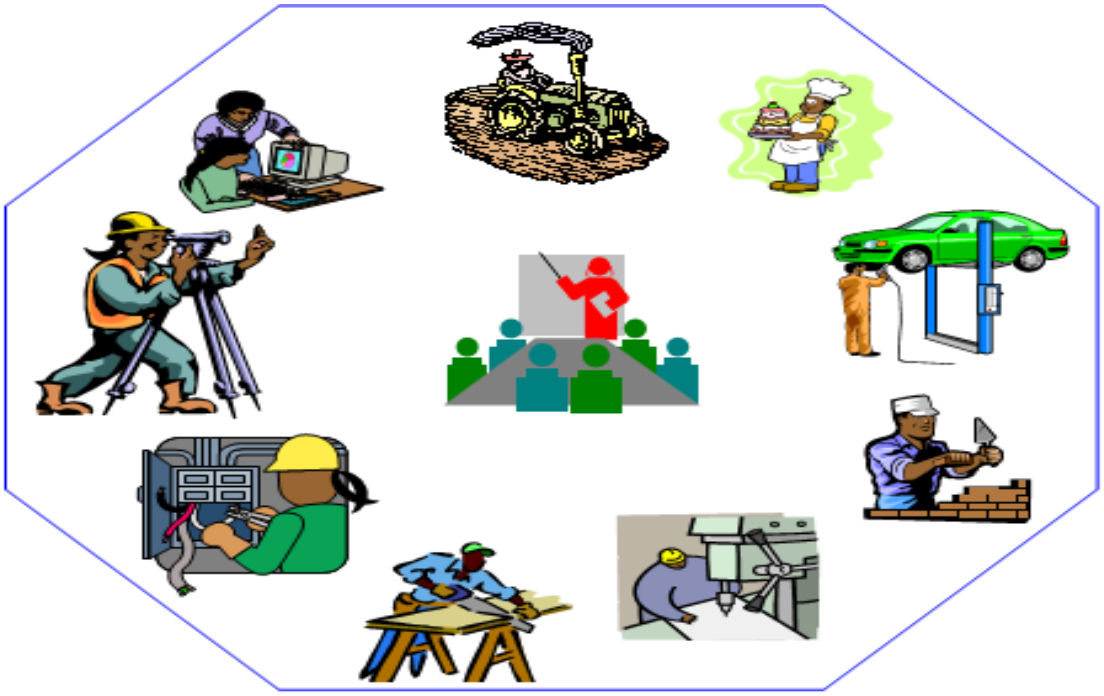
Edible oil and fats processing

Level-III

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



Module Title: Operating Interesterification Process

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Table of Contents

LG #50	LO #1- Prepare Interesterification 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
- Entering production/process parameters as required meeting safety and production requirements.
- Checking and adjusting Interesterification equipment performance.
- Carrying out pre-start checks Interesterification 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
- Enter production/process parameters as required meeting safety and production requirements.
- Check and adjusting Interesterification equipment performance.
- Carry out pre-start checks of Interesterification equipment

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 materials to meet operating requirements

1.1 Confirming different available materials

a) Catalyst

Immobilized lipases have been used successfully to achieve interesterification on an industrial scale. Lipases have been developed that will retain activity at temperatures up to 80 °C, but increased temperatures result in higher FFA and di-acyl-glycerol contents, which either require removal by refining or can adversely affect the product properties.

After catalyst addition to an oil or blend at slightly elevated temperatures under agitation, the triglyceride ester bonds are broken. The resulting fatty acids mix together and eventually reattach. If there is only one fat/oil or the fatty acids reattach to the same glycerol molecules, the specific reaction is sometimes called “intraesterification.” If the fatty acid attaches to a different glycerol molecule, it is termed interesterification.

Table1 Common Types of Chemical Interesterification Catalyst

Type of catalyst	Concentration (%)	Temperature (^{0}c)	Time (min)
Alkali metals Na, K, Na-K alloys	0.1-1	25-270	1-120
Alkoxides CH_3ONa, C_2H_5ONa	0.1-2	50-1 20	5-1 20
Alkali hydroxides NaOH, KOH	0.5-2	150-250	90
Mixture NaOH 0.5-0.1 + glycerol	0.5-0.1 +0.1-0.2	60-160	30-45
Metal soaps	0.5-1	250	60
Metal hydrides NaH, $NaNH_2$	0.2-2	170	3-1 20

Table2 Some Commercially Available Lipases and their Industrial Applications

Lipase Source	Application
Humicola lanuginose	Detergent additive
C. Cylindracea	Food processing
C. Rugosa	Organic synthesis
R. Miehei and M. miehei	Food processing
T. lanugi	Detergent additive
A. niger	Oleochemistry
Penicillium roquefortii	Food processing

b) Wash Water

To prevent contamination of washable oils with calcium and magnesium, soft water should be used for washing and in preparation of refining solutions

Figure1 washing palm oil tank

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. Lipases have been developed that will retain activity at temperatures up to 80 °C …..? (2pts)
2. After catalyst addition to an oil or blend at slightly elevated temperatures under agitation, the triglyceride ester bonds are broken**.** …..? (2pts)

Test II: Choose the best answer

1. **Which of the following are types of catalyst..?** (4pts)
   A. Alkali metals
   B. Alkoxides
   C. Alkali hydroxides
   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 2- Identifying and confirming cleaning and maintenance requirements and status

1.1 Identifying and confirming cleaning and maintenance

2.1.1 Identifying and confirming cleaning

a) Manual Cleaning

A comparative calculation of the economic efficiency between manual and robotic methods for cleaning oil tanks provides some details on the cleaning time. The cleaning time according to the process and the volume of the tank.

It can be seen from the table above that the average cleaning time of the manual method is about 3 times longer than the robotic cleaning time. Therefore, from previous data about the minimum cleaning performance of robotic cleaning, which is 10 m^3/h (meter cube per hour), we conclude that the average performance for manual cleaning is 3.5 m^3/h. This performance is a result of several factors. Starting from the beginning, the system installation time is much longer than other methods as it requires much different auxiliary and cleaning equipment, such as water jetting equipment, pumps, vacuum trucks, shovels, tool warehouses, containers, portable dressing rooms, toilets, restaurant, offices, and cranes.

Figure2 Manual Cleaning

b) Automated (Non-Human-Entry-Mechanical) Cleaning

Regarding the case studies provided by the company for cleaning crude oil tanks, the average yield of this cleaning method is 6.6 m^3/h working 24/7 or 160 m^3/day otherwise. This performance includes the transfer of equipment, installation, tank preparation (nitrogen blanketing), sludge removal and removal of equipment from the tank after completion of work.

The tank-cleaning machines clean effectively with no adverse effects on tank coatings, steam coils and other structures. This method offers maximum cleaning quality and inspection and repairs can be started directly.

Figure3 Automated Tank cleaning

c) Robotic Cleaning

This method is the most sophisticated one in the field of robotic cleaning because of the many advantages it offers over other methods. The equipment can be used in the cleaning of railway tanks, sludge collectors in oil refineries, as well as oil farms and gas-producing companies. The equipment is installed in 3 semitrailers (40 ft) and is transported by truck. It can be installed on any ground thanks to its flexible hydraulic system.

It does not require blanketing of the tank and can operate in environments with temperatures down to −35 °C. Installation takes place in a very short time (4–8 h) and does not require the use of a crane.

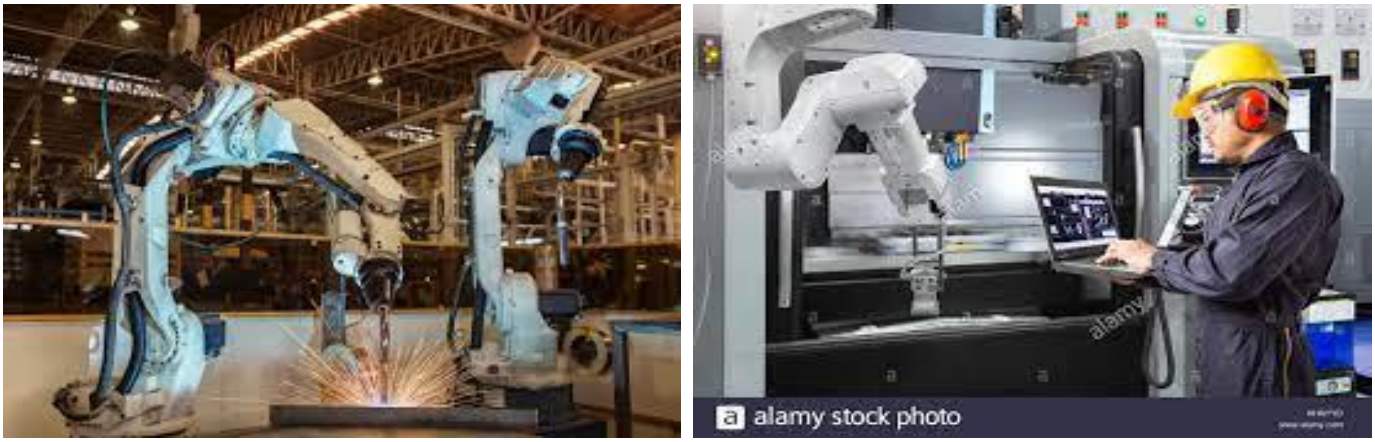

Figure4 Robotic Maintenance

2.1.2 Maintenance requirement determination

The development of maintenance policy for technical equipment involves the systematic application of a set of defined processes. These processes are collectively referred to as maintenance requirements determination (MRD).

- **The MRD process involves:**

a) Functional analysis

This form of analysis is based on the definition of system operational requirements and the system or equipment maintenance concept and is used as the basis of detailed design. MRD requires the results of functional analysis in order to identify failure modes, causes and effects, and associated criticality using failure modes, effect and criticality analysis (FMECA).

b) Maintenance determination

Once the failure modes and the effect of failure have been determined, they are used as inputs for determining the corrective and preventative maintenance requirements. The corrective maintenance determination is focused on identifying the necessary repair actions

required to return an item to serviceability. The preventative maintenance outcome is identified by the application of reliability centered maintenance (RCM)-based methodologies.

c) Maintenance task analysis (MTA)

After identifying the corrective and preventative maintenance requirements, the logistics resources necessary to support these requirements must be identified through the process of MTA. MTA will identify resources; for example:

- •Repairable and breakdown spares.
- •Trade skills and training.
- •Packaging handling and transport.
- •Procedures required performing the task
- •Facilities
- •Support and test equipment.

d) Level of repair analysis (LORA).

This consists of specialized models that look at the life-cycle cost (LCC) of performing maintenance tasks under different support scenarios. Used to determine the most cost-effective maintenance policy for a system or equipment. Maintenance policy must be subjected to appropriate LORA to ensure that defense resources are being efficiently and effectively utilized. Many of the commercially available LORA models are packaged with functions such as spares optimization and LCC analysis (LCCA).

e) Logistic support analysis record

The results of MRD must be documented in a manner that will enable the data to be used and updated throughout the material life cycle. Because MRD and LSA require similar inputs and share many common processes, the MRD results can be readily stored in a logistic support analysis record (LSAR) that has been modified with unique ADF tables.

f) Promulgation

The promulgation of maintenance requirements occurs through the issue of maintenance manuals and servicing schedules.

g) Performance monitoring and analysis

Performance monitoring, which involves the proactive monitoring of the maintenance program, can take many forms and utilize a variety of tools. The main aim is to identify developing trends or degraded performance. Such signs indicate the necessity of adjustment or review of one or more elements of the maintenance program, or of logistics support.

- **Maintenance requirements**

The maintenance requirements associated with healthcare technology have to align with the manufacturer specifications, the organization's medical equipment management plan, and regulatory bodies. The manufacture specifications and maintenance requirements are critical and can be used as a "starting point."

