow meters and different sensors. Monitoring equipment and process in an industry helps to obtain expected out puts like oil colour, flavour, density, and clarity. Without monitoring and controlling the equipment and process; it was impossible to get quality products.

4.2 Monitoring operation of equipment and processes

During extraction of oil from oil seed by using mechanical extraction process you can use many types of equipment. In these process, monitoring the equipment operation and process weather the equipment or process are going under specified conditions. So, when you extract seed oils using hydraulic oil press you have to monitor and control the temperature and pressure gauges are working under setting point or not.

Self-Check 4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Define monitoring of operation (4pts)
2 Why we need to monitor equipments and process? (6pts)
3 What are the operational parameters to be monitored in an oil processing equipments? (4pts)

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

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

Information Sheet 5 - Identifying variation in equipment operation

5.1 Identifying variation in equipment operation

Variations in equipment operations can be happen due to many factors. Such as lack of maintenance or poor maintenance, sensor defects, equipment component problem, difference in applied pressure, and power shortages. These variations may cause different damages to a machine, process, products, and environments. To minimize these variations we have to conduct pre-start checks on all components of equipment, sensors, and perform maintenance before we are going to operate equipment

5.2 Variables to be monitored to minimize variations

There are different variables in a processing industry that must be monitored and controlled. Variables to be monitored to minimize variations in equipment operations include

- ✓ Production capacity
- ✓ Equipment durability
- ✓ Equipment performance (e.g. speed, output, variations)
- ✓ equipment component performance
- ✓ sequences and timing of operation
- ✓ materials changes (desired and not desired)

For example: During oil extracting using mechanical screw preser, if the rotation speed of screw high the time to obtain the crude oil increase. But due to the temperature developed between the screw barrel the protein component of the cake may be damaged.

Self-Check 5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Write the variables that must be monitored to minimize variations in equipment operations (6pts)
2 What brings variations in equipment operations (4pts)

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

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

Information Sheet 6 Reporting maintenance requirements

6.1 Reporting maintenance requirements

Maintenance is an auxiliary operation and an important engineering function for restoration of machineries and equipments at their original effectiveness.

Deterioration of industrial facilities could happen due to;

- Tools and dice wear out of friction
- Atmospheric conditions deteriorate tools/machineries
- Aging also affect the normal operation of machines (lifetime)
- Improper handling of equipments and materials.

In oil seed processing industry there are many equipment that needs maximum maintenance due to the operation they have perform. The major equipments that needs maintenance in oil processing are; heat exchanger, heat exchanger tubes, oil extractors, oil condensers, evaporators and so on.

6.2 Objective of maintenance

- To maintain plants and equipments at its maximum operating efficiency,
- Reduce down time and ensuring operating safety
- To safeguard investment by minimizing rate of deterioration implementation of suitable procedures for procurement, storage and consumption of spare parts , tools and consumable materials etc. (inventory control)
- Standardization of spares and consumable in conforming in plants,
- To keep production cycle within the stipulated range.
- To improve productivity of existing machinery
- To prologue the useful life of the plant and machinery

Table 1: Routine maintenance checklist

Date	Tool	Maintenance check points	Signature	Maintenance required	Signature
1-2 /1 /2020	Heat exchanger	Tube	Mr. A	Tube	Mr. C
3-4 /1/2020		body	Mr. A	Body welding	Mr. B
5-6 /1/2020		Temperature sensor	Mr. A	Sensor	Mr. C

- Maintenance performed were reported using a checklist below.

Table 2: maintenance report checklist

Maintenance Performed	Date	Signature
Heat exchanger body welded	5- 8 /1/2020	Mr. B
Tube replaced	3 - 10/1/2020	Mr. C
Temperature sensor replaced	7- 9 /1/2020	Mr. C

Fig.18. Heat exchanger pipe maintenance

Fig.19. Heat exchanger maintenance

Fig.20. Tieghtenig of bolts for processing pipe

Self-Check 6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Define maintenance (4pts)

2 Write the objectives of maintenance(6pts)

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

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

Information Sheet 7 - Monitoring solvent extraction process to confirm by-product

