EDIBLE OIL AND FATS PROCESSING

Level III

Based on October 2019, Occupational standards (OS) Version 2 and March 2021, V1 curriculum

Module Title: Operating a Neutralization Process

LG Code: IND EOP3 M09 LO (1-3) LG (29 -31)

TTLM Code: IND EOP3 TTLM 0321v1

March 2021

Bishoftu; Ethiopia

United Nations Educational, Scientific and Cultural Organization

With the support of Republic of Korea Funds-in Trust

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LG #35	LO#1- Prepare the neutralization equipment for processing

Instruction sheet

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

- Confirming available materials
- Identifying and following (OHS) procedures for controlling hazards/risks
- Identifying and confirming cleaning and maintenance
- Confirming different available services
- Entering neutralization process parameters
- Checking and adjusting neutralization equipment performance
- 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 available materials
- Identify and follow (OHS) procedures for controlling hazards/risks
- Identify and confirm cleaning and maintenance
- Confirm different available services
- Enter neutralization process parameters
- Check and adjust neutralization equipment performance
- Carrying out pre-start checks

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instruction s described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 1 - Confirming raw materials

1.1 Introduction

Neutralization is a process to reduce the concentration of free fatty acids (FFA) to a maximum 0.10% through the use of a diluted alkali solution, typically sodium hydroxide. This process can be applied batch wise in vessels and continuously by means of centrifuges. After alkali treatment, the oil is washed with hot water or treated with silica to reduce its residual soap level. Soda silicate boil can be used for batch neutralization of crude or water degummed seed oils.

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.

1.2 Confirming available materials

Materials used in neutralization process includes:

- Degummed crude oil
- Soft hot water
- Phosphoric acid
- Sodium hydroxide
- Citric acid

1.2.1 Degummed crude oil

Degummed crude oil in an oil which is free from 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.

1.2.2 Soft hot water

Soft hot water is used to wash out residue of soap and dilute the caustic soda. The neutral oil is washed in order to further reduce the residual soap content. For this purpose, approximately 3 – 10% of hot water is added to the oil, mixed in a dynamic mixer and separated into wash water and oil in a separator. The residual humidity of the oil is further reduced in a vacuum drier.

The alkali treated oil is usually washed with a small quantity of hot water to remove residual soap formed by the alkali treatment.

1.2.3 Phosphoric acid

Phosphoric acid is used to converts the non-hydratable phospholipids into their hydratable form by breaking up the Ca and Mg complexes of phosphatitic acid (PA) and phosphadityl etholamine (PE).

- Concentration: 75 – 85 %
- Addition: 1 – 3 kg /t oil
- Temperature: 80 – 90 °C

✓ **Uses of Phosphoric Acid in Food Industry**

Phosphoric acid can serve for many uses in our daily life. Phosphoric acid also plays an important role in several food industry. It is widely used in the industry due to its cheap prices. A food-grade phosphoric acid is often referred as additive E338.

- Edible oil
- Su Soaps
- Polishes
- Dyes

- Detergents
- Leather treatment
- gar refining

✓ **Health effects that is Caused by Phosphoric Acid**

Phosphoric acid may bring us side effects when it is inhaled, ingestion, or get in contact with our body. If you got poisoned by phosphoric acid, you should call a doctor or seek immediate medical treatment. Those side effects can be seen as listed below.

- Dermatitis
- Diarrhea
- Pain
- Swelling
- Stomach cramps
- Tearing
- Blurred vision
- Vomiting
- Swallowing difficulty
- Breathing difficulty
- Coughing
- Chemical burns
- Irritated nose
- Irritated throat
- Severe skin burns
- Permanent eye damage
- Gastrointestinal problems

1.2.4 Sodium hydroxide

Diluted caustic soda with a concentration between 7 and 12% is then added in order to neutralize the free fatty acids. It is necessary to ensure that adequate water is present with the caustic in order to hydrate the phosphatides.

Table1: Recommended Caustic Strength for Various Crude Oils for Refining

Oil type	Recommended strength for the caustic solution, in °Be(degree brix)
Crude soybean oil	18
Degummed soybean oil	14

Super degummed oil	14
Corn	18 – 22
Cottonseed	28 – 32
Sunflower	14
Safflower	14
Coconut oil (normally physically refined)	10–12
Peanut (groundnut)	18

1.2.5 Citric acid

Citric acid is helps to chelate the trace metals and reduce the phosphorus content of the oil. Some of the acid reacts with the soap in the oil and hydrolyzes the soap. It slightly raises the FFA in the bleached oil.

Self-Check # 1	Written Test

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

1. Write materials which are used in neutralization process of edible oil (5pts)
2. Define neutralization (5pt)

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

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

Information Sheet 2 - Identifying and following (OHS) procedures for controlling hazards/risks

2.1 Identifying and following (OHS) procedures for controlling hazards/risks

Occupational health and safety (OHS) is one of the oldest and most advanced social policy areas of the work. OHS is an integral part of everyday work. Occupational safety and health (OSH) is generally defined as the science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment. This domain is necessarily vast, encompassing a large number of disciplines and numerous workplace and environmental hazards. A wide range of structures, skills, knowledge and analytical capacities are needed to coordinate and implement all of the "building blocks" that make up national. OSH systems so that protection is extended to both workers and the environment 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.

Common workplace hazards are; such as:

- Stress
- Fatigue
- Chemicals
- Electrical safety
- Bodily fluids
- Sharps
- Noise
- Work postures
- Manual handling
- Under foot hazards and moving parts of machinery

2.2 Procedures/steps for controlling hazards/risks

Step 1- Identify hazards

Identifying hazards involves finding all of the foreseeable hazards in the workplace and understanding the possible harm that the hazards may cause.

What to look for

A hazard is something in the workplace (or that will be in the workplace) that can cause harm to people. Table 1 below lists some common types of workplace hazards

Table2: Common workplace hazards

Mechanical hazards	Plant, equipment and items (and parts of them) that have the potential to cut, rip, tear, abrade, crush, penetrate, produce projectiles or cause sudden impact.
Chemical and biological hazards	Chemicals, compounds, materials, powders, dusts and vapours that have the potential to impair health, have adverse effects on human reproduction, cause disease or have explosive, flammable, toxic or corrosive properties.
Sources of energy	A range of sources of energy that have the potential to cause harm, including electricity, heat, cold, noise, high powered light and damaging radioactive sources.
Body stressing or impact hazards	Activities that cause stress to the muscles and/or skeleton, including manual handling of people, animals, goods or materials and things or circumstances that can cause a person to slip, trip or fall at the same level.
Gravity	Activities that are carried out where a person can fall or an object can fall onto people.
Psychological hazards	Events, systems of work or other circumstances that have the potential to lead to psychological and associated illness, including work-related stress, bullying, workplace violence and work-related fatigue.

- **Methods for identifying hazards**

  There are a number of methods for identifying hazards.

  The following are the most common:

  ✓ **Inspecting the workplace**

  A walk though the workplace is a direct way of identifying many hazards. This walk-through can be assisted by using a hazard checklist developed in consultation with employees to suit the workplace.

  Inspections should not be limited to physical things such as plant, equipment or buildings and structures. The inspection should also look at systems of work and work procedures.

  ✓ **Finding and applying available information.**

  A large amount of information is readily available for particular industries, types of activity and job types.

  Sources of information include:

  - Work Safe publishes information on its website and in hard copy on a range of OHS topics and industries. Visit www.worksafe.vic.gov.au or read the Work Safe publication
  - Industry associations and unions can provide information about hazards in particular industries or particular jobs.
  - Manufacturers and suppliers can provide information about hazards associated with specifi c plant, substances or processes.
  - Material Safety Data Sheets (MSDS) from manufacturers or suppliers of workplace substances.
  - Work Safe's workers' compensation insurance agents.
  - Technical and OHS specialists.

✓ **Testing and measuring**

Some hazards such as noise and atmospheric contaminants may require measurement to decide if further action is required. For instance, there are simple comparisons that can be made to estimate general noise levels (e.g. can people working within close proximity be easily heard?), and testing and measuring can provide a more accurate determination of the hazard (e.g. noise meters, atmospheric testing).

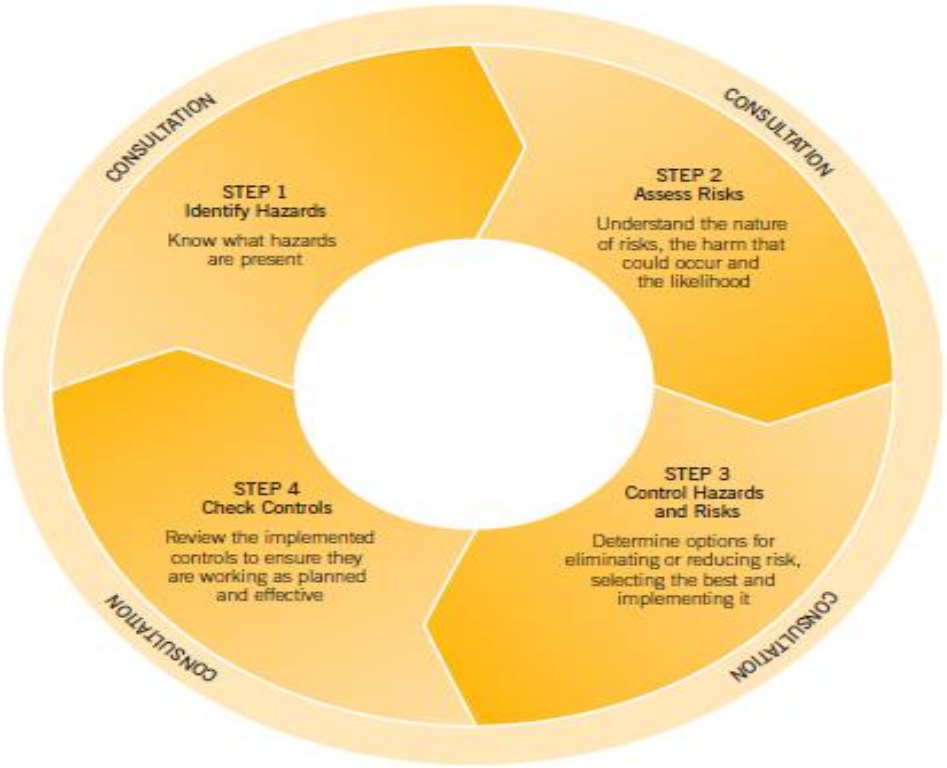


Figure 1: steps for controlling hazards/risks

Step 2 – Assess risks

Risk assessment is a process for developing knowledge and understanding about hazards and risks so that sound decisions can be taken about control. A formal risk assessment is unnecessary if the knowledge and understanding already exist. However, there will be many times when a risk assessment is the best way of building knowledge and understanding.

Risk assessment assists in determining:

- What levels of harm can occur
- How harm can occur
- The likelihood that harm will occur

A risk assessment will provide knowledge to make informed decisions about controlling hazards and risks. The risk assessment needs to be tailored to the situation and to the organization in which it is conducted; it can be as simple as structured discussion during consultation or it can be more elaborate and formal.

Step 3 – Control hazards and risks

Duty-holders are required to ensure health and safety by controlling risks. Risks must be controlled by eliminating them so far as reasonably practicable or, if this is not possible, reducing the risks that remain so far as reasonably practicable.

Arriving at appropriate controls involves:

- Identifying the options for controls. A control option may be a single control or it may be made up of a number of different controls that together provide protection against a risk.
- Considering the control options and selecting a suitable option that most effectively eliminates or reduces risk in the circumstances.
- Implementing the selected option.

Step 4 – Check controls

Controls that are put in place to protect the health and safety of people need to be monitored to ensure that they work as planned. This requires checking them and ensuring that processes are put in place to identify and quickly fix problems.

Checking controls

Checking controls involves the same methods as in the initial hazard identification step (step 1), and creates the loop in which workplace health and safety measures are maintained. Common methods used to check the effectiveness of controls are:

- Inspecting the workplace

- Consulting employees
- Testing and measuring
- Using available information
- Analyzing records and data

2.3 Hazards control measures

Measures for controlling, eliminate or minimize hazards in accordance with the hierarchy of control includes:

- Elimination (e.g. controlling the hazard at the source)
- Substitution (e.g. replacing one substance or activity at the source)
- Engineering control (e.g. installing guards on machinery)
- Administration control (e.g. policies and procedures for safe work practices)
- Personal protective equipment (e.g. respirators and ear plugs)

Self-Check # 2	Written Test

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

1. Write the common workplace hazards (5pts)
2. Write the measures for controlling, eliminate and minimize hazards (5pt)

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

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

Information Sheet 3 - Identifying and confirming cleaning and maintenance

3.1 Identifying and confirming cleaning and maintenance

All equipment requires periodic sanitation. Failure to practice proper sanitation or maintenance procedures as noted in the equipment manual can lead to unsafe conditions. Maintain optimum equipment sanitation to promote product quality and safe operating conditions.

3.2 Cleaning

Cleaning is the complete removal of food soil using appropriate detergent chemicals under recommended conditions. It is important that personnel involved have a working understanding of the nature of the different types of food soil and the chemistry of its removal.

3.3 Advantages of cleaning equipment

- Increasing the cooking oil yield, reducing the oil loss in cakes.
- Improving the quality of crude cooking oil, cake and meal.
- Adding processing capacity of cleaning equipment and oil pressing machine.
- Ensuring safe working and clean working environment.

3.4 Cleaning methods

There are a number of methods which can be used to apply detergents and disinfectants.

3.4.1 Manual cleaning

Manual cleaning using cloths, mops, brushes, pads, etc. It is normally used in small areas, equipment that is non-water proof or requires dismantling or areas which are difficult to clean by other methods. It is a labor intensive method and may limit the use of

certain chemicals for safety reasons. To ensure cleaning is effective the method must be clearly defined and staff trained to an appropriate level.

3.4.2 Foam cleaning

This is the common method for cleaning most food operations. A foam blanket, created using a wide range of available equipment is projected from a nozzle and allowed time to act on the soil. It is then rinsed off with the released deposits. Large areas such as floors, walls, conveyors, tables and well-designed production equipment are ideal for foam cleaning. Foam is a carrier for the detergent. The foam should be applied in an even layer. Coverage rates are quick and chemical usage is economical.

Figure 2. Foam cleaning method

3.4.3 Spray

Spray cleaning uses a lance on a pressure washer with chemical induction by venture. This method can be wasteful of chemical and can be slow to produce foam. It should be used where foaming properties are not essential for the cleaning action.

3.4.4 Fogging

Aerial fogging uses compressed air or other equipment to generate a fine mist of disinfectant solution which hangs in the air long enough to disinfect airborne organisms. It will also settle on surfaces to produce a bactericidal effect. The system can come in a small portable device or built in automatic central systems. Fogging should never be used as a primary sanitizing method. It should be used in conjunction with other methods. It is also important to ensure that coverage and saturation is sufficient and the mist is fine to allow proper action.