The service manual should provide specific instructions and steps toward ensuring the device is properly maintained and operating optimally. Keep in mind that with time and experience, HTM professionals can add additional steps to the manufacturer recommendations and even modify the recommended testing frequency, with justified historical maintenance data and information that show the change or modification in testing frequency or procedure, for example, does not increase the risk of failure or harm.

This has to be followed up with conducting a risk assessment to document the reasoning of this change. Different organizations have adopted various strategies to help ensure that all equipment is tested when required, with differing degrees of success. The best strategies often depend largely on local knowledge and contacts.

Figure5 Maintenance requirements

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. The average cleaning time of the manual method is about 3 times longer than the robotic cleaning time….?(4pts)

Test I: Choose the best Answer

1. **Which of the following are involved in Maintenance requirement determination**

Error! Bookmark not defined. **? (**3pts)

A) Maintenance task analysis

B) Level of repair analysis

C) Maintenance determination

D) All

2. Which of the following are types of maintenance…?(3pts)

A) Automated maintenance

B) Robotic maintenance

C) Manual 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 different available services

1.1 Confirming and made available materials

a) Power

General electricity use is through consumption by pumps, stirrers, electrical tracing and heating, lighting and the process control system.

- **Specific machines with relatively high electricity consumptions are:**
  - ✓ Centrifuges in deep degumming and neutralisation.
  - ✓ Cooling compressors in dewaxing, fractionation and dry condensing.
  - ✓ Cooling water circulation pumps and cooling tower
  - ✓ Vacuum pumps

Figure6 Transformers and electrical switch boards

b) Wash Water

Water is used in edible oil and fats processing plant for washing equipment. An adequate supply of potable (safe for drinking) water should be available from taps in the processing room. The drainage and sewage systems should be designed to prevent cross-connection of sewage with other wastes from the plant in order to avoid any potential for contamination.

Figure7 washing equipment's

c) Compressed Air

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 colour and taste, and reduced shelf life. Also, exposure to bacteria and other microorganisms can result in product recalls.

Figure8 compressor

d) 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. Intensive laboratory testing indicated that crude palm oil could be pretreated to remove trace metals and certain heat resistant organic compounds.

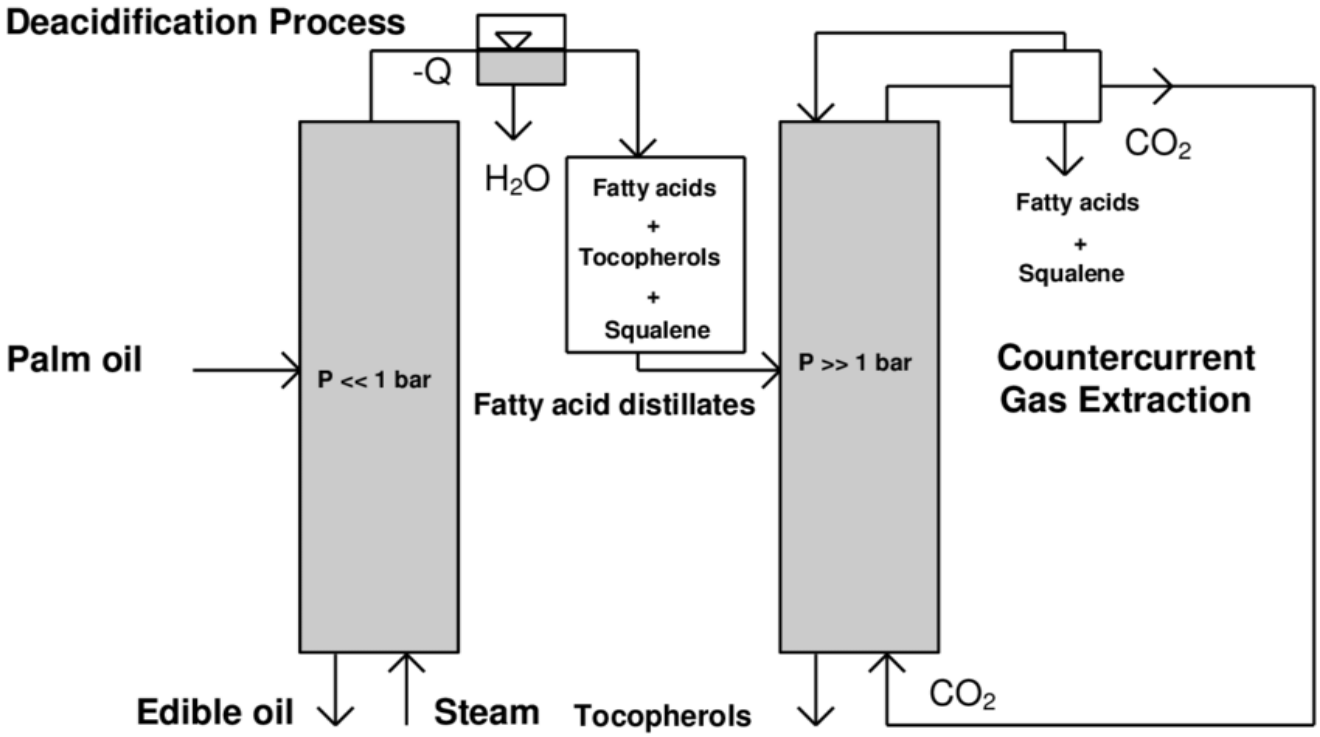

Figure9 Steam refining of Free-fatty acid

e) 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

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. Water is used in edible oil and fats processing plant for washing equipment. **….?(2pts)**
2. In many applications, compressed air is direct or indirect contact with food product**…(2pts)**

Test I: Choose the best Answer

1. **Which of the following is included in to services which are used in chocolate Extrusion? (3pts)**

A) steam C) water

B) power 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 4- Entering production/process parameters as required meeting safety and production requirements

4.1 Process parameters

As the crux of the process is a catalyzed, imperfect chemical reaction in a complex matrix, the main process parameters with which to influence the feasibility of the process are the quality of the oil, the concentration and type of catalyst and a reduction of the oil losses. The latter is achieved by keeping the former two under control.

a) Oil quality

The initial oil quality is important with respect to interesterification in the sense that minor components or contaminants will also consume the catalyst to a considerable degree. The reaction scheme outlined helps to explain why the presence of water can be a serious drawback for the 'pure reaction': moisture will consume the classic catalysts, such as sodium methylate, in the proportion of 1: 20.

FFA will also deactivate the catalyst, albeit less extremely and often a bit of caustic soda is added prior to the reaction. For this reason, in practice, the oil to be interesterified is at least neutralised (as in the case of soybean oil) or physically refined (as in the case of palm oil) before it enters into the production line.

b) Catalyst

In the light of the interesterification reaction, the active catalyst species needs to be an electron donor. It can be understood that in the early days, pure alkali metals such as sodium or potassium were ideal for such reactions, and in smallscale operations these proved successful. However, for larger operations the most used catalysts for interesterification are the alkoxides, with sodium methoxide (or **sodium methylate**) as the principal catalyst, because of the high reaction rate at rather low temperatures. This catalyst allows for a relatively clean separation after the reaction. The applied concentrations of catalysts generally range between 0.05 and 1.5%.

c) Oil losses

Depending on the pH of the water added to inactivate the reaction, the oily material lost will largely consist of fatty acid methyl ester (FAME) and FFA or soaps. Generally, between FFA and soaps, the former is the preferred end form, as in the common concentrations it is good practice to remove FFA in the post-process deodorization step, whereas soaps generally require a supplementary adsorption or washing step for adequate removal.

Apart from the direct loss of oleaginous material, such post-treatment implies an additional 'neutral oil loss' through carry-over in the deodorizer or incomplete separation during the filtration step, respectively. It should also be realized that due to the stoichiometric nature of the interesterification (and deactivation) reaction, the creation of FAME and FFA is proportional to the amount of catalyst used.

So as more catalyst generates more side products (direct loss) and more side products will imply higher neutral oil loss (indirect loss) by a factor 1.0–1.5, it is crucial to optimize the catalyst dosing to reduce the losses and keep the process affordable.

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. FFA will also deactivate the catalyst….? (3pts)
2. Depending on the pH of the water added to inactivate the reaction, the oily material lost will largely consist of fatty acid methyl ester (FAME) and FFA or soaps..? (3pts)

Test II: Choose the best answer

1. **Which of the followings are main intereserification process parameters with which to influence the feasibility of the process….?4pts**

A. Quality of the oil

B. Concentration of the oil

C. Type of catalyst and reduction of the oil losses.

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- Checking and adjusting Interesterification Equipment performance

5.1 Checking and adjusting Interesterification Equipment performance

- **Interesterification equipment**

A. Tankers

Land Storage Tanks the most suitable shape is the vertical, circular cross-section tank with self-supporting fixed roof, preferably conical in shape. Where possible, tall, narrow tanks are preferred to minimize the surface areas of the contents and, therefore, to minimize contact of the oils or fats with air and the oxygen it contains.

Tank bottoms should be conical or sloped (with a sump) to facilitate draining. All openings such as manholes, inlets, outlets, draining out points, etc., should be made such that they can be locked and/or effectively sealed. For each installation, the total storage capacity, size and number of tanks need to be related to the size and frequency of intakes, rates of turnover and the number of different products handled.

Figure10 Storage Tanker

B. Reactor

The plasma electro-catalysis assisted Trans esterification process was performed in a dielectric barrier discharge (DBD) **plasma reactor**. The DBD plasma reactor consists of a high voltage electrode, a ground electrode, DC-type high voltage power supply, a high voltage probe, and a barrier of glass material. The reactor is heated to 65^0Cbelow the boiling point of methanol.

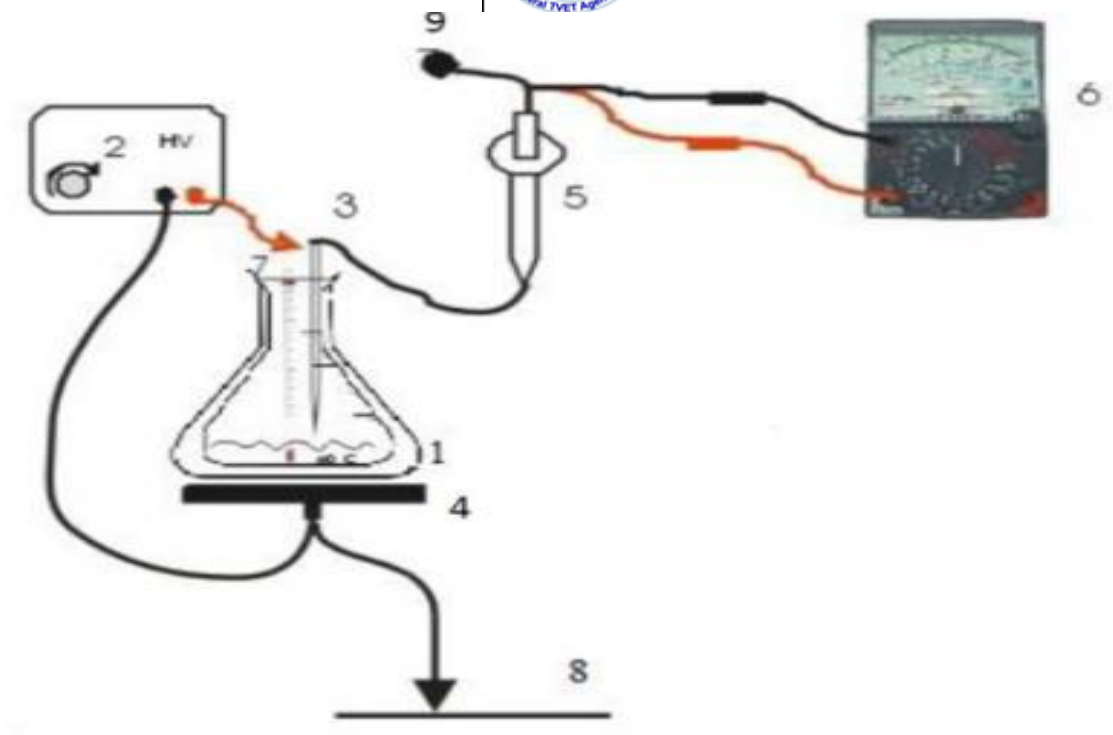

Figure 11 Schematic diagram of plasma electro-catalysis assisted trans-esterification process

Key: (1) plasma reactor, (2) high voltage power supply, (3) high voltage electrode, (4) ground electrode, (5) high voltage probe, (6) multimeter, (7) thermometer, (8) earth ground, (9) high voltage probe ground.