7.1 Introduction

In the context of production, a by-product is the "output from a joint production process that is minor in quantity and/or net realizable value (NRV) when compared with the main products". Because they are deemed to have no influence on reported financial results, by-products do not receive allocations of joint costs. The byproduct is a common outcome in the majority of production processes. It often happens that along with the main output, a secondary product is also yielded. This minor output is called the byproduct. It is in a lesser quantity and also is of lower overall value as compared to the main product. A by-product or byproduct is a secondary product derived from a production process, manufacturing process or chemical reaction; it is not the primary product or service being produced. A by-product can be useful and marketable or it can be considered waste: for example, bran, which is a byproduct of the milling of wheat into refined flour, is sometimes composted or burned for disposal, but in other cases, it can be used as a nutritious ingredient in human food or animal feed. Gasoline was once a byproduct of oil refining that later became a desirable commodity as motor fuel. The plastic used in plastic shopping bags also started as a by-product of oil refining.

Some common examples of byproducts are:

- Cake or meal(protein) from oil seed processing
- Hull from oil seed processing
- Food fines from the cereal processing
- Molasses in sugar refining
- Fruit oils recovered during the peeling of processed fruit
- Straw from grain harvesting

Simple terms, a byproduct is a secondary or incidental product derived during the synthesis or production of something else. It is not the primary product, rather it is a binary product yielded during the creation of the main product. The byproduct is simply

a minor product whose output is an inevitable result of a particular manufacturing process; the main process is not affected or altered by this derivative.

7.2 Monitoring solvent extraction process to confirm by-product

In wastewater evaporator water is continuously removed from the solvent-water separator and sent to a vessel called the wastewater evaporator, where direct steam is introduced to raise the temperature to at least 85°C (185°F). Often, the direct steam is provided by the final stripper vacuum ejector (and possibly other ejectors in the process). The purpose of this wastewater evaporator is to heat the wastewater well above the boiling point of the solvent, thus evaporating any remaining solvent in the wastewater stream. This wastewater (after cooling) flows to a large outdoor separation sump that is also connected to the floor drains of the extraction building. This sump serves two purposes:

- It provides an additional level of safety by separating any remaining oils, solvents, and miscella from the wastewater prior to its discharge.
- It provides containment for any spills.

7.3 Use of by-products

Coconut by-products have a wide variety of uses. Groundnut meal is widely used for human food (biscuits, soups etc.) when it is extracted by manual methods which do not burn the by-product. Other fruits, nuts and oilseeds produce by-products that can be used for fuel and animal feeds. The high temperatures employed in expellers burn byproducts and they are only suitable for animal feeds. However, all oil extraction businesses need to identify markets for their by-products for economic viability.

Fig.21. Pressed cake (by- product) at outlet

Self-Check 7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Define by-products (4pts)
2 Write some common examples of byproducts (6pts)
3 What are the two purposes of evaporating wastewater using wastewater evaporator? (6pts)

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

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

Information Sheet 8 - Conducting a work according to legislative environmental standards

8.1 Introduction

Conducting work is procedure sets out the steps to be followed for work activities. You must consult with affected workers when developing procedures for resolving work health and safety issues, consulting with workers on work health and safety, monitoring worker health and workplace conditions, and providing information and training. Work is carried out using loading vehicles which transport material, equipment and machine or carry heavy machine equipment product in the oil seed processing industry in order to minimize risk of injuries.

8.2 Conducting a work according to legislative environmental standards

Conventional techniques of extracting oil using organic solvents pose health, safety, and environmental concerns. In modern extraction methods, green solvents such as water, ethanol, ethyl acetate, carbon dioxide, ionic liquids, and terpenes are currently gaining prominence. These green solvents present no signs of pollution and remain in liquid form over a temperature range of 0 to 140 ◦C. These techniques are considered environmentally friendly because they exhibit less hazardous chemical synthesis, use renewable feedstock, and reduce the chemical load and emissions generated by organic solvents. Aqueous enzymatic extraction is a novel technique that uses enzymes as the medium for extraction of oil. Selection of the enzymes solely depends on the structure of the oilseed and the composition of the cell wall. Studies reveal an enzyme to substrate ratio of 1% to 8%, the temperature of 40 to 55 ◦C, and a pH of 4 to 8 to be typical for enzymatic extraction of oil from different oilseeds. Microwave-assisted extraction has proven to impart significant effects on mass transfer and offers high throughput and extraction efficiency. A microwave power of 275 to 1,000 W and a temperature range of 30 to 60 ◦C are noticed in the different studies. The review presents a comprehensive account of the modern extraction techniques, the parameters responsible for yield and quality, and their industrial applications. Besides, the review highlights the optimized parameters for oil extraction from different oil-bearing materials.