3.4.5 Machine washing

This is normally an automatic or semi-automatic washing process conducted within a purpose built machine. There are many machine designs depending on the application. But failure to maintain them correctly can lead to a contamination risk to the product. Chemicals used in these machines should be low foaming. An effective system for controlling the dose of chemical should be employed and temperature control systems should be used where critical.

3.4.6 Cleaning in place (CIP)

Cleaning-in-place (CIP) is an automatically performed method of cleaning, applied to remove residues from complete items of plant equipment and pipeline circuits without dismantling or opening the equipment. It is a system of cleaning engineered to provide fast, productive, consistent and reproducible high quality cleaning of all product contact surfaces to a predetermined level of cleanliness, by circulating chemical (detergent and disinfectant) solutions and rinsing water through tanks and piping of a food processing plant that remains assembled in its production configuration, and by jetting or spraying of the product contact surfaces under conditions of increased turbulence and flow velocity.

3.5 Different type of Maintenance and their importance

Proper maintenance is critical to personnel safety, smooth equipment operation and lasting performance. A production system or individual piece of equipment requires regular maintenance to help promote equipment safety, provide an optimum end product and to prevent costly down time. Failure to practice proper maintenance procedures lead to unsafe conditions and shorten the life of the equipment. A preventive maintenance program is imperative. Prior to any maintenance procedure, turn the equipment OFF and disconnect all power sources. Follow the lockout procedure. Failure to follow this warning could result in death or severe personal injury.

Production systems are dangerous during operation. Death or severe personal injury may result if warnings are disregarded. When working on or around all equipment, avoid the use of loose clothing, jewelry or any loose articles that may be caught in moving parts. Keep all extremities away from moving parts. Never operate any equipment while other persons are cleaning, servicing, or performing maintenance. Wear personal protective equipment (safety garments, safety glasses, gloves, etc.) appropriate for the maintenance process to be performed.

3.5.1 Preventive Maintenance

A preventive maintenance program is critical to promote safety, smooth equipment function and to prevent costly down time. Follow the Preventive Maintenance Schedules for each piece of equipment in the technical manual to properly maintain components. Each piece of equipment will have its own schedule. Depending on the operating environment and the product being processed, the equipment may require more frequent maintenance than the intervals recommended maintaining safety and optimum equipment function. Individual operating parameters will help determine the appropriate maintenance intervals.

Machine maintenance affects every asset and every employee who uses those assets. That's why it's essential to develop a strategy to keep equipment working. Depending on the assets you use, your most effective strategy will include several types of maintenance. Determining the perfect balance isn't always easy and will definitely take some time, but you'll be paid back with healthier equipment, a more productive team, and less cost-inducing inefficiency. Equipment maintenance is the means by which mechanical assets in a facility are kept in working order. Oilseed cleaning machine maintenance involves regular servicing of equipment, routine checks, repair work, and replacement of worn or nonfunctional parts. Machines to be maintained include both heavy duty industrial equipment and simple hand-operated machines.

Maintenance of equipment is frequently handled reactively (e.g. after a breakdown) though it may also be done proactively, as with preventive and predictive maintenance. Preventive maintenance keeps assets in good repair through regular scheduled service; predictive maintenance relies on equipment monitoring to detect problems before they result in a breakdown. Predictive maintenance techniques are designed to help determine the condition of in-service equipment in order to estimate when maintenance should be performed. This approach promises cost savings over routine or time-based preventive maintenance, because tasks are performed only when warranted. Thus, it is regarded as condition-based maintenance carried out as suggested by estimations of the degradation state of an item.

3.5.2 Corrective maintenance

Corrective maintenance is a type of maintenance used for equipment after equipment break down or malfunction is often most expensive – not only can worn equipment damage other parts and cause multiple damage, but consequential repair and replacement costs and loss of revenues due to down time during overhaul can be significant. Rebuilding and resurfacing of equipment and infrastructure damaged by erosion and corrosion as part of corrective or preventive maintenance programmes

involves conventional processes such as welding and metal flame spraying, as well as engineered solutions with thermoset polymeric materials

3.5.3 Routine maintenance:

Some tools may require daily checks and maintenance after use. Other tools, such as power tools, usually must be checked once in 6 months or so. More complicated power tools would need to be serviced on a regular interval. A maintenance schedule assigns a specific date to specific maintenance tasks. It states what has to be checked and will require that the assigned person signs off the document assuring that the checks were done. If faults are found, the tool must be sent for maintenance and the assigned person that fixes the tool has to report on exactly what was done and when it was completed.

Figure 3 - Maintenance of edible oil storage tanks

Self-Check # 3	Written Test

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

1. Define leaning (5pts)
2. Write the types of maintenance (5pt)

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

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

Information Sheet 4 - Confirming different available services

4.1 Confirming different available services

All services or utilities that could impact on product quality and process (e.g. steam, gases, compressed air, and heating, ventilation and air conditioning) should be qualified and appropriately monitored and action should be taken when limits are exceeded. Different services which are needed or used in oil neutralization process may include but not limited to

- steam
- Soft hot water
- compressed and instrumentation air

- **Power**

Large quantities of energy are consumed in oil processing in two ways:

✓ Thermal energy in the form of steam and hot water used for distillation, cleaning, and sterilizing. Frequently an auxiliary boiler is used to generate steam;

✓ Electricity for machinery operation, refrigeration, lighting and production of compressed air. Minimum refrigeration requirements are normally determined by regulation.

✓ Use heat recovery to heat incoming oil with the outgoing oil thereby reducing energy demand and water demand for steam;

✓ Examine other options for heat recovery and insulation, to reduce/supplement energy usage;

✓ Examine options for increasing energy efficiency through modifying work practices and installing energy efficient devices/equipment

:

- **Electric power**

  Electric power is the most important in any processing industry. Without electric power it is impossible to operate or produce any product using machine. It provides energy to operating equipments and machines which helps to process the feed raw materials in to new products. If power shortage happen during processing, it may cause many damages to raw materials, product and machine.

- **Compressed and instrumentation air**

  Compressed air is air kept under a pressure that is greater than atmospheric pressure. Compressed air is an important medium for transfer of energy in industrial processes, and is used for power tools such as air hammers, mill, presser and to transfer materials through pipes.

- **Soft hot water**

  Soft hot water is used to wash out residue of soap and dilute the caustic soda. The neutral oil is washed in order to further reduce the residual soap content. The alkali treated oil is usually washed with a small quantity of hot water to remove residual soap formed by the alkali treatment.

- **Steam**

  Steam is used in a wide range of industries. Common applications for steam are, for example, steam heated processes in plants and factories and steam driven turbines in electric power plants, but the uses of steam in industry extend far beyond this.

  - ✓ **Steam in Cleaning**

  Steam is used to clean a wide range of surfaces. One such example from industry is the use of steam in soot blowers. Boilers that use oil or coal as the fuel source must be equipped with soot blowers for cyclic cleaning of the furnace walls and removing combusted deposits from convection surfaces to maintain boiler capacity, efficiency, and reliability.

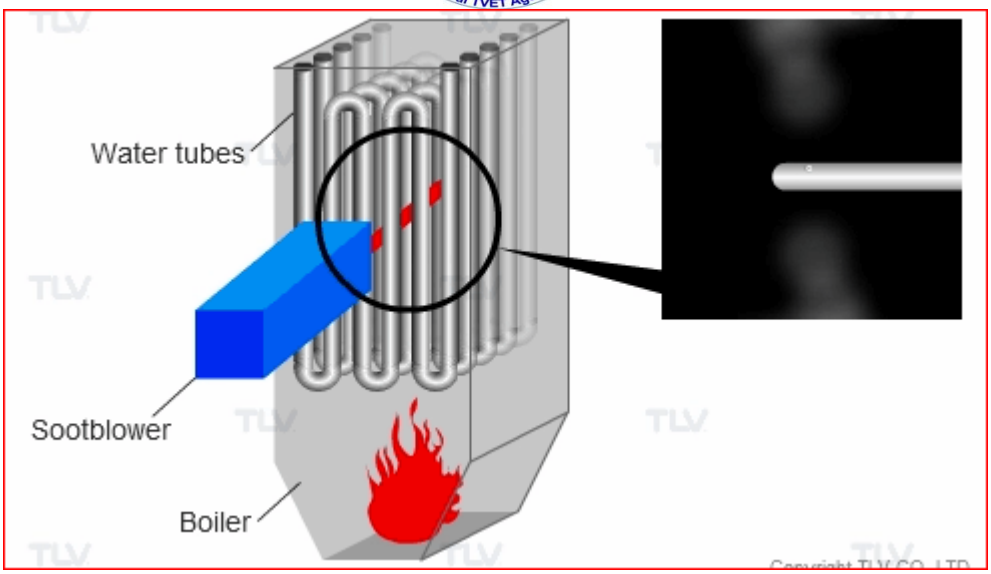


Figure 4: Boiler tube cleaning with soot blower

Self-Check # 4	Written Test

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

1. Write the importance of hot water in edible oil neutralization(5pts)

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

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

Information Sheet 5 - Entering neutralization process parameters

5.1 Introduction

Meaning of parameter is inspection or test points (control points) in the process and the related procedures. When starting up equipment, flow rates or throughput should be gradually and steadily built up to the normal operating parameters. Any changes to operating parameters should be made gradually so that the effect of the changes can be monitored and corrective action taken if required. Measuring equipment health by performance monitoring has the potential to give warning of a developing failure through the changing levels of a suitable parameter being measured, thereby indicating a change in condition of a component, machine or system

5.2 Effect of different parameters on equipment

A sudden large change in a parameter of equipment can cause a process leading to:

- Wastage of raw materials
- Production of off special materials
- Equipment shutdown
- Equipment downtime
- Increased production costs
- Damage to plant
- Environmental damage
- Potential personnel hazard.

5.3 Neutralization process parameters

Neutralization process can be batch or continuous and apply to single or different product types

- **Batch process**

Batch processes are mainly performed within a single piece of equipment; the process steps are sequential in time. The input is discontinuous at the start of the sequence, the output discontinuous at the end.

Main advantages of batch processes

- ✓ Short product change overtime;
- ✓ Suited for small production lots;
- ✓ Flexible recipe;
- ✓ Simple maintenance;
- ✓ Can be operated manually

Main disadvantages:

- ✓ limited scope for heat recovery;
- ✓ requires sequence control;
- ✓ many parallel

- **Continuous process**

In continuous processes, the process steps are simultaneous in different pieces of equipment; both input and output are more or less constant over time.

Main advantages:

✓ Suited for high-capacity lines (low space requirement);
✓ Input/output heat recover
✓ simple automation and control
✓ low manning level

Main disadvantages:

- ✓ Long product changeover time;
- ✓ Complex and costly maintenance;
- ✓ High electrical energy consumption.

5.3.1 Caustic addition temperature

Uses an oil temperature of approximately 32–40°C (90–104°F) to add caustic to it before high shear mixing. The entire process is based on the longer mixing time and reduced temperature for the oil/caustic mixture.

The refining temperature is chosen on the basis of:

- Type of crude oil
- Difficulty of removal of the phospholipids
- Difficulty of color removal

5.3.2 Water wash temperature

The temperature of refined oil and wash water mixture should be 180–190°F (82–88°C).

5.3.3 Contact Time

Entering the correct operating time for various crude oils and caustic soda is the important operating parameters in any processing industry.

Table 3: Recommended Contact Time between various crude oils and caustic in the Long Mix Process

No	Oil type	Retention time (min)
1	Soybean	
	Crude Degummed	6–15 6–12
2	Canola	
3	Crude Super degummed	6–12 4–6
4	Cottonseed	9–15
5	Corn	4–6
6	Sunflower	4–6
7	Safflower	4–6
8	Peanut (groundnut)	4–6

Self-Check # 5	Written Test

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

1. Write the difference between batch and continues process (10pts)
2. Write and explain Neutralization process parameters (10pts)

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

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

Information Sheet 6 - Checking and adjusting neutralization equipment performance

6.1 Introduction

Regular checks & adjusting equipment performance are important for oilseed cleaning in order to maintain equipment efficiency and avoid frequent breakdowns. Machine tools are capable of producing work at a faster rate, but there are occasions when components are processed at the bench. Sometimes it becomes necessary to replace or repair a component, which must fit accurately with another component on re-assembly. This involves a certain amount of hand fitting. The accuracy of work done depends upon the experience and skill of the fitter.

Fitting is make correct and proper the machine/equipment components for the pre-processing of oilseed cleaning.

Adjusting is prepare/ checking the cleanliness, power and operation of oilseed cleaning machines, equipment and containers

6.2 Checking and adjusting neutralization equipment performance

Neutralization equipment which are used in edible oil neutralization process includes:

- Tanks
- Flow meter
- Pump
- Centrifugal separators
- Chemical addition system
- Mixer
- Heat exchanger

6.2.1 Tanks

Edible oil storage tanks are the storage equipments for holding different types of edible oils. The material to be stored can be anything such as crude edible oil or refined edible oil. Oil Storage Tanks are an integral part of the edible oil factory. Any industry dealing with oil business will require the storage facility to be located on site.

Figure 5: Edible oil storage tank

6.2.2 Flow meter

Broadly two types of flow meters are widely used in industries:

Volumetric Flow meters and Mass Flow meters

I Volumetric Flow meters

Volumetric flow meters got its name because these flow meters measure the fluid volume passing through a specific location in a set period of time. Volumetric flow

meters provide an instantaneous analog, digital, or pulse output of the volumetric flow rate of the liquid or gas.

Various types of Volumetric Flow meters are available as listed below.

- **Differential Head type**
  - ✓ Orifice plates
  - ✓ Venture meters
  - ✓ Annubar

Orifice plates

- Features of Orifice Plates

Design Pressure: No limitation. Limited by DP transmitter

Design Temperature: No limitation. Limited by DP transmitter

Sizes: Maximum size is the pipe size

Flow range: limited only by pipe size.

Fluids/Applications: Cryogenic/clean gases & liquids/ Steam (saturated/superheated)

MOC: No limitation (Steel/ monel/ nickel/ haste alloy)

Accuracy: It varies from ±0.25% to ±0. 5% of actual flow. The accuracy of the DP transmitter varies from ±0.1% to ±0. 3% of full-scale error.

Range ability is 3:1 to 5:1.