C. Washing Equipment

Using the right **wash** cycle is very **important** as it protect the machine from getting damaged. **Washing machines** not only save our time but also save us from the physical effort of hand-**washing**. Moreover, with technological advancements in the **washing machines** have become more convenient

Figure 12 Tank washing Equipment

Figure13 Oil product Tank cleaning system

D. Drying vessel

Conventional drying processes can damage heat-sensitive materials such as food, medication, chemicals or electronic components, or change their product properties. Carrying out the drying process in a vacuum drying chamber reduces this risk to a minimum. Vacuum drying is one of the most effective and gentle drying methods available. The aim of this method is to gently dry a high-grade product that contains water or a solvent without endangering the materials.

Vacuum dryer can be used to dry heat sensitive hygroscopic and toxic materials. To improve quality of products, such as for product preservation, hybrid **drying** combining osmotic dehydration followed by heat pump drying and **microwave-vacuum drying** proved effective.

Figure14 Vacuum dryer

E. Pumps

Variety of pumps and pumping applications can be found in the palm oil industries, including the production process, cooling water, and water and wastewater treatment. Therefore, you will find a wide range of high-quality pumps to cater to almost every need in the palm oil industries.

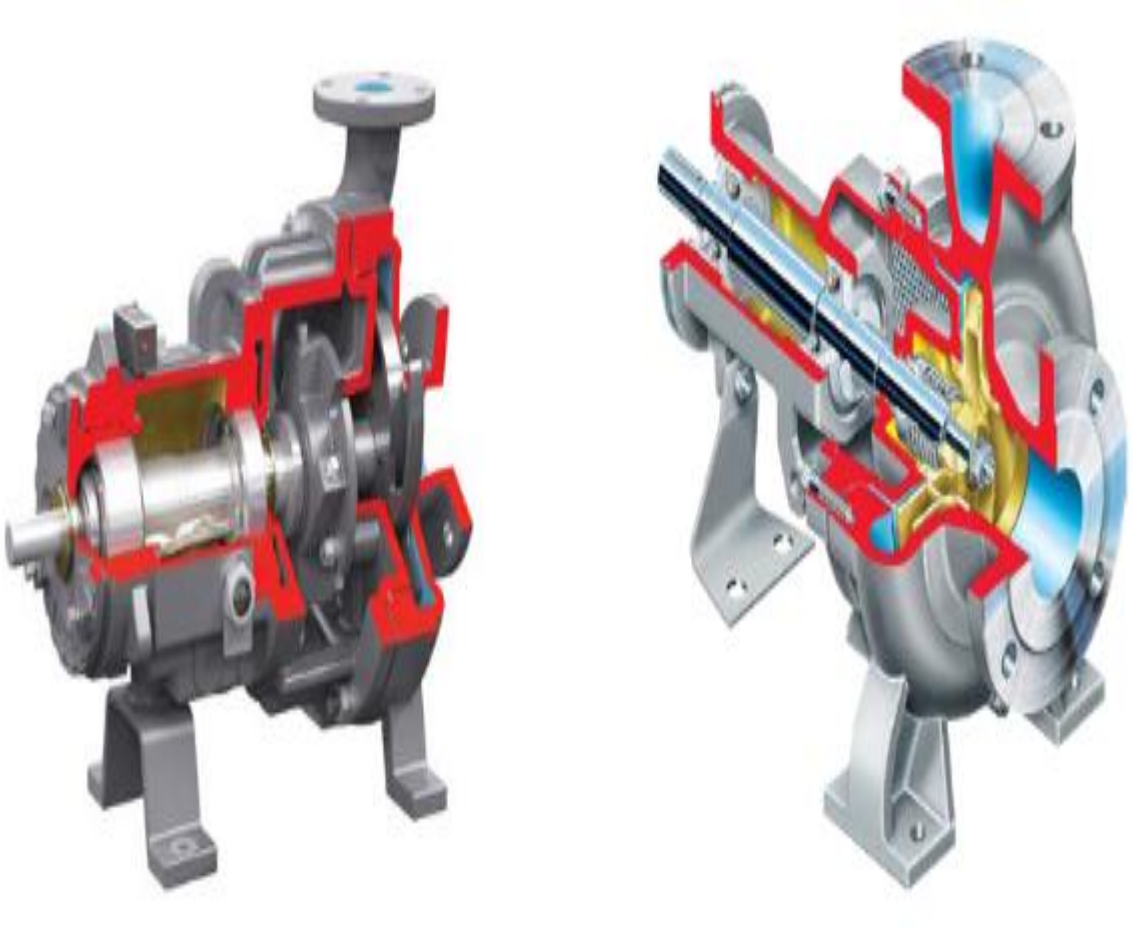

Figure15 Pumps in palm oil industries

F. Filter system

Palm oil filtration process is very important process in the palm oil processing process; it refers to remove the unwanted impurities from the crude palm oil, such as fibers, sands, water and so on.

The hybrid Filter system consists of a feed water sedimentation tank, adsorption reactor, a micron filter, a peristaltic pump, a membrane module and a permeate tank.

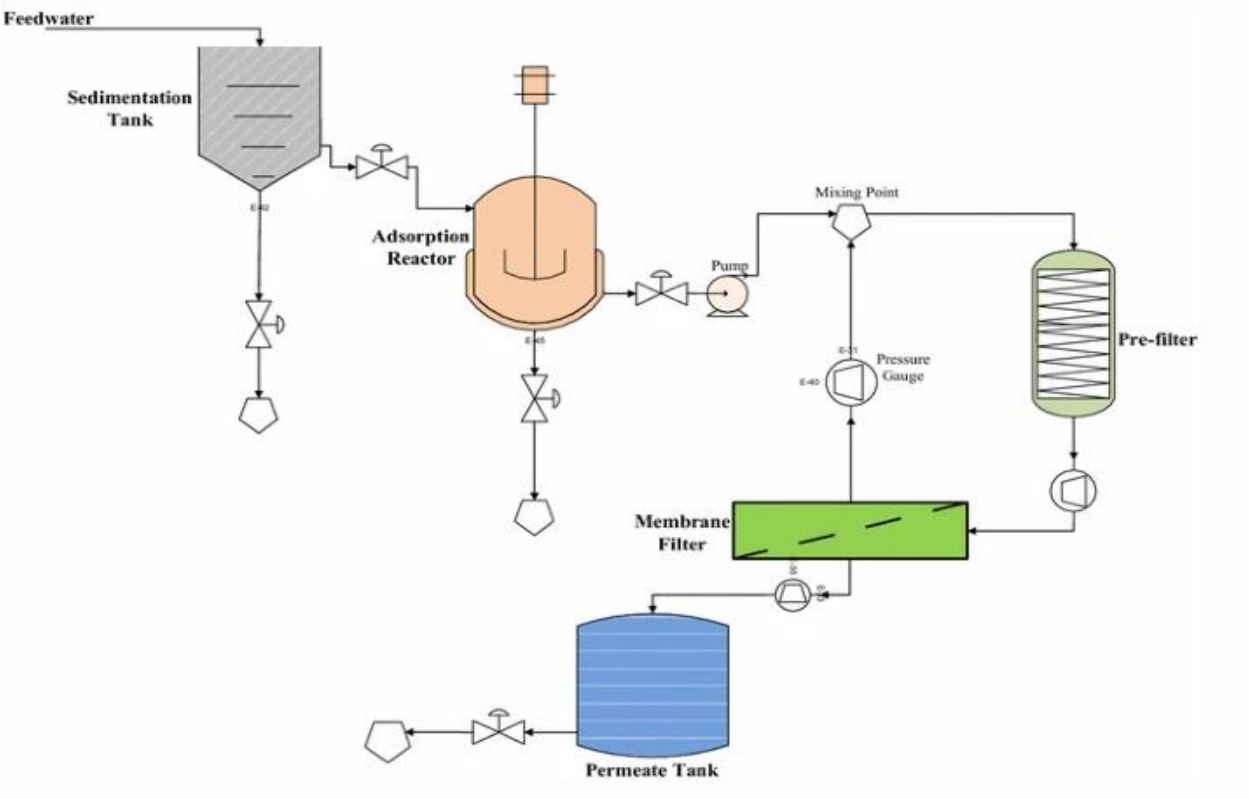

Figure16 Filter system

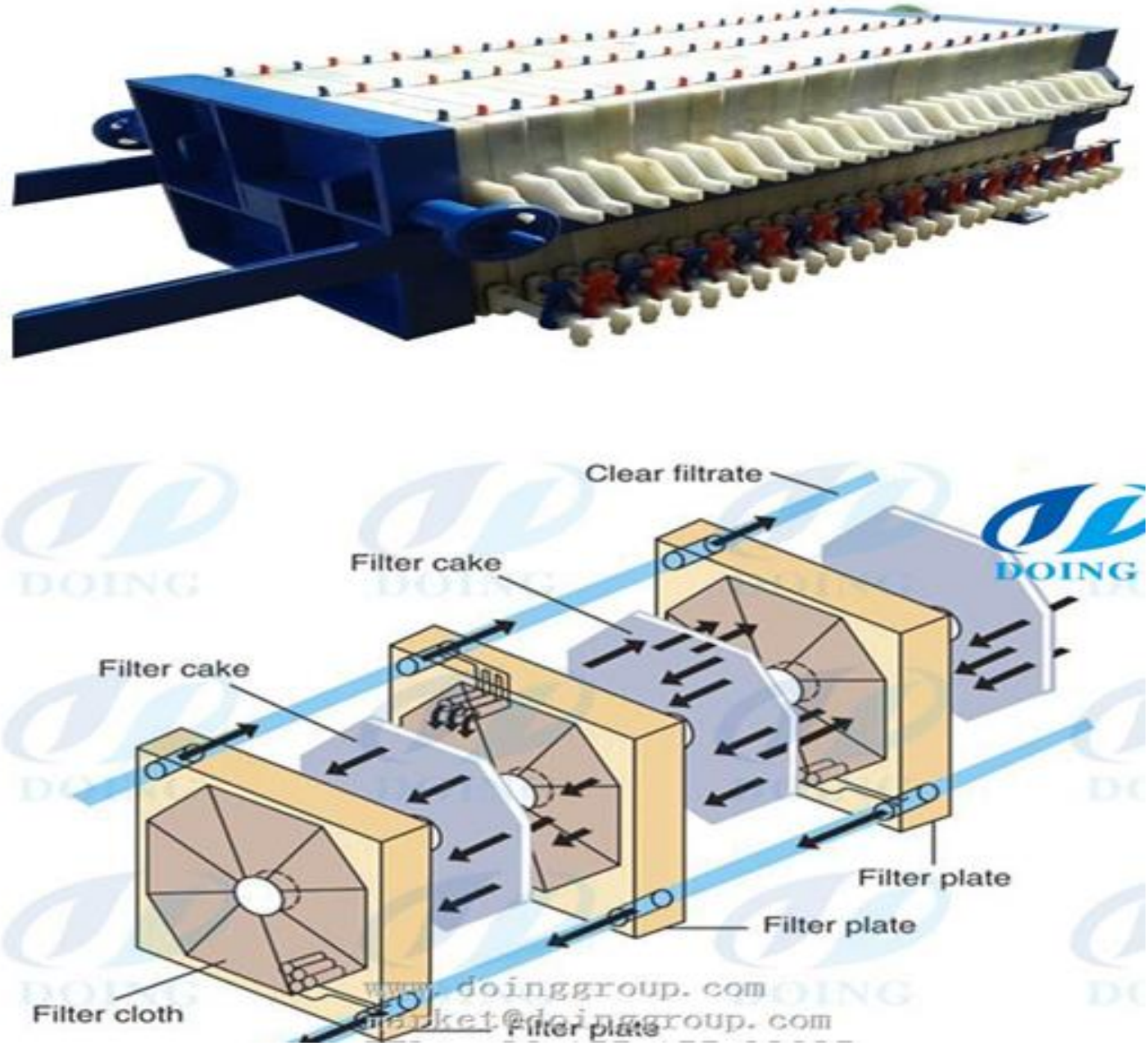

Figure17 palm oil filter

G. Separators (centrifuges)

Centrifuges are employed in Several Stages of the Process:

- **Purifiers** for separating glycerol water from fatty acid ester and biodiesel washing
- **Clarifier separator** for separating ultrafine substances from biodiesel
- **Tricanter** for processing the raw material before esterification
- **Tricanter** for 3-phase separation of free fatty acids, glycerol and precipitated salts, e.g. calcium sulphate, in one working procedure in glycerol processing
- **Decanter** for rewashing precipitated salts, e.g. calcium sulphate in glycerol processing

Advantages in Glycerol Separation and Biodiesel Washing:

- Highly efficient separation with the separator, with minimum electricity consumption
- High purity and high quality
- Explosion protection according to ATEX95 guidelines
- All components in gas-tight configuration with nitrogen blanketing

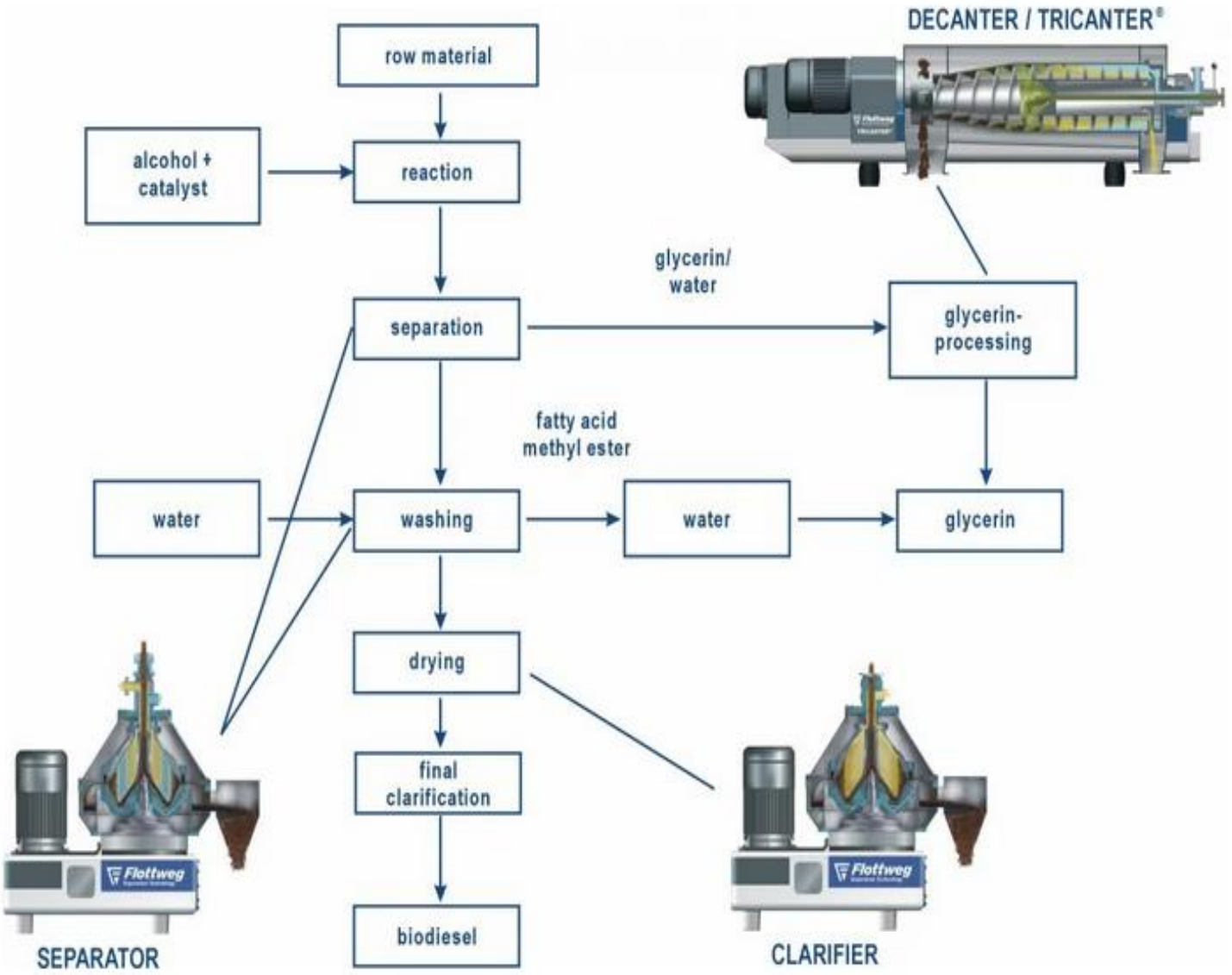

Figure18 manufacture of glycerin

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. Tank bottoms should be conical or sloped (with a sump) to facilitate draining. …?(2pts)

Test I: Choose the best answer

1. **Which of the following are advantages in Glycerol Separation**….**4pts**

A. Highly efficient separation with the separator, with minimum electricity consumption

B. High purity and high quality

C. Explosion protection according to ATEX95 guidelines

D. All components in gas-tight configuration with nitrogen blanketing

E. All

2. Which of the Interesterification equipment…. (4pts)

A. Tankers
B. Centrifugal separator
C. Drying vessel
D. Pumps
E. 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- Carrying out pre-start checks of interesterification equipment

6.1 Carrying out pre-start checks of interesterification 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:-

- **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.

- **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.

- **Filling and checking fluids**

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

- **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

- **Start-up phase**

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

- **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

The technicians should follow a start-up checklist. Beginning with the machine inter locks, the checklist will include:

- ✓ Verification of all safety devices and system interlocks
- ✓ Verification of temperatures, speeds and other indicated values
- ✓ Mechanical items related to machinery operation
- ✓ Complete system dry test
- ✓ Generation, recording, and completion of documentation

- **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.

- **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 points** **Unsatisfactory - below 10 points**

LG #51	LO#2- Operate and monitor the interesterification 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 interesterification 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 interesterification methods to confirm that interesterification 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

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Information Sheet 1- Starting and operating the process to achieve required outcomes

1.1 Starting and operating the process to achieve required outcomes

- **Oils and Fats Modification Methods**
  - ✓ Different functionalities (nutritional and physical) require specific compositions that are usually not found in a single natural fat or oil
  - ✓ For this reason, fats and oils are often modified in order to achieve these desired compositions and thus physical and nutritional properties
- **Oils and Fats Modification Methods**
  - i. Blending
  - ii. Fractionation
  - iii. Hydrogenation
  - iv. Interesterification (chemical or enzymatic)
  - v. Genetic Improvement (GIO)

A. Interesterification (chemical or enzymatic)

The term interesterification refers to a chemical or enzymatic process that rearranges the fatty acids on the glycerol backbone of a TAG molecule, in either a random or a specific way. The altered proportions of TAG molecular species that result from rearrangement can confer useful functional characteristics, including a higher melting point and altered crystalline structure, and typically increases the solid content of a fat.

Position-specific enzymatic interesterification can also be used to create infant formula products with specific TAG molecular species, which mimic the composition of human breast milk and may aid fat absorption.

a) Chemical interesterification

Chemical interesterification typically uses **sodium methoxide** as the catalyst and involves hydrolysis and random redistribution of all fatty acids within a TAG mixture.

Chemical interesterification has been in commercial use since the 1940s, when it was used to modify the solid fat content of lard as a means of improving its spread-ability and baking properties. It remains the main form of interesterification used in the UK.

- **Random Interesterification.**

This is the most common type of chemical INES. If one knows the fatty acid composition of the initial component(s), the final triacylglyceride composition (TAG analysis) can be predicted accurately, as shown earlier. The reaction normally reaches equilibrium within 30-60 min of catalyst addition.

- **Directed Interesterification.**

This is a modification of random interesterification. The reaction is directed, in that the natural equilibrium is interrupted. This is usually as accomplished by temperature, in most cases, a low temperature.

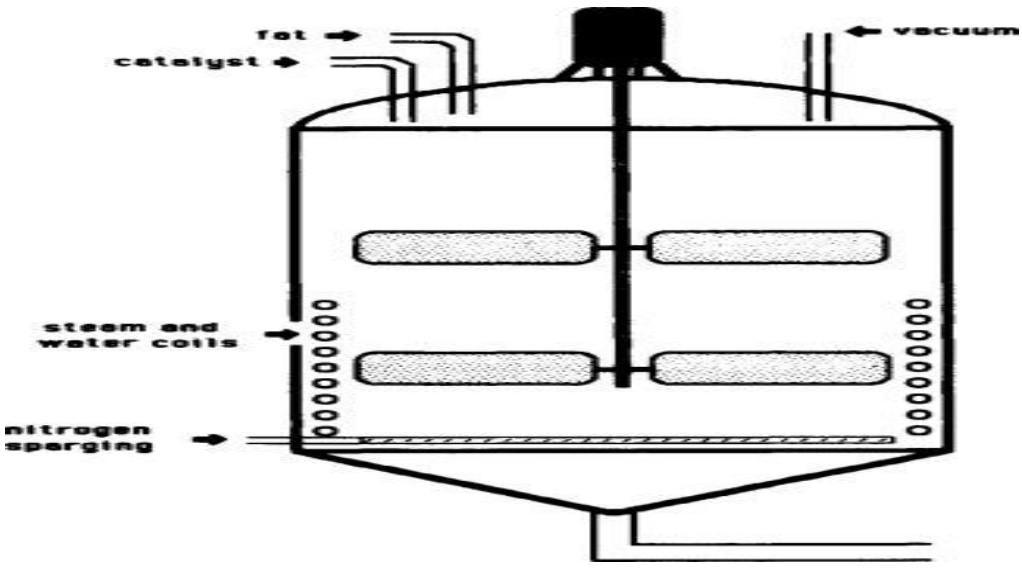


Figure19 typical batch reaction vessel for chemical interesterification

- **Method of Chemical interesterification**

At first, PS (palm stearin) was melted at 85°C and blends of PS: SFO (sunflower oil) in the mass ratios of 10:90, 30:70, and 50:50 were prepared (400 g). Prior to chemical interesterification, the blends were heated under vacuum (at 0.8 bar abs, 100°C for 15 min) to remove traces of water. Dried blends were charged into a vacuum flask and brought to 90°C. In the next step, 0.5% (w/w) dry sodium meth-oxide was added into the dried fat blends, and the interesterification process continued for 1 hr (at 90°C, under 0.8 bar abs and 300 rpm).