Self-Check 8	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Define conducting work (4pts)
2 What are green solvents that meets legislative environmental standards in an oil extraction? (6pts)
3 Write the substrate ratio, the temperature and a pH which is typically optimum for enzymatic extraction of oil from different oilseeds(6pts)

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

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

9.1 Introduction

Documentation refers to a set of records that exist online, on paper or on hard drives. It is material that provides evidence or information to serve as a record. In the workplace, documentation is retained records of employment and company actions and events as required by legal mandates and company policy. It is a document which contains technical details. Any document that provides steps or gives instructions to carry out tasks. All workplaces use documents to record their business activities. Some documents need to be completed as part of government acts or regulations, while others are developed to ensure the efficient delivery of services and products to customers. It is important to know which workplace documents, records and forms you will be expected to complete as part of your job.

9.2 Maintaining workplace documentation

9.2.1 Importance of documentation

Documentation provides information on when, who, and how to complete the task. The document provides the evidence providing that the tasks has been completed as they should be.

9.2.2 List of documents

List of documents which was recorded in processing industry are provided below

- Batch manufacturing records.
- Bill of materials
- Specification
- SOPs
- Protocols
- Test methods
- Check lists
- Forms/Log sheets
- Training assessments
- Certificate of Analysis
- Technology transfer documents
- Maintenance records
- Calibration records

9.2.3Basic requirements of good documentation practices (GDP)

- Always record the entries at the time of activity simultaneously.
- Always record date with the signature in GDP records.
- Never use a pencil or erasable or water-soluble ink in the records.
- Never sign for someone else on any documents. Only sign on the work that you have performed yourself.
- Never use white ink or correction fluid to correct the entry in GDP records.
- Never backdate GMP records.
- Never discard original raw data of any kind.
- Documentation and records used throughout the manufacturing process, as well as supporting must meet the basic requirements of GDP.

9.2.4Preparation of documents

- Clear and concise titles should be used for headings, tables, graphs' and etc.
- All documents should have the signature and date of the person who prepared the document, review the document and approved the document.
- All master documents should have an effective date, and current version number.
- Words that everyone can understand should be used. Unfamiliar words reduce the reader's understanding of what is written.
- Definition of abbreviations should always be included in the document for reffference.

Self-Check 9	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Define documentation (4pts)
2 List the documents which was recorded in processing industry? (6pts)
3 Write the importance of workplace documentation (2pts)

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

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

Operation Sheet #1- Operation procedure for Solvent Extraction Process

Operation procedures or techniques of solvent extraction process

1. Wear personal protective equipment (PPE)
2. Adjust hydraulic presser
3. Weigh raw materials
4. Clean raw materials
5. Sort and grade raw materials
6. Fed or load raw material in to oil extactor
7. Add solvents(Hexane)
8. Recover solvents
9. Extract solvents from crude oil
10. Collect the extracted solvent using solvent collection tank or vessels.
11. Collect crude oil products
12. Record data
13. Shutdown process
14. Clean presser

LAP TEST #1	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 6 hour. The project is expected from each student to do it. During your work: You can ask all the necessary tools and equipment

Task- 1: **Operate Solvent Extraction Process**

LG #46	LO #3 - Shut down solvent extraction process

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Shutting down 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: • Shut down process • 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

Information Sheet 1 - Shutting down process

1.1 Shutting down process

Shut down is a term used to describe the process of closing all systems of process control systems. Normal shutdown includes steps to render the systems safe, such as removal of hazardous process materials and inert (asphyxiating) gases. The systems might be cleaned as part of the shutdown; cleaning is often a machine shutdown is a temporary closure of a building to perform maintenance. The main activities should be preventative in nature with the focus on equipment inspections. This is the best time to replace worn-out or broken process materials and equipment at their useful end-of-life process unto itself requiring its own set of startup, operation, and shutdown procedures.