Upstream length/ Downstream straight length is 20 / 5

Where DP = Differential pressure

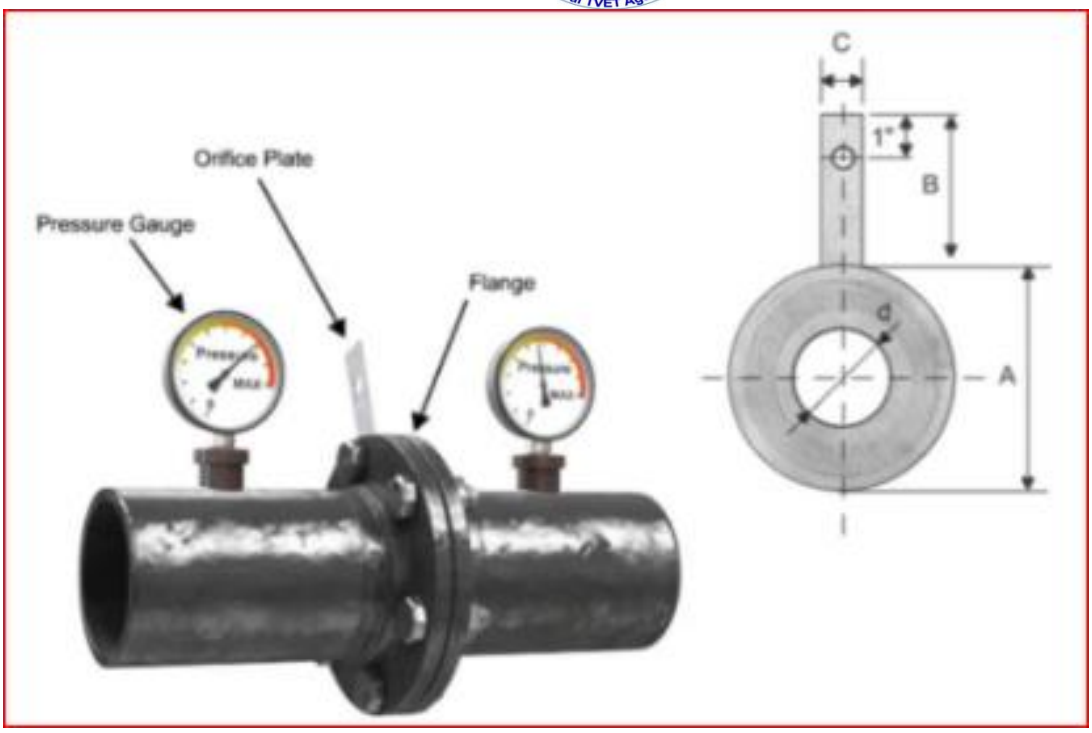


Figure 6: Orifice Plates

Advantages of Orifice Plates

- Easily installed between flanges.
- Fabrication simple and inexpensive.
- No limitations on the materials of construction, line size and flow rate
- Cost relatively independent of pipe diameter since the cost of DPT is fixed.
- No process interruption for the exchange of DP transmitter

Disadvantages of Orifice Plates

- High permanent pressure loss & hence high energy consumption to overcome pressure loss.
- Impractical for systems with low static pressure.
- Measuring range to about 3:1 to 5:1.
- Accuracies decrease with Beta ratios above approximately 0.7.

- Subject to damage by water hammer and foreign objects.

✓ Venture meters

Measures flow rates by constricting fluids and measuring a differential pressure drop.
In the upstream cone of the Venture meter, velocity is increased, the pressure is decreased.
Pressure drop in the upstream cone is utilized to measure the rate of flow through the instrument

Features of Venture meters

Design Pressure: No limitation. Limited by DP transmitter/ pipe press ratings.
Design Temperature: No limitation. Limited by DP transmitter/ pipe pressure ratings
Sizes: 25 mm to 3000 mm
Fluids/ Applications: Clean Liquids/ clean gases
Limited applications: Dirty /corrosive/viscous Liquids & Dirty gases
Flow range: limited only by pipe size and beta ratio.
MOC: No limitation (cast iron/ carbon steel/ SS/Monel, Titanium, Teflon, Hastelloy, Naval Bronze/haste alloy)
Accuracy: It varies from ±0.25% to ±0. 75% of actual flow. The accuracy of DP transitter varies from ±0.1% to ±0. 3% of full-scale error.
Range ability is 3:1 to 5:1.
Upstream length/ Downstream straight length is 20 / 5

Figure 7: Venture meters

Advantages of Venture meters

- Lower head losses than orifice plates reducing the capital expenditure on pumping eqpt. / save pump energy costs
- No process interruption for the exchange of DP transmitter.
- Can be used for temperature extremes
- Cryogenics or High Temperatures

Disadvantages of Venture meters

- Highly expensive
- Larger and heavier to handle

- ✓ **Annubar**

The probe is installed in the media line as a pressure sensor.

With the flow, the probe records both the static and the dynamic pressure via the probe openings.

In the minus chamber of the annubar, lying on the opposite side, only the static pressure has any effect

The differential pressure corresponds to the dynamic pressure in the pipeline & the flow can is calculated directly.

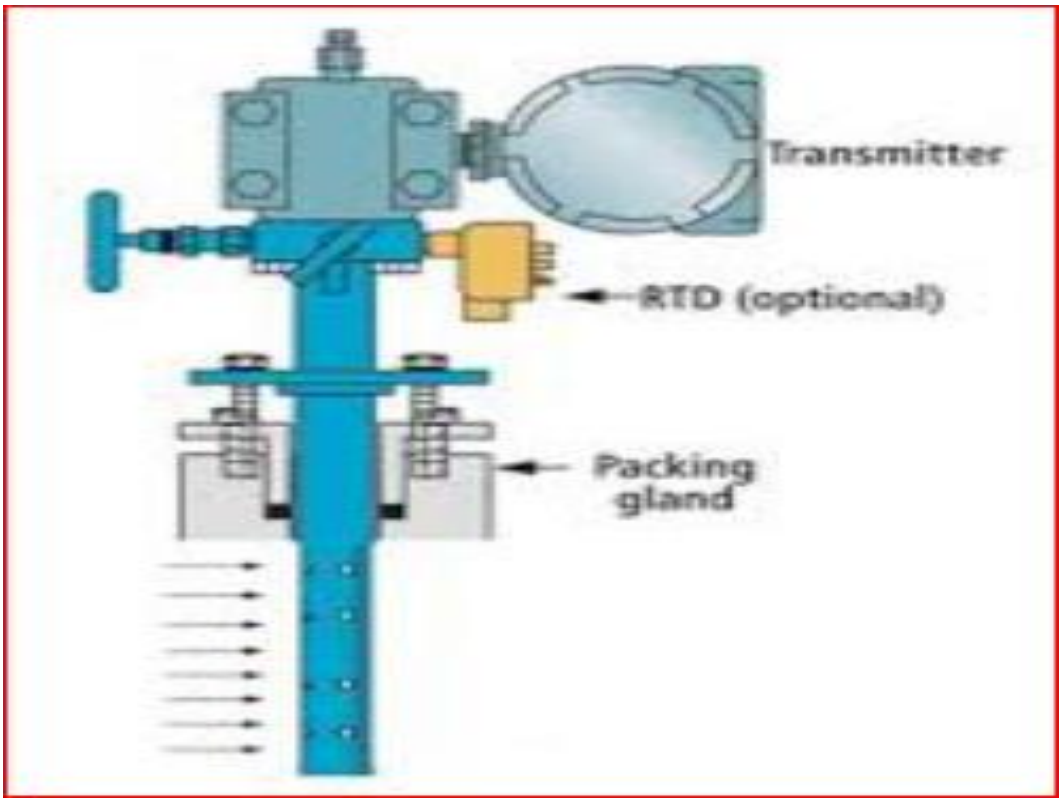


Figure 8: Annubar Flow meters

Features of Annubar Flow meters

Design Pressure: Upto 97 bars (38 Deg.C) / 55 bars (370 Deg.C)

Design Temperature: Upto 400 deg.C

Sizes: 50 mm to 3000 mm

Fluids : Clean Liquids, gases and steam

MOC: Brass / steel/ stainless steel/ Hastelloy

Accuracy: It varies from ±1% to ±2% of actual flow. The accuracy of the DP transmitter varies from ±0.1% to ±0. 3% of full-scale error.

Range ability is 3:1 to 5:1.

Upstream length/ Downstream straight length is 20 / 5

Advantages of Annubar flow meters

The integral manifold head allows direct mounting of DP transmitters

Hot tapping: Insertion/ installation without system shutdown

Very low-pressure drop

Disadvantages of Annubar

Not suitable for viscous and slurry applications

Can be used for only for clean fluids.

- **Differential Area type (Rotameters)**

A free moving float is balanced inside a vertical tapered tube

As the fluid flows upward the float remains steady when the dynamic forces acting on it are zero. The flow rate indicated by the position of the float relative to a calibrated scale.

Design Features of Rotameters

Design Pressure: Up to 350 PSIG (GLASS TUBE) / 720 PSIG (METAL TUBE).

Design Temperature: Upto 400 deg.C (GLASS TUBE) / 538 Deg.C (METAL TUBE).

Sizes: upto 75 mm

Fluids/ Applications: Clean liquids, gases and vapours

Flow range: upto 920 cub.m/hr for liquids & 2210 cub.m/hr for gases

MOC: Borosilicate glass/ brass / steel/ stainless steel/ Hastelloy

Accuracy: It varies from ±1% to ±2% of actual flow.

Range ability is 10:1

Upstream length/ Downstream straight length is 10 / 5

Advantages of Rotameters

- ✓ Simple, robust and linear output
- ✓ It does not require external impulse or lead lines.

The pressure drop is minimal and fairly constant

Disadvantages of Rotameters

- ✓ Vertical installation only.
- ✓ Glass tubes limit pressure and temperature and subject to breakage from hydraulic & thermal shock
- ✓ Glass tubes eroded by undissolved solids and unsuitable for metering alkaline solutions
- ✓ Metal tube meters more expensive.
- ✓ Foreign particles can accumulate around the float & block the flow

- **Electromagnetic flow meters**

Operate on Faraday's Law of magnetic induction. When a conductive fluid moves in a magnetic field, a voltage is generated between two electrodes at right angles to the fluid velocity and field orientation. The flow tube has a fixed area & field intensity so the developed voltage is linearly proportional to the volumetric flow rate

Design features of Magnetic Flow meters

Design Pressure: 20 BARS to 172 BARS

Design Temperature: Upto 120 deg.C with teflon liners / 180 Deg.C with ceramic liners

Sizes: 2.5 mm to 3000 mm

Fluids : Liquids (clean/ corrosive/dirty/viscous/ slurry)

Velocity range: 0.1 to 10 m/s

MOC: Liners: ceramic/ teflon/rubber : Electrodes: Platinum/ hastelloy/SS

Accuracy: It varies from ±0.5% to ±1% of actual flow.

Rangeability is 10:1

Upstream length/ Downstream straight length is 10 / 5

Advantages of magnetic Flow meters

- ✓ Flow rate unaffected by fluid density, consistency, viscosity, turbulence, or piping configuration.
- ✓ Highly accurate due to the absence of moving parts/ external sensing lines
- ✓ Corrosion-resistant using Teflon liner and platinum electrodes
- ✓ Wide flow measuring ranges & no pressure drop

Disadvantages of Magnetic Flow meters

- ✓ Costly, relative to other flow meter types.
- ✓ Temperature of the fluids being metered limited by the liner material rating.
- ✓ Cannot be used for gas flow measurements
- ✓ Costly, relative to other flow meter types.
- ✓ Temperature of the fluids being metered limited by the liner material rating.
- ✓ Cannot be used for gas flow measurements

- **Ultrasonic flow meters**

A pair (or pairs) of transducers, each having its own transmitter and receiver, are placed on the pipe wall, one (set) on the upstream and the other (set) on the downstream. The time for acoustic waves to travel from the upstream transducer to the downstream transducer (td) is shorter than the time it requires for the same waves to travel from the downstream to the upstream (tu). The larger the difference, the higher the flow velocity.

Advantages of Ultrasonic Flow meters

- ✓ No obstruction/ moving parts in the flow path
- ✓ No pressure drop
- ✓ Low maintenance cost
- ✓ Multi-path models have higher accuracy for wider ranges of Reynolds number
- ✓ Can be used in corrosive fluid flow
- ✓ Portable models available for field analysis and diagnosis

Disadvantages of Ultrasonic Flow meters

- ✓ Only clean liquids and gases can be measured
- ✓ Higher initial set up cost

- **Turbine flow meters**

Consists of a multi-bladed rotor mounted at right angles to the flow & suspended in the fluid stream on a free-running bearing. The diameter of the rotor is slightly less than the inside diameter of the flow metering chamber. Speed of rotation of rotor proportional to the volumetric flow rate

Features of Turbine Flow meters

Design Pressure: 1500 PSIG

Design Temperature: 150 Deg. C

Sizes: 5 mm to 600 mm (Full bore type)/ > 75 mm for insertion type

Fluids : Clean liquids/ gases and vapours

Velocity range: 0.3 to 15 m/s

MOC: mostly in stainless steel/ hastelloy

Accuracy is: +0.25% to + 0.5% of flow rate for full bore type/+1% to +3% of flow rate for insertion type

Range ability is 10 : 1

Upstream length/ Downstream straight length is 15/ 5

Bidirectional flow measurement

For insertion type, hot tapping in pressurized pipelines possible

Advantages of Turbine flow meter

- ✓ Very accurate. Commonly used to prove other meters.
- ✓ Digital output provides for direct totalizing, batching, or digital blending without reducing accuracy.
- ✓ There is less tendency to read high in pulsating flow than in head or variable-area type meters.

Disadvantages of Turbine Flow meters

- ✓ Not usable in dirty streams or with corrosive materials.
- ✓ Subject to fouling by foreign materials -fibers, tars, etc.
- ✓ Bearings subject to wear or damage. Shift in calibration if bearings replaced
- ✓ It can be damaged by over speeding (over 150 percent) or by hydraulic shock.
- ✓ Pressure loss at rated flow varies & can be high.

- **Vortex flow meters**

An obstruction is placed across the pipe bore at right angle to fluid flow.

As fluid flows, vortices are shed from alternating sides of the body & this shedding frequency is directly proportional to fluid velocity. Detection of the vortices by means of pressure changes in the vortex stream. Rate of creation of vortices directly proportional to the flow rate

Advantages of Vortex Flow meters

- ✓ Minimal maintenance, no moving parts.
- ✓ Calibration using fluid flow not required & unaffected by viscosity, density, pressure, and temperature within operating specification.
- ✓ Digital or analog output.

Disadvantages of Vortex Flow meters

- ✓ At low flows, pulses are not generated and the flow meter can read low or even zero.
- ✓ Reynolds number should be greater than 10000.
- ✓ Vibration can cause errors in accuracy.
- ✓ Correct installation is critical as a protruding gasket or weld beads can cause vortices to form, leading to inaccuracy.
- ✓ Long, clear lengths of upstream pipework must be provided, as for orifice plate flow meters.

- **Positive Displacement (PD) Meters**

This meter repeatedly entraps the fluid into a known quantity and then passes it out. The quantity of the fluid that has passed is based on the number of entrapments. The volume flow rate can be calculated from the revolution rate of the mechanical device.