During the interesterification process, SMP of fat blends alters until reaching constant values. Therefore, the reaction equilibrium was monitored by SMP (slip melting point) determination. After reaching the reaction equilibrium point, to inactivate the catalyst, 2% (w/w) aqueous citric acid solution (20%, w/v) was added. Then, the stirring of mixture was continued for 15 min (at 70°C and 300 rpm). The excess alkalinity, sodium meth-oxide, and citric acid were removed by addition of 1.5% bleaching earth (bentonite) into the blends (at 300 rpm, under 0.8 bar abs and at 110°C for 15 min).

b) Enzymatic interesterification

Enzymatic interesterification uses microbial sourced **lipase enzymes** (e.g. from Candida rugosa) and gives either a random or specific redistribution of fatty acids, depending on the specificity of the lipases used.

Enzymatic interesterification was first developed in the early 1980s to provide a cheaper source of confectionery fat to replace cocoa butter, by modifying the TAG molecules within palm oil and has subsequently become the predominant interesterification method used in the US and Canada. While enzymatic interesterification may have lower equipment costs than chemical interesterification, it requires the use of a more expensive catalyst (lipase enzyme compared to sodium methoxide).

However, enzymatic methods can be carried out at lower operating temperatures, lead to lower neutral oil losses and preserve the oxidative stability of the resulting product.

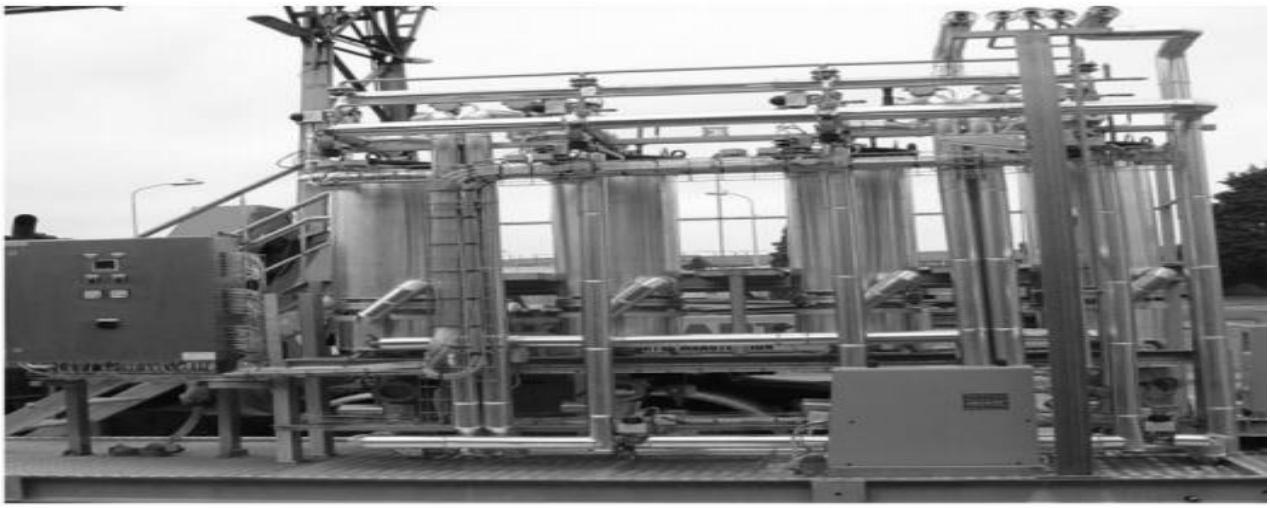
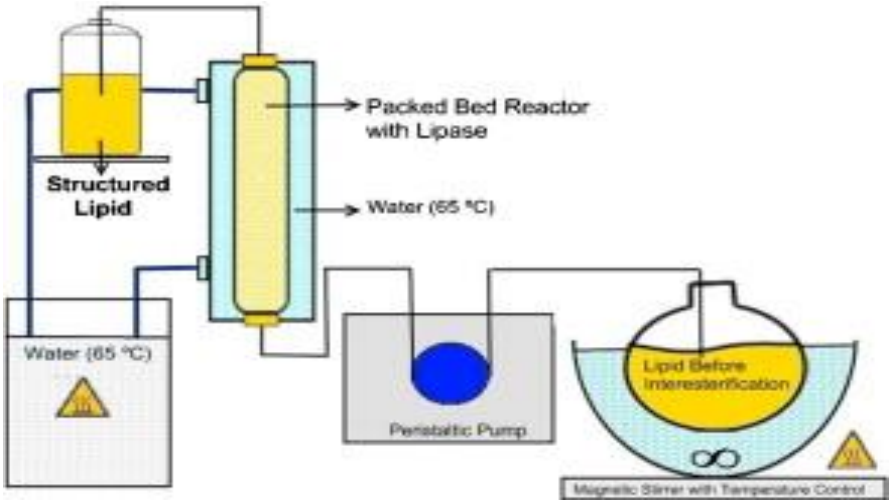


Figure20 Industrial enzymatic interesterification plant (four packed-bed reactors)

The fatty acid groups in triacylglycerol's can be rearranged within single oil (intraesterification) or by exchange of fatty acid groups with those of other oils, the latter being known as interesterification. As is the case with the other oil modification processes, the purpose of interesterification is to alter the melting properties of the fat or fat blend in order to improve the functional properties of the product. The reaction requires the presence of a catalyst, and alkaline catalysts are generally used. In particular, sodium methylate, also referred to as sodium methoxide, is extensively used, but metallic sodium has also been used.



Figur21 Enzymatic Interesterification

In the early stages of the development of this process, both directed interesterification and random interesterification were proposed for use, the former involving interesterification and simultaneous cooling in order to crystallize the saturated triacylglycerols being formed and thus move the equilibrium towards the formation of more saturated triacylglycerols. Random interesterification, however, simply aims to randomize the distribution of the available fatty acid groups on the glycerol molecule and thereby to alter the melting properties of the fat or oil blend.

Indeed, more and more fat processing industries are shifting to enzymatic processing technology. In this light, it should not be forgotten that in the commodity oils and fats industry, the economy of a process is still more important than its novelty. As such, the attraction of an enzymatic randomization process consists largely in the fact that it generates fewer oil losses than the chemical technology, rather than an enhanced (or faster) randomization. It also means that enzymatic technology will be adopted by fats and oils manufacturers for as long as the enzyme cost does not exceed the cost of oil losses that can be expected in chemical interesterification. Though the quality and the stability of the enzyme lipases have evolved considerably, the general perception in the industry is that this technology is less robust than its chemical counterpart.

Examples of products made via INES include the following:

- Low/no-trans margarines and shortenings
- Cocoa butter substitutes, alternatives, and equivalents
- Low- and no-calorie fats and oils (Salatrim, Caprenin, OlestrdOlean)
- Nutritionally designed fats and oils

Note:-Video **Interesterification**

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: Say true or false

1. The term interesterification refers to a chemical or enzymatic process that rearranges the fatty acids on the glycerol backbone of a TAG molecule …? **(2pts)**
2. While enzymatic interesterification may have lower equipment costs than chemical interesterification **….?(2pts)**

Test II: Choose the best answer

1. **Which of the following are oils and fats modification methods...? (3pts)**
   A. Blending
   B. Fractionation
   C. Hydrogenation
   D. Interesterification (chemical or enzymatic)
   E. Genetic Improvement (GIO)
   F. All
2. Which of the following are examples of products made via INES…? **(3pts)**
   A) Low/no-trans margarines and shortenings
   B) Cocoa butter substitutes, alternatives, and equivalents
   C) Low- and no-calorie fats and oils
   D) Nutritionally designed fats and oils
   E) All

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

Note: **Satisfactory rating – Answers all** **Unsatisfactory – below 10 points**

Information Sheet 2- Workplace Policies and procedures

2.1 Workplace Policies and procedures

Many workplaces, environmental, food safety, and other regulations apply to oilseed processors and oil refiners. Most of the environmental and workplace legislation came about in the 1970s in response to increased general public awareness, concern, and desire for a cleaner environment, safer workplace, and safer food supply. This has led to an increasing number of regulations, and it is expected that there will continue to be more and stricter regulation in the future.

2.1.1 Workplace Regulations (OSHA)

Workplace regulations are promulgated and enforced by the Occupational Safety and Health Administration (OSHA). The purpose of OSHA is to ensure that employers maintain a safe and healthful workplace. OSHA general industry standards [29 Code of Federal Regulations (CFR) 19101 apply to oilseed extraction and oil refining, and several of these workplace standards are discussed. Many other health and safety standards that cover all industries (e.g., blood borne pathogens, noise, and lockout/tag-out) also apply. In addition, even if there is not a specific standard, OSHA can site a facility under the “general duty clause” [Sec. 5(a) (1) of the OSH Act] because the OSH Act requires the employer to maintain a safe and healthful workplace.

a) Air Contaminants Standard (29 CFR 191 0.1000)

The purpose of the air contaminants standards is to reduce risk of occupational illness for workers by reducing permissible exposure limits (PELs) for chemicals. Table 16.3 lists the PELs for n-hexane, hexane isomers, and some other solvents and chemicals. PEL are 8-h time-weighted average (TWA) exposures. To achieve compliance with the PELs, administrative or engineering controls must first be determined and implemented, whenever feasible. When such controls are not feasible to achieve full compliance, personal protective equipment, work practices, or any other protective measures are to be used to keep employee exposure below the PEL.

b) Hazard Communication Standard (HCS) (29 CFR 1910.1200)

The **HCS** requires all employers to provide information to their employees on the hazardous chemicals to which they are exposed through:-

- hazard communication programs
- labels and other forms of warning
- material safety data sheets (MSDS)
- and training programs

A written hazard communications program and recordkeeping are also required. A substance is a “hazardous chemical” if it is a “physical hazard” or a “health hazard” [29 CFR 19 10.1200 (c)].

Flammable or explosive liquid is a “physical hazard.” A flammable liquid means “any liquid having a flashpoint below 110^{O}F (37.8OC), except any mixture having components with flashpoints of 100°F (37.8OC) or higher.

“**Health hazard”** means “a chemical for which there is statistically significant evidence based on at least one valid study that acute or chronic health effects may occur in exposed employees.

c) Process Safety Management (PSM) Standard (29 CFR 191 0.1 19)

PSM is for the prevention or minimization of the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. This regulation applies to all processes that involve one or more of 137 listed chemicals (29 CFR 19 10.1 19, Appendix A) above their threshold quantities or have 210,000 lb of a flammable liquid or gas, as defined by the U.S. OSHA HCS [29 CFR 1910.1200(~)]. This includes n-hexane, hexane isomers, and the other solvents.

2.1.2 Environmental Regulations (EPA)

The Environmental Protection Agency (EPA) administers all regulations affecting the environment and chemicals in commerce. The purpose of the EPA is to protect human health and welfare and the environment.

The legislation that serves as the basis for the regulations can be divided into the following statute areas:

1. Statutes that are media-specific [Clean Air Act (CAA) and Clean Water Act (CWA)].
2. Statutes that manage solid and hazardous waste [Resources Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA; "Superfund")].
3. Statutes that directly limit the production rather than the release of chemical substance [Toxic Substances Control Act (TSCA) and Federal Insecticide, Fungicide and Rode-nicide Act (FIFRA)].

I) Clean Air Act (CAA; 42 US. Code 7401 et se9.)

The purpose of the CAA is to protect the public health and welfare. To satisfy the CAA requirements, states and state air control boards are required to implement regulations and develop state implementation plans (SIP) (1 3,14).

II) Oil and Hazardous Substances Spills and Response Plans.

Under Oil Pollution Prevention and Response (40 CFR 112), there are requirements for oilseed extraction and refining for storage and transportation of vegetable oil.

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: Say true or false

1. The purpose of the air contaminants standards is to reduce risk of occupational illness for workers **…? (2pts)**
2. Flammable or explosive liquid is a “physical hazard.” **….?(2pts**)
3.