1.2 Uses of Shutdown Processes

- Safely shut down of the equipment.
- To locate emergency stop functions on the equipment.

1.3 Shut down the process includes.

Shutdown procedure may include but not limited to:

- The appropriate shutdown procedure is identified.
- The process is shut down according to shutdown procedures.
- Maintenance requirements are identified and reported according to workplace reporting requirements

1.4 Advantage of appropriate shut down procedure

- Reduced unplanned downtime
- Reduced overtime and
- Reater operational efficiencies

1.5 Seven steps for a successful shutdown

Follow these steps to ensure a successful outage and restart. Scheduled outages may be plant wide, occur through different sections or be cold or running. Job plans for each asset is a prerequisite.

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. Examples of assets for most plant checklists include: Agitators, Airlocks, Conveyors, Doors, Dust baggers, Gearboxes Man ways Mixers and blenders, Motors, Piping, Pumps, Valves.

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).

Because equipment is shut down, personnel may have a false sense of security

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.

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

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.

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 questions

1. Define shut down processes (3 points)
2. Uses of shutdown processes (3pointts)

Note: Satisfactory rating – 5 points Unsatisfactory - below 5

You can ask you teacher for the copy of the correct

Information Sheet 2 - Identifying and reporting maintenance requirements

2.1 Definition of maintenance requirement

Maintenance requirements are the processes of maintaining work area to meet housekeeping standards and Respond to and/or report equipment failure within level of responsibility. Maintenance is a general upkeep and repair of equipment, buildings and grounds, heating and air-conditioning; removing toxic wastes; parking; and perhaps security. Food premises and equipment that are not kept in good repair and condition are a potential source of microbiological and physical contamination of food. Poorly maintained premises and equipment cannot be cleaned effectively. Poor maintenance may allow the entry of other sources of physical, microbiological and chemical contaminants such as water, pests and dust. Poor maintenance can have health and safety implications for workers.

2.2 Identifying and reporting maintenance requirements

To minimize the hazards that might be happen during equipment operation, you have to check that the equipments are in a god operating condition or not. If there is a defects on it, report and undertake maintenance before starting operate equipment. The maintenance that needed may be adjusting thermocouple, pressure sensors, some components of a machine or equipment and etc. Maintenance requirement requires that all sorting and grinding, extracting, refining and desolventizing equipment be maintained in an efficient state, in efficient order and in good repair. Where any machinery has a maintenance log, the log is kept up to date; and that maintenance operations on work equipment can be carried out safely.

2.3 Maintenance activities

Maintenance of equipment was the basic and mandatory activities in an industry. Many hazards that might be happen was due to lack of maintenance activities before, during and after operating a machine or an equipment. The following are the maintenance activities that will be done in a food processing industries. Such as: Operational maintenance (e.g. connection-disconnection of hoses, greasing,

lubrication and lubricant systems, adjusting sealing glands, cleaning and changing filters, 'nipping up' flanges) General cleaning Removal and replacement (e.g. gland packing, changing blades or cutters, replacing gaskets, replacing /maintaining seals, changing filter elements, servicing strainers).

2.4 Uses of Maintenance Requirement

Are used to maintain typical equipment faults and related causes, including signs and symptoms of faulty equipment and early warning signs of potential problems

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 - Short Answer Questions

1. Define maintenance requirement (3points)
2. Describe uses of maintenance requirement (3pts)

Note: Satisfactory rating – 5 points Unsatisfactory - below 5

You can ask you teacher for the copy of the correct

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AKNOWLEDGEMENT

We wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

We would like also to express our appreciation to the TVET Instructors and respective industry experts of Regional TVET Beau rues, TVET College/ Institutes, BEAR II Project, UNESCO and Federal Technical and Vocational Education and Training Agency (FTVET) who made the development of this Teaching, Training and Learning Materials (TTLM) with required standards and quality possible.

This Teaching, Training and Learning Materials (TTLM) were developed on October 2020 at Bishoftu Management Institute Center.

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