Features of Positive Displacement (PD) Flow meters

Design Pressure: 1500 PSIG (liquids)/: 100 psig (gases)
Design Temperature: 293 Deg. C (liquids): -34 to 60 Deg. C (gases)
Sizes: 6 mm to 400 mm
Fluids: Clean Liquids/ gases
Flow range: 0 – 20000 GPM (liquids)/: 0 – 3000 cub.m/hr (gases)
MOC: mostly in aluminum, stainless steel, plastics, hastelloy
Accuracy is + 0.5% to + 1% of flow rate
Range ability is 15: 1

Advantages of PD Flow meters

- ✓ Good accuracy and high range ability

- ✓ Can be used in viscous liquid flow
- ✓ Low to medium initial set up cost
- ✓ Require no power supply and available in wide variety of read out devices

Disadvantages of PD Flow meters

- ✓ Maintenance required at frequent intervals because of the `moving parts.
- ✓ High pressure drop due to obstruction
- ✓ Not suitable for low flow rate
- ✓ Not suitable for fluids with suspended solids
- ✓ Gas (bubbles) in liquid could significantly decrease the accuracy

II Mass Flow meters

Mass flow meters measure the fluid mass flow rate that travels through a tube per unit time. There are two types of mass flow meters

a The Coriolis Mass flow meter and

b Thermal Mass flow meters

a. Thermal Mass flow meters

Operates by monitoring the cooling effect of a gas stream as it passes over a heated transducer. Gas flow passes over two PT100 RTD transducers. The temperature transducer monitors the actual gas process temperature, whilst the self-heated transducer is maintained at a constant differential temperature by varying the current through it. The greater the mass flow passing over the heated transducer, the greater the current required to keep a constant differential temperature. The measured heater current is, therefore, a measure of the gas mass flow rate.

Figure 8: Thermal Mass Flow meters

Design Features of Thermal Mass Flow meters

Design Pressure: 1200 PSIG

Design Temperature: 176 Deg. C

Sizes: 15 mm to 1000 mm

Fluids: Clean gases

Flow range: 0 – 2500 SCFM

MOC: mostly in stainless steel/ glass, teflon, monel

Accuracy is +1% to + 2% of flowrate

Range ability is 10: 1 to 100:1

Upstream length/Downstream straight length is 5/ 3

Advantages of Thermal Mass Flow meter

- ✓ No temperature or pressure compensation required
- ✓ Linear output (as temperature differential is proportional to mass flow)
- ✓ Can be used on corrosive process streams if proper materials are specified
- ✓ DC voltage or 4 to 20 mA dc outputs available

Disadvantages of Thermal Mass Flow meters

- ✓ Practical for gas flow only
- ✓ Subject to blockage by foreign particles or precipitated deposits due to small openings in flow meter
- ✓ Power requirements excessive in larger pipe sizes
- ✓ Has to taken out of process line for servicing
- ✓ Accurate field calibration is difficult

b. Coriolis Mass flow meter

When a moving mass is subjected to an oscillation perpendicular to its direction of movement, Coriolis forces occur depending on the mass flow.

When the tube is moving upward during the first half of a cycle, the fluid flowing into the meter resists being forced up by pushing down on the tube.

On the opposite side, the liquid flowing out of the meter resists having its vertical motion decreased by pushing up on the tube. This action causes the tube to twist.

This twisting movement is sensed by a pick-up and is directly related to the mass flow rate

Figure 10: Coriolis Mass flow meter

Coriolis Mass Flow meter Characteristics

Design Pressure: 345 bar

Design Temperature: 200 to 426 Deg. C

Sizes: 1.5 mm to 150 mm

Fluids/ Applications: Liquids (clean/ dirty/viscous/ slurries) clean /liquified gases

Flow range: 0 – 25000 lb/m

MOC: mostly in stainless steel, hastelloy/titanium

Accuracy is + 0.15% to + 0.5% of flowrate

Range ability is 20: 1

Bidirectional flow measurement

Advantages of Coriolis Mass Flow meters

- ✓ Capable of measuring difficult handling fluids
- ✓ Independent of density changes, flow profile and flow turbulence. Hence straight lengths are not required.
- ✓ No routine maintenance required since no moving parts
- ✓ High accuracy

Disadvantages of Coriolis Mass Flow meters

- ✓ Not available for large pipes (upto 150 mm only)
- ✓ High flow velocities required for detection resulting in high pressure drop
- ✓ Expensive compared to other flow meters
- ✓ Difficulty in measuring low pressure gases

6.2.3 Pumps

Pumps are one of the vital process accessories at the oil processing plant. These are used to transfer oils between tanks, pump oil through the process, unload and load trucks and rail cars, transfer oil out of various process unit operations for processing.

A pump is a device that is used for lifting the liquid from ground sources to the upper top surface or from one place to another place. Pumps are operated by the mechanism that is rotary, reciprocating and it consumes energy while performing mechanical work which is moving fluid from one place to another. This can be operated by many energy resources which include manual operation, electricity, engine, wind power and many more, day to day life to industrial applications.

Types of Pumps:

A pump can broadly be classified into two categories, and those are:

I Positive Displacement Pump and

II Dynamic Pump

I Positive Displacement Pump

There are two types of Positive Displacement Pump, and those are:

- **Rotary Pump**

Single Rotor Pump (For example, Piston Pump, Vane Pump, Screw Pump)

Multiple Rotor Pump (For example, Gear pump, Lube pump)

- **Reciprocating Pump**

Diaphragm Pump (For example, Fluid Operated Pump, Mechanically Operated Pump). A reciprocating pump is a hydraulic machine which converts the mechanical energy into hydraulic energy. Here a certain volume of liquid is collected in the enclosed volume and is discharged using pressure to the required application. Reciprocating pumps are more suitable for low volumes of flow at high pressures.

II Dynamic Pump

And again Dynamic Pumps can be classified into two types:

- Centrifugal Pump
- Axial Pump

Main Parts of Centrifugal Pump

- ✓ Impeller
- ✓ Casing
- ✓ Suction pipe with a foot valve
- ✓ strainer and
- ✓ Delivery pipe
- ✓ Impeller:

An impeller is a rotating component of a centrifugal pump which transfers energy from the motor that drives the pump to the fluid being pumped by accelerating the fluid outwards from the center of rotation.

The Casing that receives the fluid being pumped by the impeller, slowing down the fluid's rate of flow.

A volute is a curved funnel that increases in area as it approaches the discharge port.

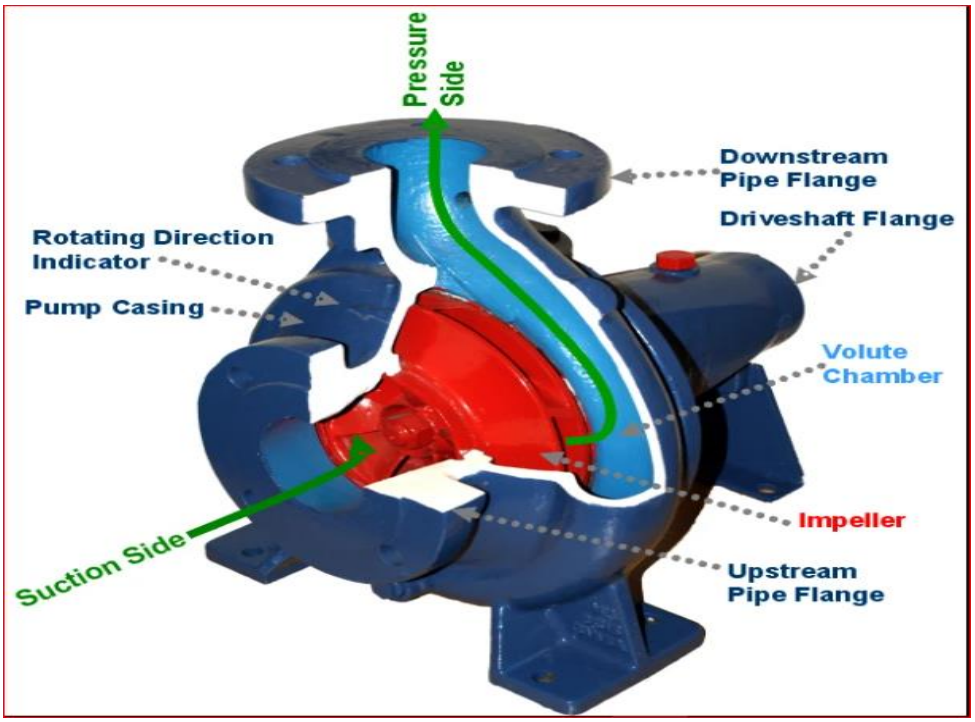


Figure 11: Centrifugal Pump

Advantages of Pump

- ✓ As there is no drive seal so there is no leakage in the pump.
- ✓ There are very less frictional losses.
- ✓ The construction of the pump is Simple.
- ✓ Almost no noise.
- ✓ Minimum wear as compared to others.

Disadvantages of Pump:

- ✓ Produce cavitation.
- ✓ Corrosion.
- ✓ Cannot be able to work at high speed.

Applications of Pump

The main applications of the pump are:

- ✓ As we already discussed Pumping Water from one place to another place.
- ✓ Aquarium and pond filtering
- ✓ This is also used for Water cooling and fuel injection in automobiles
- ✓ Pumping oil or gas and operating cooling towers in the energy industry.
- ✓ Uses in waste-water recycling, pulp, and paper, chemical industry, etc.

6.2.4 Centrifugal separators

Centrifugal separators are driven by the technique of centrifugation. Centrifugation utilizes centrifugal force to separate particles from the solution. This process is mainly employed to separate two immiscible substances existing in a solution.

Working Principle of Centrifugal Separator

The centrifugal separator features an inlet, outlet, and separator. The liquid-solid, solid-liquid, or gas-solid mixture is pumped into a cone-shaped working apparatus in the separator. The separator produces a spinning vortex, which leads to the filtration

of solids from liquids. The separated solids are collected at the bottom of the separator, and they are purged from there. High-density liquid flows out of the separator, along with the contaminant, and low-density component will remain inside. Water is one of the denser liquids, so it flows outside, and is removed through a discharged outlet. However, lower density fluids such as oil will remain at the center of the vortex. Segregated oil can be easily recovered from the suction orifice of the separator.

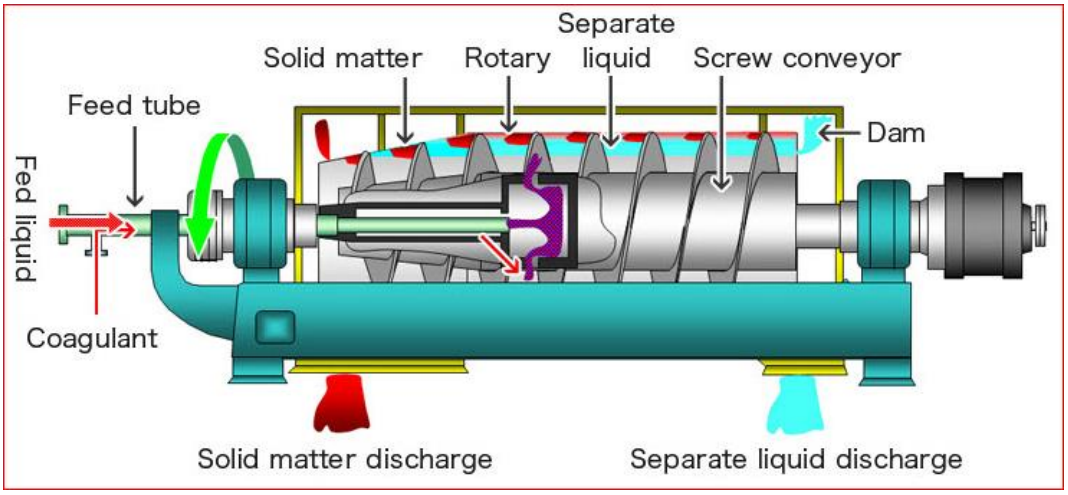


Figure 12: Centrifugal separators

Figure 13: Disk type Centrifugal separators

Types of Centrifugal Separation

Centrifugal separators are mainly used for liquid-based applications. They are widely used to separate

Liquid- Solis Suspension

Liquid – Liquid Mixture

Solid/Gas – Liquid Mixture

Advantages of Centrifugal Separators

Centrifugal separators are used in a variety of industrial applications, owing to various advantages they offer. They have a few moving parts than other separators and have no filters, bags, screens, as well as cartridges, which makes them an ideal choice for various industrial applications.

In addition to their design advantages, these separators provide the following benefits:

Maintenance Free: The centrifugal separator is largely maintenance-free owing to the absence of moving parts or other components. It is fitted with an automatic purge valve designed to flush the debris and contaminants automatically.

Minimal or No Downtime: This is another major advantage of centrifugal separator water filters or centrifugal separators used in the industrial process. As the filtration is performed by the spinning of a vortex, there are no real filters involved. This means there will no accumulation of debris in filters, and there will no breakdown due to this accumulation. Also, there will no need to change the filters more often, as in the case of other liquid separators.

Minimal Liquid Loss: Do you know there is a little liquid loss by purging while using centrifugal separators than other filters! Typically, the users have to bear major liquid loses when cleaning sand media filters or automatic strainers.

High Efficiency: The efficiency of centrifugal separation is 98% of 40 microns in a single pass. However, for centrifugal separator, this is 44 microns.

6.2.5 Mixer

There are a very large variety of mixers available, due to the large number of mixing applications and the empirical nature of mixer design and development. So in edible oil neutralization dynamic mixer is used to mix crude oil and hot water and separated into and separated into wash water and oil in a separator.

6.2.6 Chemical addition system

The chemical addition system can be mechanical or automatic

In mechanical addition system, the needed amount of chemical is added manually using man power. In automatic addition system, the needed amount of chemical is added using computer control system.

6.2.7 Heat exchanger

A heat exchanger is a system used to transfer heat between two or more fluids. Heat exchangers are used in both cooling and heating processes

Heat is the energy produced due to temperature difference. Heat transfer occurs when there is a temperature difference between two or more mediums. There are three different heat transfer processes: conduction, convection, and radiation

Figure14: Heat exchanger

- **Classifications of heat exchangers**

There are three primary classifications of heat exchangers according to their flow arrangement.

✓ **Parallel-flow heat exchangers**

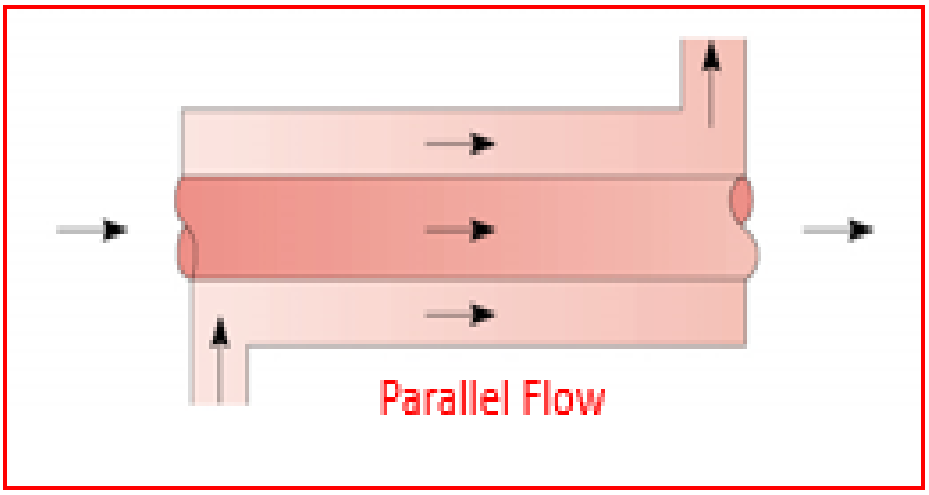


Figure 15: Parallel-flow heat exchangers

In parallel-flow heat exchangers, the two fluids enter the exchanger at the same end, and travel in parallel to one another to the other side.