Test II: Choose the best answer

1. **One of the following is included in Hazard Communication Standard…4pts**
   A. hazard communication programs
   B. labels and other forms of warning
   C. material safety data sheets (MSDS)
   D. and training programs

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

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

Information Sheet 3- Monitoring operation of equipment to identify variation

3.1 Monitoring operation of equipment to identify variation

- **Use process control panels and systems**

Industrial Control Panels Impacting the Food Industry

The food industry is respectfully one of the largest and most important to human life. Industrial control panels play a vital role in the different roles of the production process. High-quality digital control panels ensure safety, quality and the streamlining of the production process. An important thing to distinguish at this point is that, unlike other industries, the food industry is divided into different subsections. The food industry divides further into 4 main categories:

- Food processing industry
- Food production industry
- Extraction industry
- Food Service industry

Automatic Control System for Edible Oil Processing Plant

1. Process Design

With the whole plant production process displayed on the computer screen, Myande auto-control system allows for simulation & real-time dynamic inspection of each equipment unit, modification of all pre-set parameters, and automatic adjustment of working parameters. It is capable of intelligent system control, auto backup of system programs with data recovery function, storage of process data and real-time print-out of all types of the production data report.

2. Project Capacity

a. Providing automatic control system for oils & fats, starch extraction, Fermentation.
b. System-based modular design with the customized control process
c. Fully computerized high precision adjustment of process parameters
d. High reliability of the control process and capability of monitoring the complete production line.
e. Extraordinary user-friendliness is capable of remote control.

3. Service Police and Technical Support

Generally, we guarantee all equipment are completely new and unused, and under normal operation conditions the warranty period would be 12 months after installation or 18 months from the date of shipments whichever comes first.

We can send experienced and qualified engineers (electrical engineer and mechanical engineer) to the Buyer's site for the supervision of equipment installation and commissioning. And after the plant had been successfully commissioned, our engineer will stay to train the buyer's plant personnel in process operations and equipment maintenance by

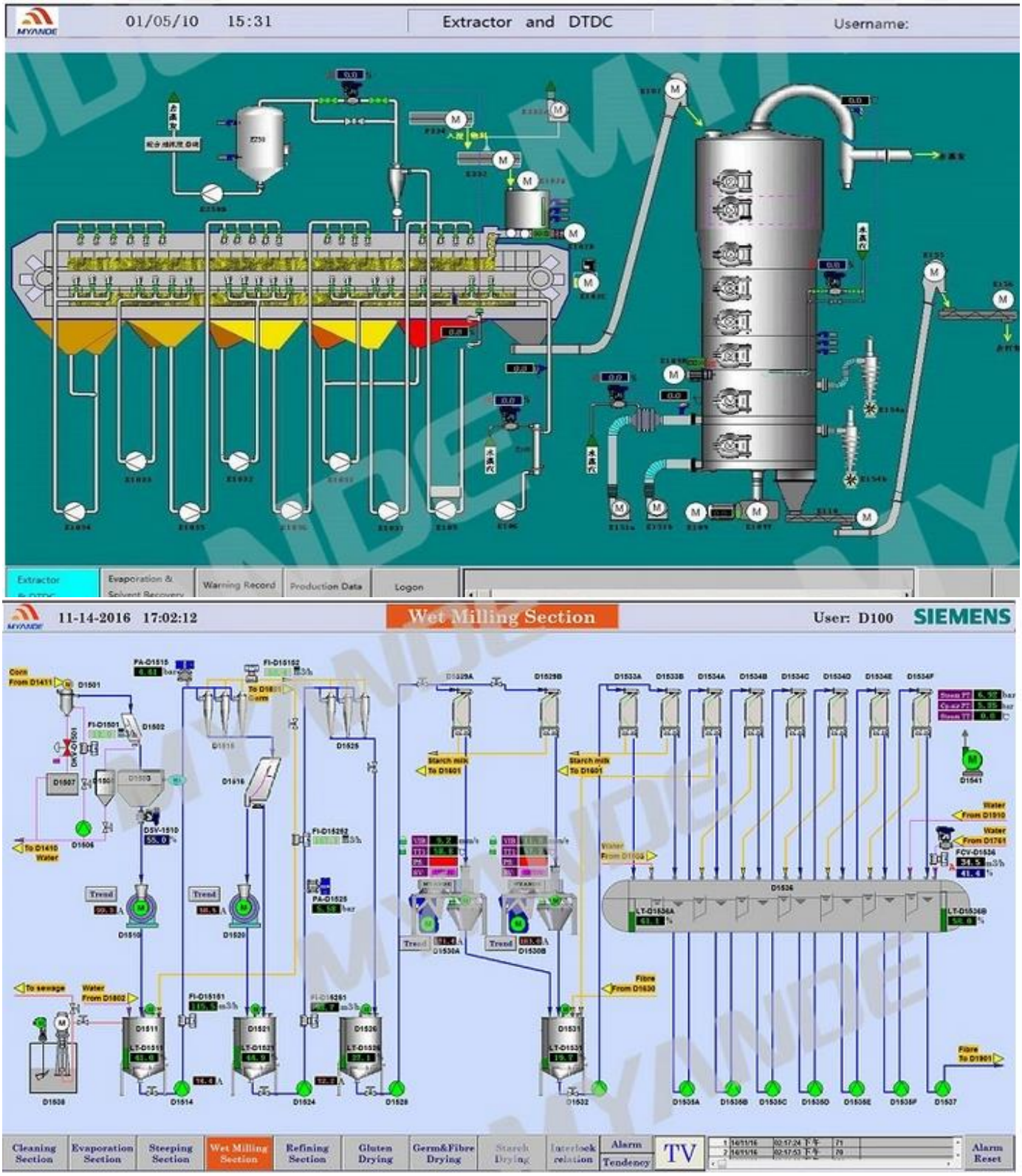


Figure22 Control panel system

- **Fulfilling the Need for Controls**

The equipment needing control can be from any subsection/category among the food industry. There are two important types of controls; human controls, and; any other types of controls.

Human controls we have highlighted above are inadequate. How can you be able to monitor a production facility of 800 machines producing thousands of products each day with a few employees at your disposal? If you increase the number of employees will the firm be able to reap the competitive advantages of using machine technologies when a plethora of employees are also part of its pay roll? As a result of questions like these, digital control panels were developed to exercise control over equipment.

Control Panels have a number of advantages. One of them is being able to fulfill the need for controls. There are several types of quality control panels available in the market, some of them are designed to deal with single equipment, other times they are designed with a technological capability of controlling a number of different equipment at once.

Figure23 process control room edible oil processing plant

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 food industry is respectfully one of the largest and most important to human life….**.?(2pts)**
2. Industrial control panels play a vital role in the different roles of the production process**..?(2pts)**

Test II: Choose the best answer

1. One of the following is 4 main categories of food industry **(3pts)**
   A. Food processing industry
   B. Food production industry

Information Sheet 4- Identifying variation in equipment operation and Reporting Maintenance requirement

raction industry

2. Which of the following controls in oil industry is best?
   A. Human controls
   B. Control panel controls.
   C. B is Answer

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

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

4.1 Identifying variation in equipment operation

Equipment Variation (EV) this is the "within appraiser" **variation**. It measures the **variation** one appraiser has when measuring the same part (and the same characteristic) using the same gage more than one time.

Process variation happens when **processes** fail to follow a precise pattern. It's a leading cause of quality issues both in transactional and production **processes**. ... When quality issues arise, the problem is often only identified once the issue has turned into a full-blown disaster.

There are two basic types which can occur in a process:

- Common cause
- Special cause.

a) Common Cause

Common cause variation happens in standard operating conditions. Think about the factory we mentioned before. Fluctuations might occur due to:

- temperature
- humidity
- metal quality
- Machine wear and tear.

Common cause variation has a trend that you can chart. In the factory mentioned before, product differences might be caused by air humidity. You can chart those differences over time. Then you can compare that chart to weather bureau humidity data.

- Common cause **variation** is inherent to the system. This **variation** can be changed only by improving the equipment or changing the work procedures; the operator has little influence over it.

b) Special Cause

Conversely, special cause variation occurs in ***non***-standard operating conditions. Let's go back to the example factory mentioned before. Disparities could occur if:

- Substandard metal was delivered.
- One of the machines broke down.
- Worker forgot the process and made a lot of unusual mistakes.

This type of variation does not have a trend that can be charted. Imagine a supplier delivers a substandard material once in a three-month period. Subsequently, you won't see a trend in a chart. Instead, you'll see a departure from a trend. Assignable **cause variation** comes from sources outside of the system

Importance of Differentiate

It's important to separate common cause and special cause because:

- Different factors affect them.
- We should use different methods to counter each.

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. Process variation happens when processes fail to follow a precise pattern **…?(2pts)**
2. Special cause variation occurs in non-standard operating conditions?**(2pts)**

Test I: Choose the best answer

1. **Which of the following is true about the occurrence of Fluctuations**
   A. temperature
   B. humidity
   C. metal quality
   D. All
2. **Which of the following is reason to separate common cause and special cause because**

A. Different factors affect them

B. We should use different methods to counter each

C. All are answer

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

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

Information Sheet 5- Monitoring the interesterification process to meets melting point and odor specification

5.1 Interesterification process

The **interesterification** process is used to modify the physical properties of the oil or fat blend by rearranging the fatty acid groups within and between the different triglycerides. It is applied directly to naturally derived oils or fats, or to hydrogenated or fractionated oils

5.1.2 Trans esterification

Although the primary focus is trans-esterification, including random, directed, and enzymatic variations, we will begin with a brief overview of acidolysis, alcoholysis and glycerolysis.

a) Acidolysis

Acidolysis is the exchange reaction between a fat/oil and free fatty acids. This is the least used **INES** process. The reaction results in less selectivity; it is relatively time consuming and requires high temperatures. The finished product composition is also difficult to duplicate because the interchange of both free fatty acids and fatty acids available in the fat/oil is random.

b) Alcoholysis

Alcoholysis refers to the reaction of an alcohol with a fat/oil. The basic reaction is similar to that of acidolysis

As an example, by methanolysis (methyl alcohol), fats and oils are converted to fatty acid methyl esters (FAME) for fatty acid determination using gas-liquid chromatography (GLC).

c) Glycerolysis

Glycerolysis is an important reaction that is used for the production of monoand diglycerides.

During glycerolysis, a triglyceride is reacted with excess glycerol and mono- and diglycerides are produced. The use of mono- and diglycerides in both food and industrial applications is

widespread. Glycerol can react with various fatty acids or fats/oils to produce these extremely functional compounds.

- Some of the more common uses are as:-
  - ✓ Emulsifiers
  - ✓ Wetting agents
  - ✓ Starch complexing agents
  - ✓ Aeration and foaming agents
  - ✓ Crystal modifiers
  - ✓ Lubricants and agglomerating agents

5.2 Monitoring the interesterification process to meets melting point and odor specification

1.2.1 Monitoring the interesterification process to meet melting point

To date, all methods for end-point determination are off-line; these somewhat timeand labor-consuming methods are discussed in the following.

a) Melting Point

Melting point is the temperature at which a given solid material changes from a solid state to a liquid, or melts.

Depending upon the effect of INES, melting point can be used. In most cases,-the melting point does change as was shown in Table 12.1. This test is relatively quick, simple, and reliable; it has been used for many years. Extra time is given before taking a sample, however, to ensure complete randomization.

b) Solid Fat Measurement

This can be done via SFI, SFC or DSC. Although extermly accurate, all are time-consuming and somewhat labor intensive.

c) Sterol Content

In most oils, there is a detectable level of free sterols. During INES, these sterols are also esterified. The sterol content can be measured in a sample. Complete randomization has been assumed when the free sterol content drops below detectable levels.

d) Glyceride Compositional Analysis

INES changes the specific fatty acid order in triglycerides. Methods such as thin-layer chromatography (TLC) and GLC with mass spectrometry (MS) have been used on production applications (lo).

e) On-Line Specrometric Monitoring

Recently, it has been discovered that chemical INES can be monitored by ultraviolet (UV)/visible spectrometry, at least on a bench scale. There is a direct correlation between the absorbance at 350-400 nm to the reaction itself.