✓ **Counter-flow heat exchangers**

In counter-flow heat exchangers the fluids enter the exchanger from opposite ends. The counter current design is the most efficient, in that it can transfer the most heat from the heat (transfer) medium per unit mass due to the fact that the average temperature difference along any unit length is higher.

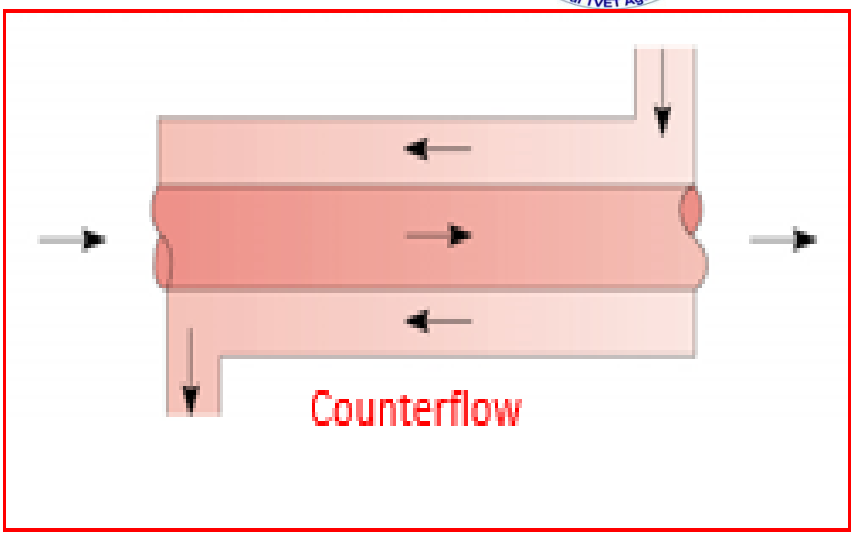


Figure 16: Counter-flow heat exchangers

- ✓ **Cross-flow heat exchanger**

In a cross-flow heat exchanger, the fluids travel roughly perpendicular to one another through the exchanger.

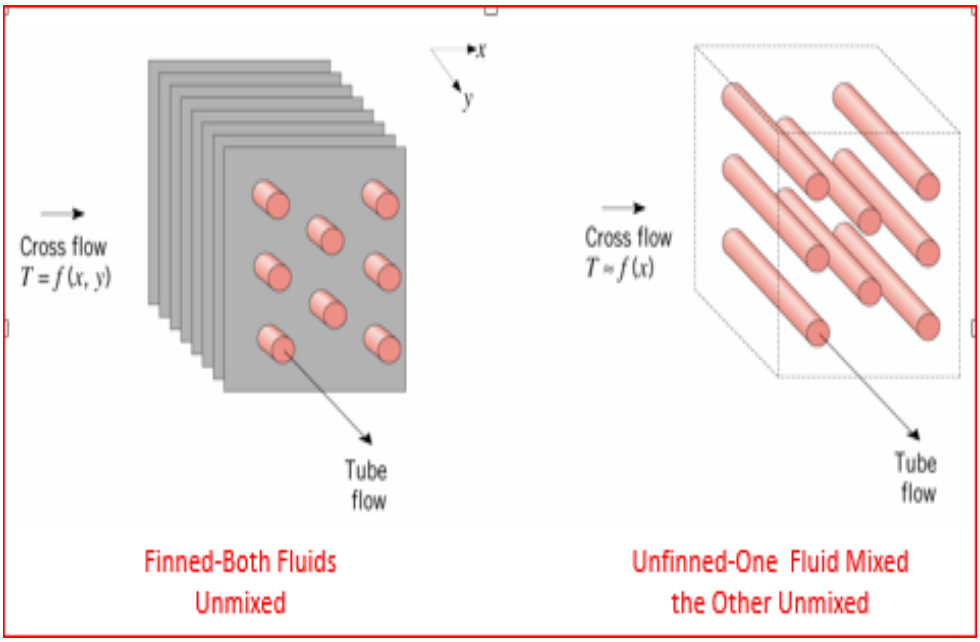


Figure 17: Cross-flow heat exchanger

Types of heat exchangers

- ✓ **Double pipe heat exchangers**

Double pipe heat exchangers are the simplest exchangers used in industries. On one hand, these heat exchangers are cheap for both design and maintenance, making them a good choice for small industries. On the other hand, their low efficiency coupled with the high space occupied in large scales, has led modern industries to use more efficient heat exchangers like shell and tube or plate. However, since double pipe heat exchangers are simple, they are used to teach heat exchanger design basics to students as the fundamental rules for all heat exchangers are the same.

When the other fluid flows into the annular gap between two tubes, one fluid flows through the smaller pipe. The flow may be a current flow or parallel flow in a double pipe heat exchanger.

Parallel flow, where at the same point, the hot and cold liquids join, flow in the same direction and exit at the same end.

Counter flow, where at opposite ends, hot and cold fluids join, flow in the opposite direction and exit at opposite ends.

- ✓ **Shell-and-tube heat exchange**

The main constituents of this type of heat exchanger seem to be the tube box, shell, the front rear end headers, and baffles or fins.

The baffles are used to support the tubes, direct the fluid flow to the tubes in an approximately natural manner, and maximize the turbulence of the shell fluid. There is many various kinds of baffles, and the choice of baffle form, spacing, and geometry depending on the allowable flow rate of the drop in shell-side force, the need for tube support, and the flow-induced vibrations. There are several variations of shell-and-tube exchangers available; the differences lie in the arrangement of flow configurations and details of construction.

Shell and tube heat exchangers consist of a series of tubes which contain fluid that must be either heated or cooled. A second fluid runs over the tubes that are being

heated or cooled so that it can either provide the heat or absorb the heat required. A set of tubes is called the tube bundle and can be made up of several types of tubes: plain, longitudinally finned, etc. Shell and tube heat exchangers are typically used for high-pressure applications (with pressures greater than 30 bar and temperatures greater than 260 °C). This is because the shell and tube heat exchangers are robust due to their shape.

The thickness of the wall of the tubes is usually determined to ensure:

- There is enough room for corrosion
- That flow-induced vibration has resistance
- Axial strength
- Availability of spare parts
- Hoop strength (to withstand internal tube pressure)
- Buckling strength (to withstand overpressure in the shell)

Baffles - are used to establish a cross-flow and to induce turbulent mixing of the shell-side fluid, both of which enhance convection.

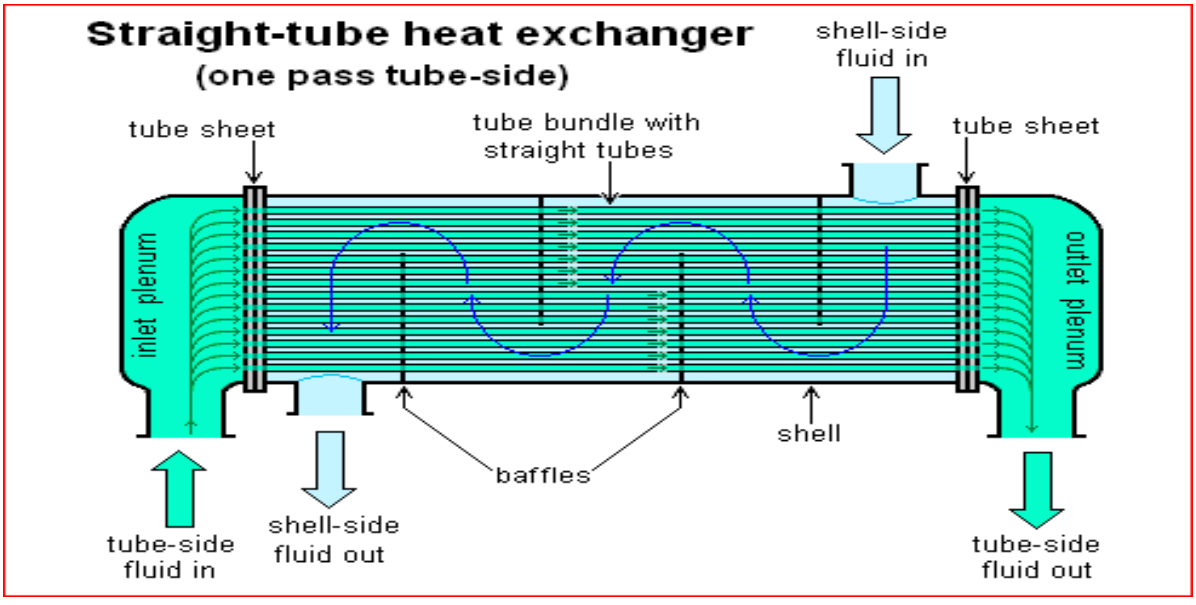


Figure 18: Shell-and-tube heat exchange

- ✓ **Plate Heat Exchanger**

A plate heat exchanger contains an amount of thin shaped heat transfer plates bundled together. The gasket arrangement of each pair of plates provides two separate channel system. Each pair of plates form a channel where the fluid can flow through. The pairs are attached by welding and bolting methods. The following shows the components in the heat exchanger.

These exchangers are composed of many thin, slightly separated plates that have very large surface areas and small fluid flow passages for heat transfer. Advances in gasket and brazing technology have made the plate-type heat exchanger increasingly practical. A gasket plate heat exchanger has a heat region from corrugated plates. The gasket function as seal between plates and they are located between frame and pressure plates. Fluid flows in a counter current direction throughout the heat exchanger. An efficient thermal performance is produced. Plates are produced in different depths, sizes and corrugated shapes. There is different type of plates available which includes plate and frame, plate and shell and spiral plate heat exchangers. The distribution area guarantees the flow of fluid to the whole heat transfer surface. This helps to prevent stagnant area that can cause accumulation of unwanted material on solid surfaces. High flow turbulence between plates results in a greater transfer of heat and a decrease in pressure.

These exchangers are composed of many thin, slightly separated plates that have very large surface areas and small fluid flow passages for heat transfer. Advances in gasket and brazing technology have made the plate-type heat exchanger increasingly practical.

When compared to shell and tube exchangers, the stacked-plate arrangement typically has lower volume and cost. Another difference between the two is that plate exchangers typically serve low to medium pressure fluids, compared to medium and high pressures of shell and tube. A third and important difference is that plate exchangers employ more countercurrent flow rather than cross current flow, which

allows lower approach temperature differences, high temperature changes, and increased efficiencies.

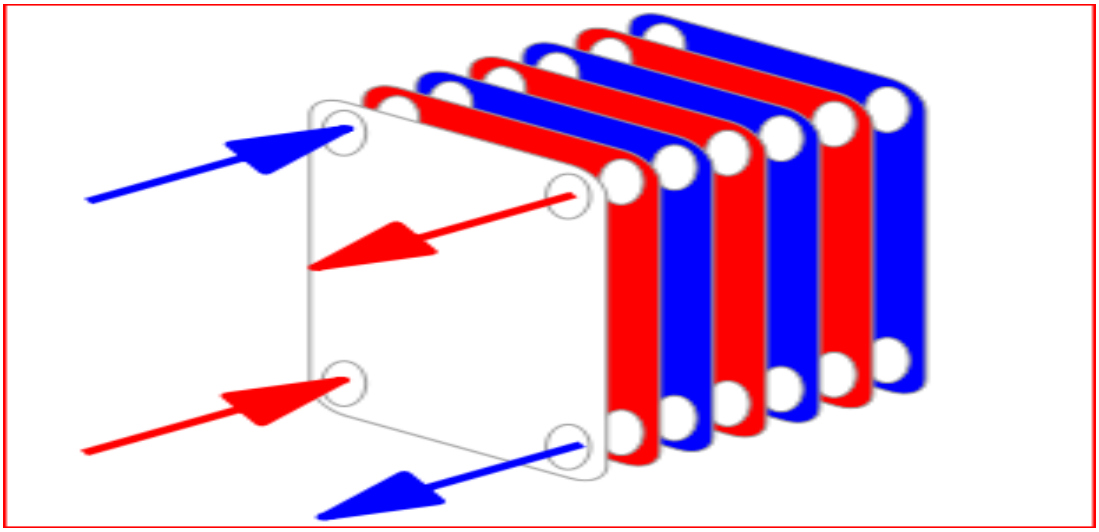


Figure 19: Plate Heat Exchanger

- ✓ **Condensers and Boilers Heat exchangers**

Using a two-phase heat transfer system are condensers, boilers and evaporators. Condensers are instruments that take and cool hot gas or vapor to the point of condensation and transform the gas into a liquid form. The point at which liquid transforms to gas is called vaporization and vice versa is called condensation. Surface condenser is the most common type of condenser where it includes a water supply device. The pressure of steam at the turbine outlet is low where the steam density is very low where the flow rate is very high. To prevent a decrease in pressure in the movement of steam from the turbine to condenser, the condenser unit is placed underneath and connected to the turbine. Inside the tubes the cooling water runs in a parallel way, while steam moves in a vertical downward position from the wide opening at the top and travel through the tube. Furthermore, boilers are categorized as initial application of heat exchangers. The word steam generator was regularly used to describe a boiler unit where a hot liquid stream is the source of heat rather than the combustion products. Depending on the dimensions and

configurations the boilers are manufactured. Several boilers are only able to produce hot fluid while on the other hand the others are manufactured for steam production

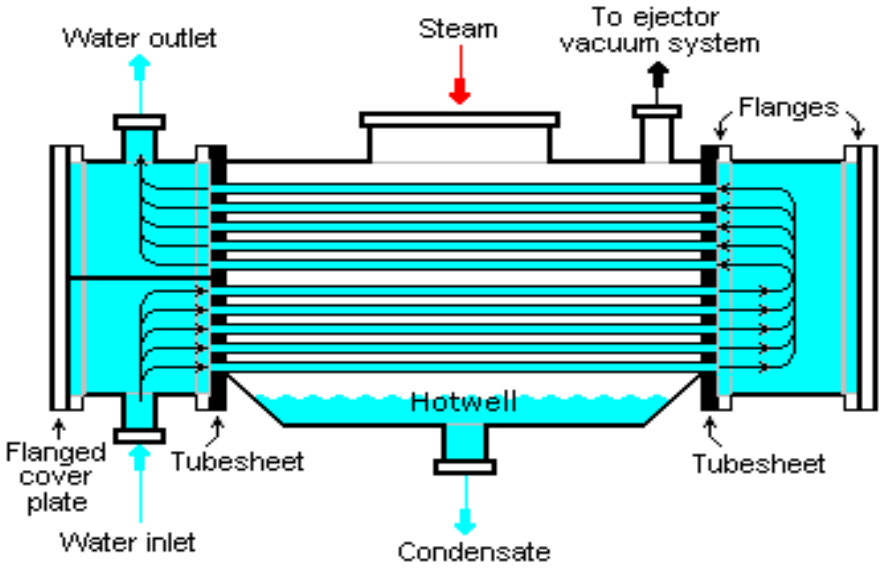


Figure 20: Condensers and Boilers Heat exchangers

6.3 Checking and adjusting Venture meters and centrifugal separator

The figure below indicates the adjustment of the flow valve in venture meters

Figure 21- Venture meters adjustment

- **Checking and adjusting centrifugal separator**

The adjustment or installation procedures for centrifugal separator are given in figure below.

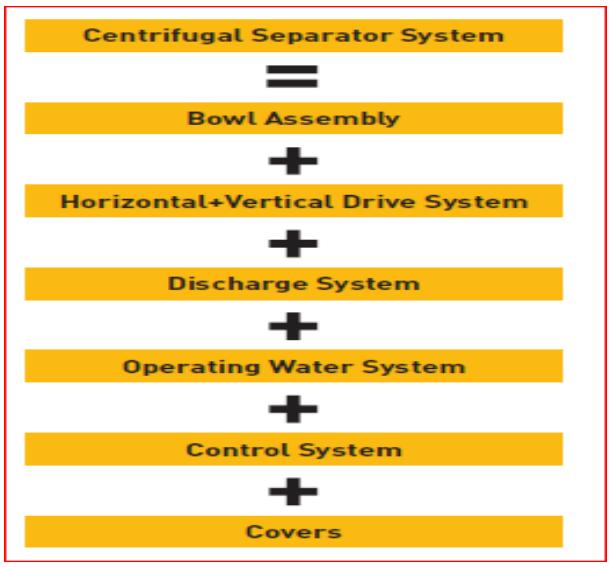


Figure 22: steps in Checking and adjusting centrifugal separator

1. Adjusting or assembling the centrifugal separator bowl

2. Adjustment system for:
    - Horizontal and vertical drive
    - Discharge system
    - Operating water system

3. Adjustment system for process control system

Self-Check # 6	Written Test

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

1. Write and explain two types of flow meters used in edible oil processing (6pts)
2. Write the uses of pump (5pt)

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

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

Information Sheet 7 - Carrying out pre-start checks

7.1 Introduction

Pre starts often involve routine inspections conducted by the machine or equipment operator. Prior to operating any oilseed cleaning equipment, the operator of that equipment completes a visual assessment, check levels, wear, indicator lights, or signs of damage. The Prestart checklist ensures the operators assessments are recorded and saved, this acts not only as a verification that checks are done, but also an accountability measure for operators of that equipment to take responsibility for their equipment.

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.

7.2 Purpose of pre-start checks

- To make the process easy
- To reduce hazards
- To take action

7.3 Carrying out 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
- start, operate, monitor and adjust neutralization process equipment to achieve required outcomes

Self-Check 7	Written Test

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

1. what are pre-start check we have to do before start operating equipment (6pts)
2. List pre-start checks we perform before going to operate equipment (4pts)

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

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

LG #36	LO#2- Operate and monitor the neutralization process

Instruction sheet

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

Policies and procedures for starting and operating neutralization process

- Monitoring operation of equipment
- Identifying variation in equipment operation and reporting maintenance
- Workplace information
- Monitoring neutralization process
- Identifying, rectifying and/or reporting out-of-specification product/process
- Legislative requirements
- Maintaining work area to workplace 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:

Policies and procedures for starting and operating neutralization process

- Monitor operation of equipment
- Identify variation in equipment operation and reporting maintenance
- Workplace information
- Monitor neutralization process
- Identify, rectify and/or report out-of-specification of product/process
- Legislative requirements
- Maintain work area to workplace housekeeping standards

Maintain workplace records
Learning Instructions:
Read the specific objectives of this Learning Guide. Follow the instructions described below. Read the information written in the information Sheets 1. Accomplish the Self-checks 2. Perform Operation Sheets 3. Do the “LAP test”

Information Sheet 1 - Policies and procedures for starting and operating neutralization process

1.1 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

1.2 Policies and procedures for starting and operating neutralization process

Policies and procedures may include but not limited to:

- Company policies and procedures,
- Regulatory and licensing requirements,
- Legislative requirements, and industrial awards and agreements

1.2.1 Company policies and procedures,

Workplace policies are statements of principles and practices dealing with the ongoing management and administration of the organization.

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.

Policies: Are a statement of purpose, which highlight broad guidelines on action to be taken to achieve that purpose. 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.

Benefits of workplace policies

Well-written workplace 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.

1.3 Starting and operating neutralization process

When starting up equipment, flow rates or throughput should be gradually and steadily built up to the normal operating parameters. Any changes to operating

parameters should be made gradually so that the effect of the changes can be monitored and corrective action taken if required. The following are some of parameters should be checked

- Voltage/power needed
- PH
- Pressure
- Speed
- T^{o}

Self-Check # 1	Written Test

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

1. Write the benefits of workplace policies (5pts)

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

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

Information Sheet 2 - Monitor operation of equipment

2.1 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, clarity, and other quality parameters of oil. Without monitoring and controlling the equipment and process; it was impossible to get quality products.

2.2 Monitor operation of equipment

Monitor operation of equipment include the use of process control panels and systems. Most machine and process characteristics which affect quality, availability, capacity, safety, risk and cost can be continually evaluated throughout an asset's lifetime. This is essential in identifying impending failure and will be applied to critical areas identified in the reliability plan. The current state-of-health of process plant is important information related to current information, diagnosis and prognosis of various defects, and predicted useful life in the optimizations of safety, quality and high production rates.

In edible oil neutralization process, the operating parameters like:

- Heating temperature of caustic soda
- hot water for soap washing,
- Operating pressure of centrifugal separator and

- Mixing time of oil with caustic soda was the basic process parameters for edible oil that should be monitored on centrifuges.

Self-Check # 2	Written Test

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

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

Information Sheet 3 - Identify variation in equipment operation and reporting maintenance

3.1 Identify variation in equipment operation and reporting maintenance

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

3.2 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 mixing using, 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.

3.3 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

3.4 Reporting maintenance

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.

Table 4: maintenance report checklist

Maintenance Performed	Date	Signature
Heat exchanger body welded	5- 8 /3/2021	Mr. B
Tube replaced	3 - 10/3/2021	Mr. C
Temperature sensor replaced	7- 9 /3/2021	Mr. C

Fig.22. Heat exchanger maintenance

Self-Check 3	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 - 10 points **Unsatisfactory - below 10 points**

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

Information Sheet 4 - Workplace information

Workplace information may include but not limited to:

- Standard Operating Procedures (sops)
- Specifications
- Production schedules and instructions
- Manufacturers' advice
- Standard forms and reports

4.1 Specification

A specification is defined as a list of tests, references to analytical procedures, and appropriate acceptance criteria which are numerical limits, ranges, or other criteria for the tests described. It

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).

4.2 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.

Benefits of SOP

The development and use of SOPs minimizes variation and promotes quality through consistent implementation of a process or procedure within the organization, even if there are temporary or permanent personnel changes. SOPs can indicate compliance with organizational and governmental requirements and can be used as a part of a personnel training program, since they should provide detailed work instructions. It minimizes opportunities for miscommunication and can address safety concerns. When historical data are being evaluated for current use, SOPs can also be valuable for reconstructing project activities when no other references are available. 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.

4.3 Production schedules and instructions

In production scheduling the products to be manufactured and their quantities are determined initially. The sequence of manufacturing processes required for the production of these items are also established. The manufacturing resources are then allocated to perform production processes to realize various items. This is spread over a predetermined time. This function is known as production scheduling. The objectives of scheduling also include maximization of the resource utilization, minimization of the work-in-process inventory, reduction of manufacturing lead time, etc.

4.4 Standard forms and reports

All business organizations formulate their standard operating procedures and have it documented. The document contains a set of instructions that are acceptable and adhered by all members and/or the workforce. These standard operating procedures are made in order for each and every one to engage themselves in an organization with less failure and omission of required tasks, thus helping them achieve or obtain efficiency and uniformity of their overall performances. Nevertheless, these procedures or mechanisms make them

capable of producing standard and quality output. By means of this, all business forms must be formalized in order to ensure that all corporate policies are observed and heeded accordingly.

STANDARD REPORT FORM

misconduct, whether on or off the field of play, by any player, club official or any other participant.

Division: _____ Date: _____

Match: _____ v. _____

Venue: _____

Umpires _____ _____

Details of Club(s), player(s), captain(s) or other participant(s) being reported

Report:

Describe the incident with a brief factual account of the details of the alleged breach(es). Include specific times

Signatures: _____ _____

Print names: _____ _____

Date: _____ _____

Fig.23. Standard forms and reports

Self-Check # 4	Written Test

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

1. Write the benefits of SOP (5pts)
2. Define specification (5pt)

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

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

Information Sheet 5 - Monitor neutralization process

5.1 Introduction

The purpose of neutralization is to reduce the concentration of free fatty acids (FFA) to a maximum 0.10% through the use of a diluted alkali solution, typically sodium hydroxide. This process can be applied batch wise in vessels and continuously by means of centrifuge. After alkali treatment, the oil is washed with hot water or treated with silica to reduce its residual soap level.

Soda silicate boil can be used for batch neutralization of crude or water-degummed seed oils. Traded crude seed oils or fats contain 1-3% FFA, good batches 50.5%. In some batches of palm, olive or fish oil, up to 20% FFA may be found. Well-refined oils have a maximum of 0.1% FFA (depending on further usage). There are several methods of neutralization that have all been tested for large-scale use. Most processes that have been developed, how- ever, are not suitable for industrial production or have not succeeded in the market. Principally, one can distinguish between physical and chemical processes. Physical processes include distillative removal of FFA, steam distillation, selective adsorption of the FFA and selective extraction of the FFA. Chemical processes include re-esterification of the FFA with glycerol, neutralization of the FFA with alkali lye and neutralization of the FFA with ammonia. All methods cause different neutral oil losses, which add up in the total refining loss.

Neutralization using caustic soda

The impurities you most often have to deal with in conjunction with fats and oils are the free fatty acids. These normally stem from lower-quality raw materials and/or inappropriate storage.

The greater the free fatty acid content, the more challenging the purification process and the stronger the caustic soda concentration needed to neutralize and remove it.

5.2 Methods of Oil 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

Alkaline neutralization involves the reaction between FFA and an alkaline solution such as sodium hydroxide/calcium hydroxide/potassium hydroxides. Since the sodium hydroxides used are highly concentrated, they tend to saponify the triglycerides leading to the loss of oil. Hence, it is used in conjugation with sodium carbonate or is diluted using hot water (Gunstone et al. 1994). Caustic soda and oil are agitated intensively and passed into a disc separator which removes the soap from the oil. A process called re-refining is carried out only in those cases where the quality of the oil is very poor. Following this process is the washing of the mixture to attain low residual soap content. This process is done at high temperatures, high mixing intensities, and long contact time. The water used for this purpose is hot, generally hotter than oil. In cases where very low quantities of soap are to be removed, acidified water prepared with either phosphoric acid or citric acid is recommended. Finally, the washed oils are sent for vacuum drying to remove the moisture from the oil. Use of sodium bicarbonate, sodium carbonate, and sodium hydroxide for rice bran oil neutralization was explored at 150 – 210°C at 2– 4 mmHg pressure.

There are two methods of neutralization; physical and chemical methods

5.2.1Physical Methods

a . Distillative Removal of FFA.

Distillative removal of FFA is part of a process that as a whole is called physical refining.

b . Selective Adsorption of FFA.

Adsorption of FFA on silica gel or aluminum oxide has been proposed and tested with moderate success. Only adsorption on an ion exchangers has delivered good results.

The application of strong basic quaternary ammonium salts yielded very good test results in the laboratory, but could not be extended into practice

c . Selective Extraction of FFA.

If oils have a very high concentration of FFA, these can be selectively separated with solvents. If olive oil with an FFA > 20% is extracted with ethanol, it is possible to bring down the FFA to values 4% (Gander 1%9). Another solvent that proved to selectively dissolve FFA and highly unsaturated triglycerides at suitable temperatures is furfurol. Liquid prop, which is used counter currently (Solexol process), selectively dissolves saturated neutral oil, whereas fatty acids, oxidation products, unsaponifiable matter and the higher unsaturated glycerides are almost untouched

5.2.2 Chemical process

- **Re-esterification with Glycerol.**

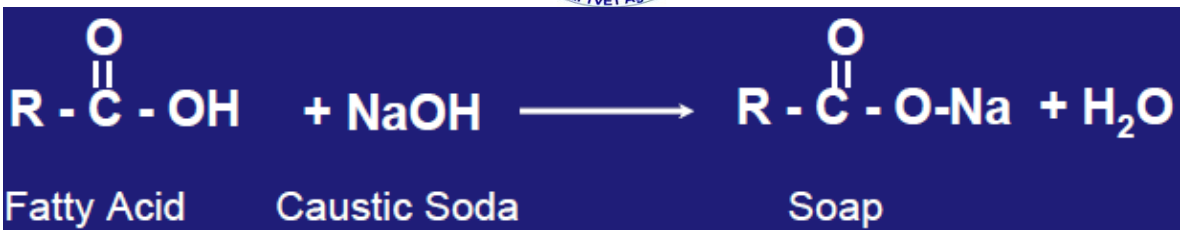
The reaction equation of fatty acids and glycerol to yield fat is as follows:

Glycerol + fatty acids + fat + water

Following that reaction, from the right to the left (fat splitting), FFA are formed. This fat splitting can also be enforced by applying a pressure p > 3 MN/m2 (30 kg/cm2) in the presence of water. In refined oils and fats, fat splitting is usually caused by enzymatic processes. Going from the left to the right, re-esterification takes place if an excess of glycerol is present under reduced pressure and at high temperature (t > 250°C). The pressure should not be higher than 5-6 hPa If catalysts (for example, zinc powder or zinc chloride) are used, the reaction temperature can be reduced to 220°C.

- **Neutralization with Alkali**

Today, the most common method for neutralization of fats and oils is neutralization with caustic soda solution. In the course of the reaction, soaps and water are formed from the free fatty acids as follows:



At normal pressure, this reaction proceeds completely from the left to the right at temperatures of 60- 85°C. The soaps formed could be split working from the right to the left at a pressure >30 bar.