- **Monitoring the interesterification process to Meet Stability (oxidative and/or flavor) and odor specification**
  - ✓ **fat and oil stability affect final Flavor**

There are a number of variables that can affect fat and oil stability, including fatty acid position on the glycerol backbone and effect on tocopherols. It has been shown in a number of studies that the stability of interesterified fats and oils decreases compared with the natural starting materials.

Flavor was examined in involving a physical mix of 90% soybean oil and 10% fully hydrogenated soybean stearin before and after INES. In this case, the flavor of the physical blend was slightly worse and thought to be due to the soy stearin portion.

- ✓ **The storage quality of oils is predicted by their FFA content**.

It causes off-flavor extension in oils during storage. FFAs impair catalyst performance, and their level in initial blends should be maintained as low as possible, preferably below 0.1%. Chemical interesterification led to a significant increase in FFA % ($p < .05$).

The FFA content of the interesterified PS: SFO blends (0.10%–0.16%).

The lower the FFA content, the higher the oxidative stability of fats.

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 interesterification process is used to modify the physical properties of the oil or fat blend by rearranging the fatty acid groups within and between the different triglycerides **….? (2pts)**
2. Acidolysis is the exchange reaction between a fat/oil and free fatty acids**...? (2pts)**
3. The lower the FFA content, the higher the oxidative stability of fats. **...? (2pts)**

Test II: Choose the best answer

1. **Which of the following is Some of the more common uses of Glycerol?(3pts)**

   A. Emulsifiers
   B. Wetting agents
   C. Crystal modifiers
   D. Lubricants and agglomerating agents
   E. 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- Identifying, rectifying and/ or reporting out-of-specification product/process outcomes

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

6.1.1 out-of-specification Outcomes of Interesterification process

a) Fatty acid and TAG composition

Presents the fatty acid composition of base stocks and the IE (Interesterification) samples. Palmitic (52.9%) and oleic (30.1%) acids were the most abundant fatty acids in PS (palm stearin), and the predominant fatty acids in SFO were:-

- linoleic acid (which is an essential fatty acid)= **54.62%**
- oleic acid=**32.54%,**
- Palmitic acid = **7.32%,** (respectively).

All the obtained blends contained TFA (Trans-free acid) <0.36%. Based on defined regulations, trans-free products should have <2% of the trans-isomer.

The blends had lower than 0.36% TFA which was favorable. The amount of saturated fatty acids (SFAs) in blends from 10:90, 30:70, and 50:50 were 16.26%, 25.75%, and 35.26%, respectively.

b) Oxidative stability

The high oxidative stability is one of the most important features of fats, which has a great impact on the shelf life of final products. Due to higher oxidative stability of SFAs, the higher content of them can be more desirable in fat formulations.

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. Machine operators are alerted to issues before they happen, reducing unplanned downtime while also collecting valuable data**…? (2pts)**
2. Vibration sensors on extruder reducer provide data regarding the condition of the gears, bearings and lubrication system**…? (2pts)**

Test I: choose the best answer

1. **Which of the following most abundant fatty acids in PS (palm stearin)..? (3pts)**
   - **A.** Palmitic (52.9%)
   - **B.** oleic (30.1%) acids
   - **C.** A $ B answers
2. **Which of the following most abundant fatty acids in PS (palm stearin)..? (3pts)**
   - **A.** linoleic acid (which is an essential fatty acid)= 54.62%
   - **B.** oleic acid=32.54%,
   - **C.** Palmitic acid = 7.32%
   - **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-. Maintaining the work area according to housekeeping standards

7.1. Maintaining the work area according to housekeeping standards

7.1.1 Identify Housekeeping Requirements

- **Safety and housekeeping standards**

Site safety and housekeeping

In the workplace there may be many hazards present that have the potential to cause harm to personnel, the equipment, the environment and the local community if precautions are not taken.

Typical hazards are as follows:

- Slip, trip and fall hazards
- Chemical hazards
- Toxic hazards
- Heat radiation hazards
- Electrical hazards.

The effects of hazards can be minimized or eliminated by knowing and applying the site safety procedures as outlined in the Standard Operating Procedures, or in other resources such as safety procedure manuals, etc. Safety in the workplace is extremely important, and can be improved and maintained by the application of housekeeping standards.

Housekeeping is a program of maintaining the workplace in a clean and orderly state and leads to improved site safety. Good housekeeping principles will also provide other benefits to the individual, work group and company such as:

- Reduced accidents
- Reduced hazards
- Reduced costs
- Increased morale
- Increased work group efficiency.

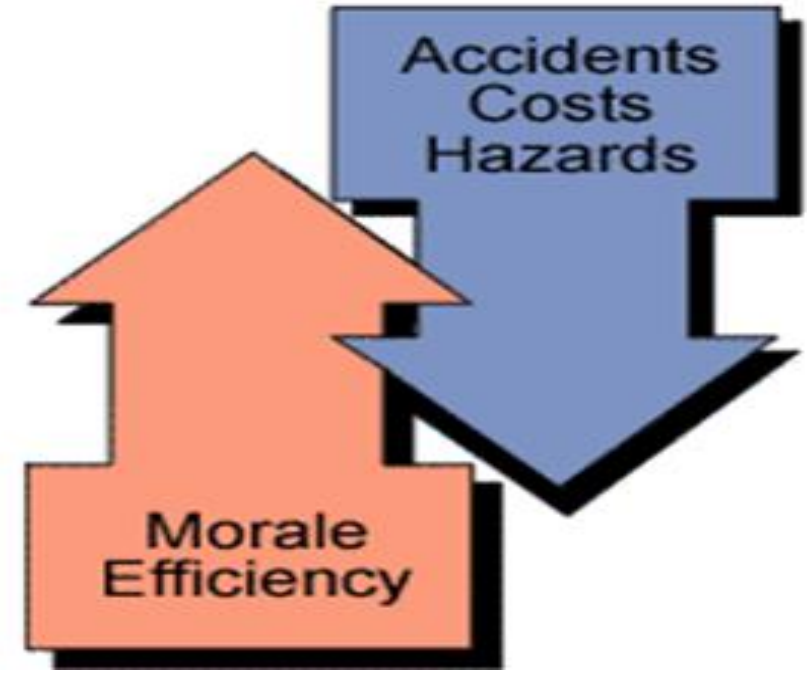


Figure25 Results of Good house keeping

Housekeeping must be practiced routinely and often by performing basic tasks such as:

- rolling up and storing hoses, ropes and cables
- cleaning up spills, drips and leaks
- removing foreign materials such as debris
- storing waste in proper containers
- disposing of waste materials in the correct manner
- keeping walkways, platforms, stairs, exits and aisles clear of obstructions
- stacking all materials correctly (separate incompatible materials)
- reporting and investigating continual non-conformances
- cleaning and storing tools and equipment
- planning and organizing all work activities
- Storing and handling chemicals in their correct containers.

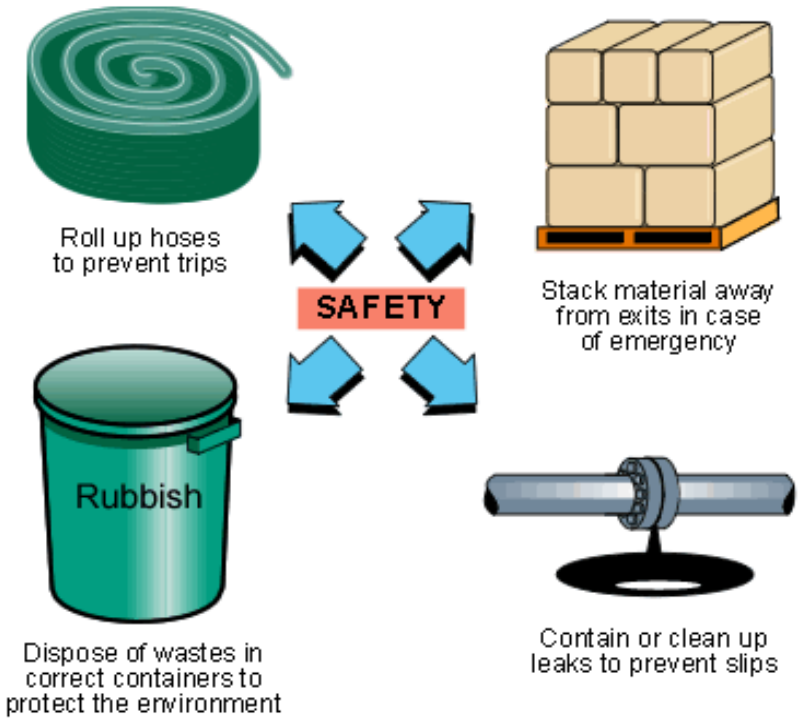


Figure26 Benefits of Housekeeping

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: Choose the best answer

1. **Which of the following are likely to be reduced by good housekeeping? 5pts**
   A) Accidents
   B) Hazards
   C) Costs
   D) All

3. **Which of the following Housekeeping must be practiced routinely and often by performing basic tasks**

   A. rolling up and storing hoses, ropes and cables
   B. cleaning up spills, drips and leaks
   C. removing foreign materials such as debris
   D. storing waste in proper containers
   E. disposing of waste materials in the correct manner

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

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

Information Sheet 08- Conducting work in accordance with workplace environmental guidelines

8.1. Conducting work in accordance with workplace environmental guidelines.

The EHS Guidelines for Vegetable Oil Processing are applicable to facilities that extract and process oils and fats from vegetable sources. It covers crude oil production and refining processes, from the preparation of raw materials to the bottling and packaging of final products for human or animal consumption, among other uses. Annex A contains a full description of industry activities for this sector. The production of oilseeds, beans, and palm oil fresh fruit bunches at the plantations is covered by the EHS Guidelines for Annual Crop Production and the EHS Guidelines for Plantation Crop Production. This document is organized according to the following sections.

- **Industry-Specific Impacts and Management**

The following section provides a summary of EHS issues associated with vegetable oil processing that occur during the operations phase, along with recommendations for their management. Recommendations for the management of EHS issues common to most large industrial facilities during the construction and decommissioning phases are provided in the

- **General EHS Guidelines**

✓ **Environmental**

Environmental issues associated with the operational phase of vegetable oil processing primarily include the following:

- Solid waste and by-products
- Wastewater
- Emissions to air
- Water and energy consumption
- Hazardous materials

- **Solid Waste and By-Products**

Vegetable oil processing activities generate significant quantities of organic solid waste and by-products, such as empty fruit bunches (EFBs) and waste palm kernels. The amount of waste generated depends on the quality of the raw materials and the use or reprocessing of the discarded materials into commercially viable by-products. Other solid wastes from the vegetable oil manufacturing process include soap stock and spent acids from chemical refining of crude oil; spent bleaching earth containing gums, metals, and pigments; deodorizer distillate from the steam distillation of refined edible oils; mucilage from degumming; and spent catalysts and filtering aid from the hardening process.

Recommended techniques for prevention and control of solid wastes and by-products include the following:

- ✓ EFBs from oil palm plantations should not be incinerated.
- ✓ EFBs should be returned to the plantations where, together with the trimmings from trees, they are valuable as soil amendment and a source of carbon;
- ✓ Collect waste palm kernels for fuel for steam and power generation at refineries.

The waste kernel cannot be burned by typical crude palm oil (CPO) mills because, unlike refineries, their boilers are not designed to manage the high silica content of the kernel;

Use uncontaminated sludge and effluent from on-site wastewater treatment as fertilizer in agricultural applications;

Dispose of contaminated sludge from wastewater treatment at a sanitary landfill or by incineration. Incineration should only be conducted in permitted facilities operating under international recognized standards for pollution prevention and control;

Reduce product losses through better production control (e.g. monitor and adjust air humidity to prevent product losses caused by the formation of molds on edible materials);

Recycle autoclave condensate to remove vegetable oil;

Optimize the design of packaging material to reduce its volume (e.g. by reducing the thickness or number of layers) but without compromising food safety, transport safety, or other quality requirements;

Investigate the following options for the responsible disposal of spent bleaching earth: (Use as a feedstock for brick, block, and cement manufacturing).

- **Wastewater**

Industrial Process Wastewater

Vegetable oil processing wastewater generated during oil washing and neutralization may have a high content of organic material and, subsequently, a high biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Wastewater may also have a high content of suspended solids, organic nitrogen, and oil and fat, and may contain pesticide residues from the treatment of the raw materials.

Recommended measures for the prevention of process wastewater include the following:
Use emulsion breaking techniques, (e.g. dissolved air flotation [DAF]), to segregate high BOD and COD oils from wastewater; Recycle condensates; Use grids to cover drain in the production area and to prevent solid wastes and concentrated liquids from entering the wastewater stream; Select disinfection chemicals to match the cleaning operation being applied on the process equipment to the type of problem.

Caustics (e.g. lye) are typically used for polymerized fat, and acids are used for lime deposit acids; Apply cleaning chemicals using the correct dose and application; Apply Cleaning-in-Place (CIP) procedures to help reduce chemical, water, and energy consumption in cleaning operations; Properly treat and discharge cleaning solutions (e.g. through a soap-splitting process) to separate oil and fatty acids from the water phase and then through a fat trap; When feasible, replace phosphoric acid with citric acid in degumming operations (this reduces the phosphorus load in the wastewater and also brings about a slight reduction in sludge quantities).

Process Wastewater Treatment

Techniques for treating industrial process wastewater in this sector include grease traps, skimmers or oil water separators for separation of floatable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers; biological treatment, typically anaerobic followed by aerobic treatment, for reduction of soluble organic matter (BOD);biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals; in some

instances composting or land application of wastewater treatment residuals of acceptable quality may be possible. Additional engineering controls may be required to contain and neutralize nuisance odors.

- **Emissions to Air**

Volatile Organic Compounds

Particulate matter (dust) and VOCs are the principal emissions from vegetable oil processing. Dust results from the processing of raw materials, including cleaning, screening, and crushing, whereas VOC emissions are caused by the use of oil-extraction solvents, normally hexane.3 Solvent emissions arise from several sources within vegetable oil processing plants, including the solvent-recovery unit, the meal dryer and cooler, and leaks in piping and vents. Small quantities of solvent may be present in the crude vegetable oil if the oil has been extracted by a solvent and will volatilize during the oil-refining process, particularly during deodorization. Odor emissions arise from multiple sources (e.g. cookers, soap splitting, and vacuum generation).

The recommended management techniques to prevent and control VOCs include the following:

- ✓ Ensure the efficient recovery of solvent by distillation of the oil from the extractor
- ✓ Recover solvent vapors where feasible
- ✓ primarily through the use of countercurrent flow de-slovenlier–toaster in vegetable oil extraction
- ✓ Use a re-boiler and a gravity separator to treat condensates with high solvent content
- ✓ to reduce solvent emissions and reduce the risk of explosions in the sewer

This guideline covers the production of edible oils through extraction from seeds, beans, fruits and nuts. It does not cover the production of oils from animal-derived sources, or the manufacture of biodiesel.

- **Palm Oil/Biodiversity**

Palm oil plantations are under increasing scrutiny for their effects on the environment, including loss of carbon sequestering forest land.

There is also concern over displacement and disruption of human and animal populations due to palm oil cultivation.

Production of palm oil has been controversial in recent years and could reflect on purchasers and processors of these crops.

The extracted crude oil will be refined either through chemical/alkali refining or through physical means. The primary purpose refining is to separate the free fatty acids and remove other unwanted substances.

Self-Check –08	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. Vegetable oil processing activities generate significant quantities of organic solid waste and by-products**..?(2pts)**
2. The extracted crude oil will be refined either through chemical/alkali refining or through physical means ...**2pts)**
3. The primary purpose refining is to separate the free fatty acids and remove other unwanted substances.....**2pts)**

Test II: Choose the best Answer

4. **One of the following Environmental issues is primarily included in the operational phase of vegetable oil processing**..?**(4pts)**
   - **A.** Solid waste and by-products
   - **B.** Wastewater
   - **C.** Emissions to air
   - **D.** Water and energy consumption
   - **E.** Hazardous materials
   - **F.** All

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

Note: **Satisfactory rating – Answers All** **Unsatisfactory - below 10 points**

Information Sheet 9- Maintaining the work Records

9.1. Maintaining Work Records

9.1. 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).

9.1.1 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 –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. Standard operating Procedures (SOP) is a procedure specific to policies and standards needed in the operation…**2pts**
2. The records are preserved in such a way that they are readily accessible and do not get damaged…**2pts**

Test II: Choose the best answer

1. Which of the following are Purpose records? 4pts

A. To provide evidence of conformity to requirements.

B. Evidence of the effective operation of the food safety management system.

C. Ensure proper identification and up gradation

D. storage, protection, retrieval, retention time and disposition of records

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

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

Operation sheet-1	Practical Demonstration

Procedure of Chemical interesterification

Step1 melt at first, PS (palm stearin) was at 85°C and blends of PS: SFO in the mass ratios of 10:90, 30:70, and 50:50 were prepared (400 g).

Step2 Remove the blend heat under vacuum (at 0.8 bar abs, 100°C for 15 min) to traces of water.

Step4 Brought dried blends charge into a vacuum flask to 90°C.

Step5 Add In the next step, 0.5% (w/w) dry sodium meth-oxide into the dried fat blends,

Step6 Continue the interesterification process for 1 hr (at 90°C, under 0.8 bar abs and 300 rpm).

Step7 Blend SMP of fat until reaching constant values.

Step8 Monitor the reaction equilibrium by SMP (slip melting point) determination. After reaching the reaction equilibrium point, to inactivate the catalyst, 2% (w/w) aqueous citric acid solution (20%, w/v) was added.

Step9 stir the mixture for 15 min (at 70°C and 300 rpm).

Step10 Remove excess alkalinity, sodium meth-oxide, and citric acid by addition of 1.5% bleaching earth (bentonite) into the blends (at 300 rpm, under 0.8 bar abs and at 110°C for 15 min).

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 operate Chemical Interesterification

LG #52	LO #3- Shut down the interesterification 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 interesterification 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

1.1 Identifying the appropriate shutdown procedure

It is most important to adopt a sensible shutdown procedure as it can save a great deal of time and money. If, for example, the product is prevented from burning then there will not be so much urging required on re-heating and the cost of a complete shutdown and machine clean out may be saved.

Shutting Down Centrifugal Pumps

- Close the discharge valve prior to stopping the pump
- This takes the load off the motor and, if any check valves leak
- It may prevent reverse flow through the pump
- Next shut down the driver and leaves the suction valve open.
- Avoidance of water hammer is the primary concern during the shutdown of a pump
- Especially in installations with long discharge piping.
- Gradual closing of the discharge valve is one way to eliminate or reduce any water hammer pressure spikes**.**

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 appropriate Shutdown procedure for Centrifugal Pumps**…10pts**

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

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

Information Sheet 2- Shut down the Interesterification process

2.1 Shut down the process

To prevent contamination or deposit formation in your machine s, use purging compound to clean the equipment and displace any unwanted matters from the machine completely.

Normal safety precautions for working around any moving machinery are to be:-

- Avoid loose clothing such as unbuttoned shirtsleeves, lab coats, or dangling ties.
- Jewelry, such as bracelets and rings, should be removed.
- Inspect tools and electrical equipment such as heater bands, etc. for defects.
- Use gloves and sleeves when making adjustments and changes.
- Never place fingers or metal probes in the feed throat. If necessary, use a plastic probe for clearing the throat.
- Because of possible overpressure, clamp or bolt failure, never stand directly in front of any equipment during start up, operation, or shutdown.
- Use a vacuum for cleaning and an air hose with low-pressure nozzle for cleaning inaccessible areas.
- Keep the floor area around the equipment's clean of compound and water, which could cause a slipping or electrical shock hazard.

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 safety precautions for working around any moving machinery **… (10) pts.**

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

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

Information Sheet 3- Identifying and reporting maintenance requirements

3.1 Identifying and reporting maintenance requirements

- **Internal verification audits** a systematic examination of Processes/procedures to ensure compliance to requirements:
  - ✓ by obtaining factual evidence (e.g. records, visual inspection reality check, etc.); and
  - ✓ carried out by an independent/ impartial suitably skilled auditor

- **Inspecting machinery and equipment**

An inspection is, most generally, an organized examination or formal evaluation exercise. It means careful examination or scrutiny. Examine, check, and or checkup etc. Inspection Machines include manual, mechanical and computerized systems which inspect products, packages or packaging components to ensure they conform to specification

The purpose of an inspection is to identify whether work equipment can be operated, adjusted and maintained safely – with any deterioration detected and remedied before it results in a health and safety risk. Not all work equipment needs formal inspection to ensure safety and, in many cases, a quick visual check before use will be sufficient.

3.2 Reporting maintenance activity

Finally any reporting activity should be reported and recorded in a compiled form. This includes reporting operations, approving operations and closing work order operations and work orders.

Five steps to create a maintenance report

Step 1: Create the cover page. Open a new document in MS Word and write the title.

Step 2: Cover Letter. On the next page include the cover letter.

Step 3: Device Information

Step 4: New Parts Cost Details

Step 5: Suggestions and Signature.

The report shows maintenance details of each event in the time range, including the:-

- Setup/Takedown Time
- Instructions
- Event Time
- Facility
- Event, ID (Rental, Contract or Event)
- Service, and Customer

Table3 Simple Gear repair report of Centrifugal Separator

Gear drive repair report					
Location: building 511, 1st floor			**Machine** **Centrifugal separator 1**		
Gear drive type: reducer 1:20			**Serial no.:** 10245156		
Date of putting in operation: 5/20/1997			**Manufacturer**: Bishoftu, Ethiopia		
Date of repair: 5/26/2000 **Special maintenance requirements**: Oil grade 05			Auxiliary drives: belts _____ chain _____ coupling flexible coupling others _____		
Part	**Failure**	**Mark**	**Part**	**Failure**	**Mark**
Auxiliary drive	Chain or belt broken		**Gears**	Seat worn out	
	Sprocket/pulley worn out			Broken teeth	
	Keyway problem			Worn out teeth	X
	Drive shaft bent			Others	
	Coupling damaged		**Lubrication**	No oil	
	Coupling rubber broken	X		Little oil	X
	Others			Dirty oil	
Sealing	Lip seal defective	X		Water in oil	X
	Housing seal defective			Breather defective	
	Others			Others	

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. List down Five steps to create a maintenance report?....**8pts**

Test II say true or false

1. The purpose of an inspection is to identify whether work equipment can be operated, adjusted and maintained safely?…**2pts**

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

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

Operation sheet 1– Appropriate shutdown Procedure of Centrifugal Pumps

Procedure for Shutdown Centrifugal Pumps

Step1 Wear PPE

Step2 Close the discharge valve prior to stopping the pump

Step3 This takes the load off the motor and, if any check valves leak

Step4 It may prevent reverse flow through the pump

Step5 Next shut down the driver and leaves the suction valve open.

Step7 Avoidance of water hammer is the primary concern during the shutdown of a pump

Step8 Especially in installations with long discharge piping.

Step9 Gradual closing of the discharge valve is one way to eliminate or reduce any water hammer pressure spikes**.**

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 Centrifugal Pumps

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~~THX'S~~

~~INTERESTERIFIED PRODUCTS~~