The amount of alkali lye that is necessary for neutralization-almost exclusively caustic soda solution-is determined by titration of the oil immediately before neutralization. This is usually not done in the laboratory but on the factory floor. From the titration result, plant operators can read the required amount of caustic soda from tables. Depending on the lye strength (often in Baume units, abbr. Be), an excess of 5-25% is applied to ensure complete neutralization. In the US some old plants still exist in which the oil is neutralized at 20-30°C (cold neutralization). However, this process is dis- appearing gradually. Because of the different composition of fats from fatty acids of different molecular weight, the amount of caustic soda required for neutralization is also different (Table 5)

Table5: Amount of Lye Necessary for Neutralization of Different Oils and Fats

Oil/fat	Density at 15%C (g/cm3)	Average molecular weight	Amount of lye needed per % of FFA to neutralize one MT of oil with caustic soda		
			(kg NaOH)	(L 4n-NaOH)	(L NaOH, 14 Bé)
Lard	0.920	273	1.35	8.4	12.3
Tallow	0.945	270	1.40	8.8	12.7
Palm oil	0.935	270	1.39	8.7	12.6
Soybean oil	0.928	280	1.33	8.3	12.1
Cottonseed oil	0.925	275	1.35	8.4	12.3
Sunflower seed oil	0.923	280	1.32	8.2	12.0
Peanut oil	0.918	278	1.32	8.3	12.0
Rapeseed oil (LEAR)	0.915	285	1.28	8.0	11.6
(HEAR)	0.913	308	1.19	7.4	10.8
Coconut oil	0.923	215	1.72	10.7	15.6
Palm kernel oil	0.930	225	1.65	10.3	15.0

The amount L (in liters) of N-normal lye solution needed to neutralize 1 MT of oil can be calculated as follows:

$$L = \frac{A.\ FFA * 1000 * k}{100 * M.\ N}\ l/h$$

$$L = \frac{A.\ FFA * 1000 * 1000}{100 * M.\ N} = \frac{A.\ FFA * 10{,}000}{M.N}$$

If the amount C (kg) of caustic soda, NaOH , has to be calculated, 40 N has to be added in the numerator and 1000 in the denominator, resulting in the following:

$$C = \frac{A.\ FFA * 1000 * 1000 * 40\ N}{100 * M.\ N * 1000} = \frac{A.\ FFA * 400}{M}$$ where;

Where; L = Amount of lye; A = oil flow (kg/h); FFA = content of free fatty acids (%);
k = factor for lye excess; M = molecular weight of the fatty acids (kg/mol);
N = normality of lye (mol/l)

If oils are difficult to refine with common neutralization techniques, a soda water glass boiling step can be included. The silicates that precipitate bind undesired particles. Soda water glass boiling is conducted at temperatures of 1W105"C and takes 15 - 30 min. The approximate amounts of energy required for common neutralization processes per ton of oil are as follows: discontinuous process, 150 kg steam and 4 kwh electrical energy; centrifugal process, 85 kg steam and 13 kwh electrical energy.

- ✓ **Discontinuous neutralization**

A neutralizer for discontinuous neutralization is a vertical cylindrical vessel of up to 75 ton content; it is conical in its lower part. It is equipped with an outer heating mantle and an inner heating coil to ensure proper heating. Also, there is a stirrer for good agitation and some shower heads to dose finely dispersed caustic soda solution onto the oil. In the lower part, there is a view glass. After being heated to 60"C, the lye is finely sprayed onto the oil. It is then heated to 70 - 80°C. Because of its higher specific weight, the caustic soda solution percolates through the oil, thereby neutralizing the FFA on its way. Stirring supports this process. The aqueous soap solution collects in the lower cone and is decanted. The completeness of soap separation is optically controlled using the view glass (manually) or by ultrasonic or conductivity measurements (automatically). The soap is collected and the oil is washed soap free. Then the oil is dried in the neutralization vessel. Discontinuous neutralization has advantages if small batches of different oils have to be neutralized or if the daily throughput does not exceed 10 MT. The investment for such a plant is low. On the other hand, it cannot be automated easily, thus incurring higher labor costs. This makes discontinuous neutralization of particular interest for countries with low wages even for higher throughput. In addition, such plants can be manufactured and maintained locally, which is very important in countries with high import duties or with no reserves of foreign currency. Compared with these advantages, in special situations, the high energy costs usually do not matter.

- ✓ **Continuous neutralization.**

Using centrifuges for separation, a fully continuous neutralization plant can be designed. These plants require a high investment but can be run at very low cost.

The oil passes through an oil meter and a plate heat exchanger where it is indirectly heated to the reaction temperature of 80- 9O^{0}C. From there, it is pumped into a mixer where it is dosed with an amount of caustic soda equivalent to the acid value of the oil. This dosing step is coupled with the oil meter to ensure the addition of the correct amount of lye. Then the oil soap mixture is pumped into a reaction vessel and a second mixer from which it passes through a self-discharging separator. Less than 15 second after addition of the caustic soda the soap is already separated by centrifugation. The bowl rotates at 400-5000 rotations/min and the soap solution is continuously discharged. If needed, water can be added to the bowl to improve soap separation.

Bad quality oils may require a second treatment (refining), following the same principle as the first process. The plate heat exchanger for the second stage is much smaller because the oil leaving the first separator is at a sufficiently high temperature so as to require only post heating. The oil is then heated to washing temperature in a plate heat exchanger and washed with hot water (10% of the amount of oil). The washing water is also separated by a centrifuge. After separation of the washing water, the oil is dried. It is subsequently fed into a vacuum dryer where it flows in a thin film under reduced pressure (25hPa) over a series of cascades. The water easily evaporates from that thin film, and the oil is collected at the bottom of the vessel to be pumped into the neutral oil storage. The soaps are also collected and are worked up or sold as such.

Advantages Chemical process

- High Oil quality
- Low bleaching earth consumption
- Well know process

- Simple process control
- Low energy consumption

Disadvantages Chemical process

- Lower Yield compared with physical refining especially for high FFA oils
- But Acid Oil can be recovered in soap-stock splitting
- Effluent stream after soap-stock splitting

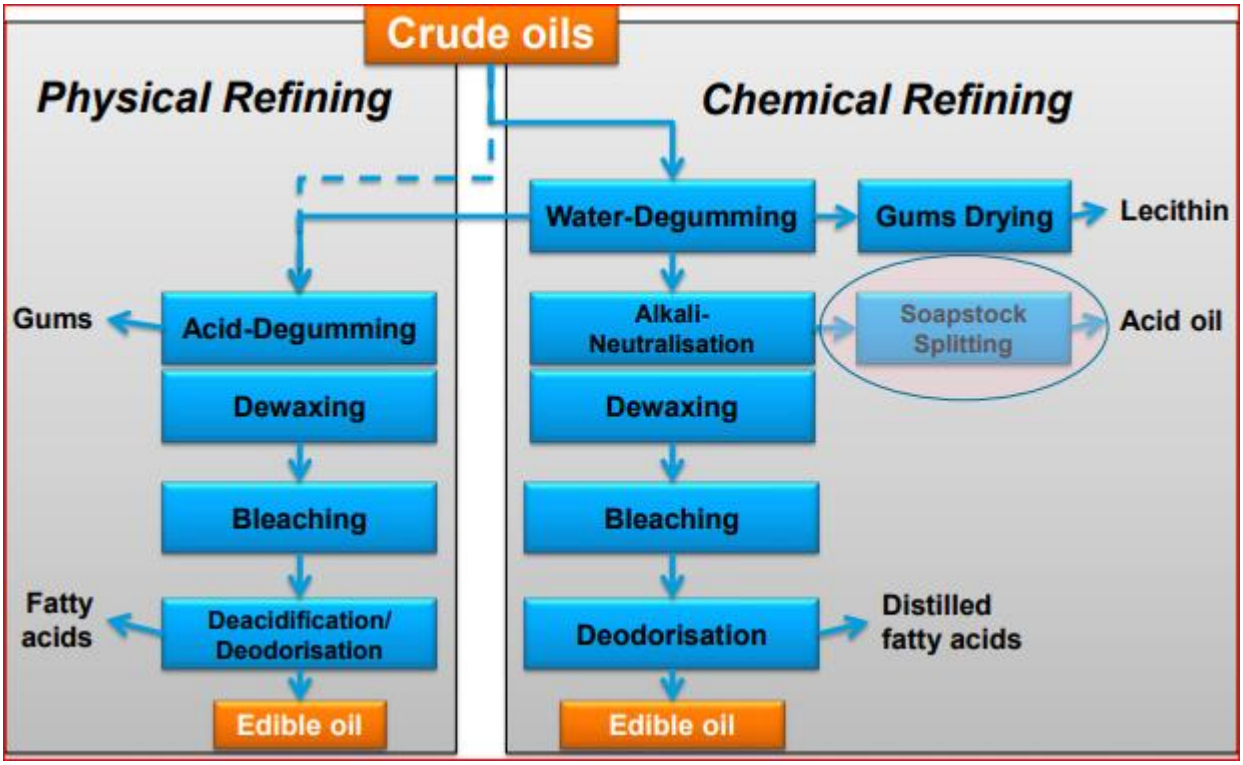


Fig.24: Physical and chemical edible oil processing flow diagram

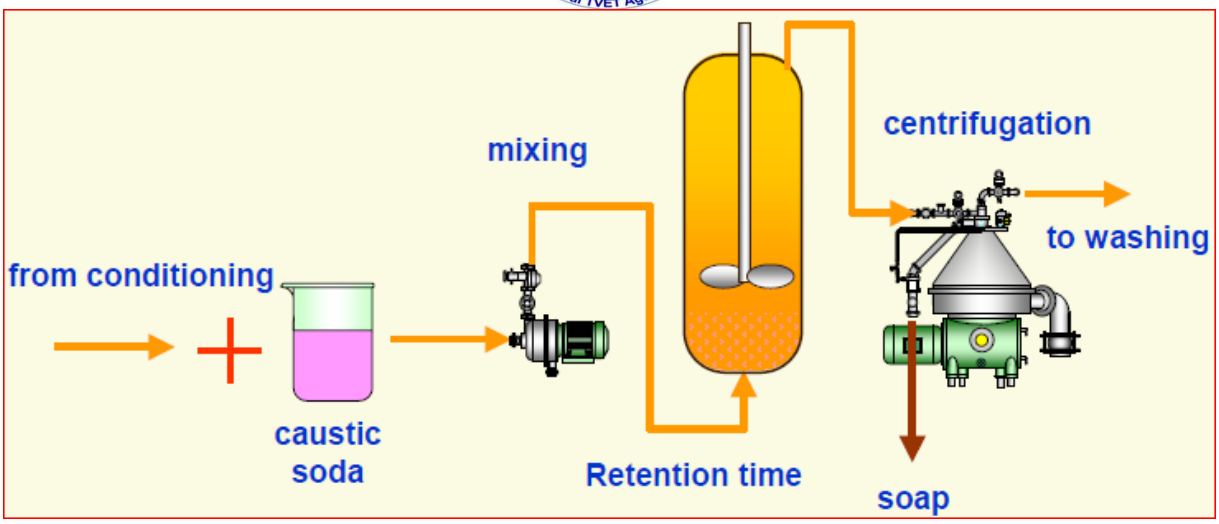


Fig.25: Crude oil neutralization flow diagram

Video: https://www.youtube.com/watch?v=_OH-I_NwHaI

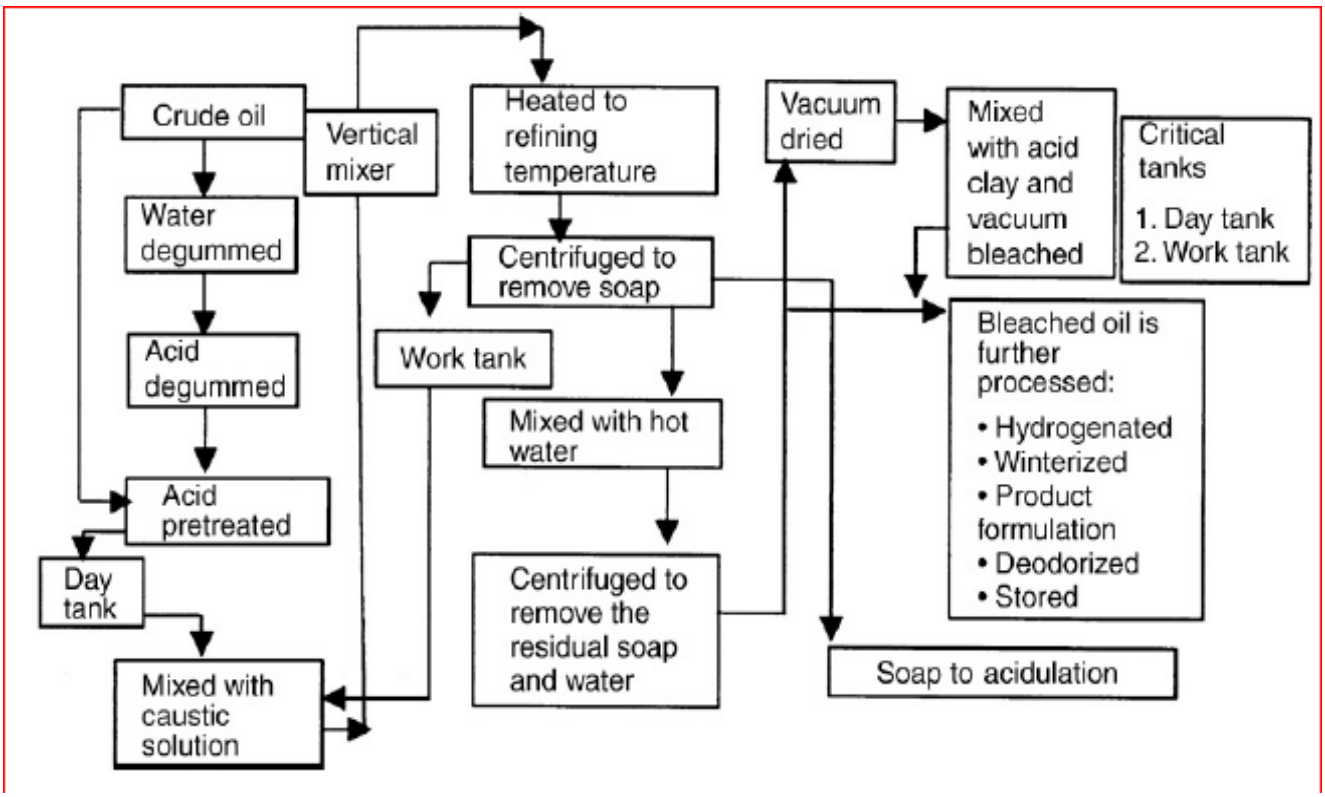


Fig.26: schematic flow diagram of complete edible oil processing

Self-Check # 5	Written Test

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

1. Write the two methods of edible oil neutralization process (10pts)

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

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

Information Sheet 6 - Identify, rectify and/or report out-of-specification product/process

2.1 Introduction

In any food processing industry, out-of specification can be happen due to many factors. Several general factors affect the oxidative stability of sunflower oil as well as most vegetable oils during storage. One of these factors is the degree of unsaturation, i.e., the relative content of oleic and linoleic acids. Product shelf-life is affected by manufacturing conditions such as the type of extraction process (pressing , with solvent, with super critical fluids), degree of purification (crude, refined, deodorized, etc.), addition of antioxidants, and type of packaging (container material , incorporation of inert atmosphere, etc.). Other major factors influencing the oxidative stability are the particular storage conditions: time, temperature, and light, among others.

2.2 Identifying out-of-specification of product

Out-of specification of a product means a condition in which the product did not fall in a specified condition, like chemical composition, physical appearance, recommended quality and so on.

There are many factors that leads a product in to out-of specification are:

- Quality of raw material,
- Processing temperature and pressure
- Processing conditions.
- Packaging materials used
- Efficiency of a machine

The out-of-specification (OOS) process is not applicable for In-process testing while trying to achieve a manufacturing process end-point i.e. adjustment of the manufacturing process. (e.g. pH, viscosity), and for studies conducted at variable

parameters to check the impact of drift (e.g. process validation at variable parameters).

Out-of-Specification (OOS) Result:

- Test result that does not comply with the predetermined acceptance criteria (i.e. for example, filed applications, Food master files, approved marketing submissions, or official compendia or internal acceptance criteria).
- Test results that fall outside of established acceptance criteria which have been established in official compendia and/or by company documentation (i.e., Raw Material Specifications, In-Process/Final Product Testing, etc.).
- Out of Trend (OOT) Result is generally a stability result that does not follow the expected trend, either in comparison with other stability batches or with respect to previous results collected during a stability study. However the trends of starting materials and in process samples may also yield out of trend data.

2.3 Out-of-specification product, process and equipment

- **Out-of-specification of product**

The edible oil will always have color, odor flavor, acid value, and other quality parameters. However, the various grades of edible oil that are sold under specification seem to perform in a uniform manner in producing the edible oil of undesired quality.

- **Out-of-specification of process**

  An irregularity of the measurement process and an aberration of the manufacturing process.

- **Out-of-specification of equipment**

  Calibration failure; calibration frequency inadequate; old equipment; wrong equipment used for processing.

- ✓ **Techniques of identifying out-of-specification of equipment**
  - Assess quality of received components, parts or materials
  - Continuously check received components, parts, materials, information, service or final products against workplace standards and specifications for conformance
  - Demonstrate an understanding of how the received components, parts or materials, information or service relate to the current operation and how they contribute to the final quality of the product or service
  - Identify and isolate faulty components, parts, materials or information that relate to the operator's work
  - Record and/or report faults and any identified causes in accordance with workplace procedures.
  - Follow machine manufacturers manual

- ✓ **Steps of corrective action in response to variations**
  - Define the Problem

    Take time to adequately define the problem (who, what, when, why, where, how much and how often).

  - Interim actions

    Once a problem as been detected, the first priority should be to contain the problem, and prevent shipment to the customer. If already shipped, the customer needs to be notified to prevent further liability.

  - **Root cause analysis**

    The key to resolving a problem is identifying the true root cause. There may be several underlying causes, a new operator, a change in procedure, or another „rush job" circumventing the system. This is why it is important to find the root cause of the issue and define a permanent solution.

- **Permanent Actions**

  The process should be reviewed to arrive at a solution for correcting the root cause. This review should engage the 7 basic quality tools. The solution may involve longer term planning, requiring milestone dates, capital justification, training, and/or approval from the customer. It is good to review progress in management review to assure accountability after the Interim Actions have „stopped the bleeding".

- **Verification**

  Checkpoints in the process should be created to verify effectiveness. This could be accomplished by inspection, internal audits, and/or measurement.

- **Control**

  If mistake proofing was not part of the solution, then a measurement to detect the root cause early should become part of the system. A procedural change should become part of the system by updating the work instruction and training for accountability. Consider putting a reaction plan in place should the problem reoccur.

- **Prevention**

  Very few organizations reach this step. For example, all the above steps are completed, yet the problem returns 6 months later. Perhaps, a new operator shows up who may have been qualified through „On-the Job" training without verification of their competency. Or the filter was replaced as part of the solution, but it is dirty again and hasn't been placed on the Preventive Maintenance schedule.

Self-Check 6	Written Test

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

1. Define out-of-specification of product means (4pts)
2. What are factors that leads a product in to out-of specification (6pts)

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

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

Information Sheet 7- Legislative requirements

7.1 Legislative requirements

Legislative requirements include

- Ethiopian food standard code
  - ✓ Weights and measures legislation
  - ✓ Ethiopian Food and Drug Authority
  - ✓ Environmental management (Environmental Protection Authority)

- **Ethiopian food standard code**

A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.

Standardization is a process of ensuring uniformity in products and services by use of appropriate standards. The process ensures efficient utilization of resources through reduction of wastes.

Ethiopian Authority for standardization establishment proclamation No. 328/1987, which repealed Proc. No64/1970 was enacted. The objective of this proclamation was promoting standardization and quality control with a view to ensuring the quality and safety of products (Ethiopian Standards, 2009). Ethiopian Standards Regulations No. 12/1990 was promulgated to provide for the compulsory Ethiopian standards and 389 standards are developed and made compulsory, from which about 180 of them deal with food and food products. A new public health proclamation No.200/2000 was also enacted by incorporating provisions which deal with the issues of food quality.

- ✓ **Ethiopian Food and Drug Authority**

The Ethiopian Food and Drug Authority (EFDA) is the National Regulatory Body of Ethiopia which is under the Ministry of Health. The Authority is responsible to ensure the quality, safety and/or efficacy of medicines, food, cosmetics and medical devices, the standards of health and health related institutions, the healthcare practice, and competence and ethics of Health professionals.

Figure 27: Refined oil

7.2 Mandatory oil seed and edible oil standard

7.2.1 Mandatory oil seed and edible oil standard

Ethiopian legislative requirements for different products are listed below in the table.

Table 6: Mandatory oil seed and edible oil standard

No	Product	Ethiopian Standard Number	Ethiopian Standard Title
1.	Oil seeds	CES 05-2013	Oil Seeds-Specification
2.	Oil seeds	CES 06-2013	Oil Seeds Method Of Packaging

3.	Edible oil additives	CES 12-2013	Edible Oils-Specification For Additives
4.	Edible Vegetable oil	CES 21-2013	Edible Vegetable Oils-Packing
5.	Edible groundnut oil	CES 16-2013	Groundnut (Peanut) Oil-Specification
6.	Sunflower seed oil	CES 17-2013	Sunflower Seed Oil- Specification
7.	Edible cottonseed	CES 19-2013	oil Cottonseed Oil-Specification
8.	Edible linseed oil	CES 18-2013	Linseed Oil-Specification
9.	Edible sesame seed oil	CES15-2013	Sesame Seed Oil– Specification

7.2.2 Mandatory packaging and labeling standard

In accordance with the Ethiopian Food, Medicine and Healthcare Administration and Control Authority Proclamation No. 661/2009, “packaging material shall be made out of substances, which are safe and suitable for their intended use, and the product shall be packed in container which will safeguard its hygienic, safety, quality and food grade.” Further, the Proclamation states that “no…packaging material shall be put into use unless it complies with the international and national safety and quality standards.”

Individual product standards may also contain additional guidance and/or requirements as it relates to packaging and container requirements.

As an example, the standard for canned peaches indicates packing requirements, including lacquer usage inside the can as well as can thickness.

- Name of the food
- Nutrition content
- List of ingredients (except for single ingredient foods) in descending order of weight
- List of minerals or vitamin supplements added to fortify foods (if needed)
- List of ingredients that may cause an allergic reaction

- Net weight or volume of contents
- Name and address of the manufacturer, packer, distributor, importer, exporter or vendor
- Country of origin
- Production and expiration dates (Note: Food products must have at least 50 percent of their shelf life remaining when they arrive at customs. Expired food cannot enter the country not can it be sold in the marketplace. Certain foods are exempt from carrying expiry dates, including fresh fruits and vegetables, wines, beverages with 10 percent alcohol by volume, vinegar and chewing gum.)
- Code identifying producing factory and lot
- Instructions for use (if needed)
- For beverages containing more than 1.2 percent alcohol, the alcohol proof is required on the label.
- GM foods must carry the label with the following statement: 'genetically modified food'.

7.2.3 Required Labeling Elements for Raw Foods

- Name
- Ingredient list
- Net content
- Name and address of the producer and/or importer
- Country of origin
- Lot identification
- Expiry date or minimum useful life
- Conditions for product storage

Self-Check # 7	Written Test

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

1. Write legislative requirements needed in oilseed processing (5pts)
2. List and write five oil products with its Ethiopian standard number and Ethiopian Standard Title. (5pts)

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

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

Information Sheet 8 - Maintain work area to workplace housekeeping standards

8.1 Maintaining the work area to workplace housekeeping standards

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.

8.1.1 Housekeeping standards

The purpose of housekeeping is to improve the livability and conditions of the dwellings owned and managed by the authority and to preserve authority property for future generations, uniform standards for resident housekeeping have been developed for all tenant households.

Housekeeping Standards are as follows:

8.1.11 Inside the Dwelling

I. General

a. Walls: Must be clean, free of dirt, grease, holes, cobwebs, and fingerprints.
b. Floors: Must be clean, clear, and free of hazards.
c. Ceilings: Must be clean and free of cobwebs.
d. Windows: Must be clean and not nailed shut. Shades should be intact.

e. Doors: Must be clean, free of grease and fingerprints. Doorstops should be present. Locks must work.
f. Heating Units: Must be dusted and access uncluttered.
g. Trash: Must be disposed of properly and not left in the dwelling. “Proper Disposal” means that the trash is placed in a sealed plastic bag and put down the chute or in the dumpster.
h. Hallways, Walkways, and Stairways: Must be clear of furniture and other belongings so as to permit easy passage.
i. Motor vehicle parts, or other similar machine parts, may not be stored in the dwelling.
j. Flammable materials shall not be stored in the dwelling.

II. Food process lab

a. Stove: Must be clean and free of food and grease.
b. Refrigerator: Must be clean, refrigerator and freezer doors must close properly.
c. The freezer shall have no more than one inch of ice/frost build-up.
d. Cabinets: Must be clean and neat. Cabinet surfaces and countertops must be free of grease and spilled food. Cabinets must not be overloaded. Storage under the sink must be limited to only those items (lightweight) which will permit easy access for purposes of repairs or inspections. Heavy pots and pans shall not be stored under the sink.
e. Exhaust Fan/Vent: Must be free of grease and dust.
f. Sink: Must be clean, free of grease and garbage, dirty dishes must be washed and put away in a timely manner.
g. Food Storage Areas: Must be neat and clean without spilled food.
h. Trash/Garbage: Must be stored in a covered container until removed to the disposal area

III. Bathroom

a. Toilet and Tank: Must be clean and odor free.

b. Tub and Shower: Must be clean and free of excessive mildew and mold. Where applicable, shower curtains must be in place and of adequate length.
c. Bathroom Sink: Must be clean.
d. Exhaust Fans: Must be free of excessive dust.

IV. Storage Areas

a. Closets must be neat and clean
b. No flammable materials or newspapers are to be stored in the dwelling.
c. Other storage areas must be clean, neat, and free of hazards.

8.1.12 Outside the Dwelling

The following standards apply to family, elderly, and scattered site property. Further, the standards apply even if the Tenant shares the area with other Tenants.

- Yards: Must be free of debris, trash, and abandoned cars.
- Exterior Walls: Must be free of graffiti.
- Porches (front and rear): Must be clean and free of hazards. Any items stored on the porch shall not impede access to e the dwelling.
- Steps (front and rear): Must be clean and free of hazards.
- Sidewalks: Must be clean and free of hazards
- Storm Doors: Must be clean
- Parking Lot: Must be free of abandoned cars. There must be no car repairs done in the parking lot.
- Hallways: Must be clean, uncluttered, and free of hazards.
- Stairwells: Must be clean, uncluttered, and free of hazards.
- Laundry Areas: Must be clean and neat. The Tenant owned dryers must be properly vented.
- Utility Room: Must be free of debris, motor vehicle parts, and flammable
- No motorized vehicles are to be driven or stored on lawns or grounds except in driveways and parking lots. Dirt bikes, snowmobiles, and boats are prohibited.

- Tenants shall not install antennas, satellite dishes or anything else on the building, or erect fences, storage sheds, recreation structures or ANY other type structures on the grounds materials.

8.2 Cleaning and sanitation procedure work area

The correct order of events for cleaning/sanitizing of working area is as follows:

- Rinse
- Clean
- Rinse
- Sanitize

Cleaning

Cleaning is the complete removal of food soil using appropriate detergent chemicals under recommended conditions. It is important that personnel involved have a working understanding of the nature of the different types of food soil and the chemistry of its removal.

Sanitization

Sanitization is the process of reducing the number of microorganisms to a level that has been officially approved as safe. It is important to differentiate and define certain terminology:

Self-Check # 8	Written Test

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

1. Write cleaning and sanitation procedure in a work area (6pts)

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

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

Information Sheet 9- Maintain workplace records

9.1 Introduction

Among the specific expectations and work habits that must be followed and practiced in the work place, the following are very important : -

- Positive attitude,
- Traits of honesty and dependability,
- Work with others,
- Time management,
- Safety on the job,
- Good communication skills,
- Appropriate use of computers and internet,
- Appropriate behavior,
- Health

9.2 Types of records

- **Paper-based records**

Paper-based records are one of the most common ways of dealing with information. Examples of paper-based records include:

- ✓ Reports
- ✓ Magazines, journals and newspapers
- ✓ Project files
- ✓ Contracts
- ✓ Minutes of meetings
- ✓ Business letters
- ✓ Email messages and memos
- ✓ Faxes
- ✓ Forms
- ✓ Diaries and other note-taking methods.

- **Electronic records**

  Examples of electronic records include:

  ✓ E-mail messages,

  ✓ Word- processed documents,

  ✓ Electronic spreadsheets,

  ✓ Digital images and databases.

Document relating specifically to operations and services provided by a particular department or division, and which is distinct from the general administrative (housekeeping) records. Also called functional record or unique record.

- **Recording activities**

In oil seed and pulse processing there are many activities to be recorded:

  ✓ Equipment performance

  ✓ Equipment variation

  ✓ Maintenance activities

  ✓ Faults and problems

  ✓ Out of specification materials etc…

Self-Check # 9	Written Test

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

1 Mention the types of recording and give examples? (5 points)
2 Write recording activities? (5 points)

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

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

Operation Sheet 1: Operating procedure/step for physical neutralization process edible oil

Objective: To remove FFA from degummed oil using (caustic soda) physical neutralization process

Sequence for physical neutralization process edible oil

1. Wear personal protective equipment's
2. Collect measured amount of crude oil into a refining kettle.
3. Add caustic soda solution into edible oil
4. Treat free fatty acids at 82- 100 degree with a small amount of concentrated sodium hydroxide solution
5. Check for the FFA in the oil at the end of the reaction.
   - It should be 0.01% – 0.02%, expressed as oleic acid.
6. Check the oil for phosphorus content.
   - It should be <5 ppm

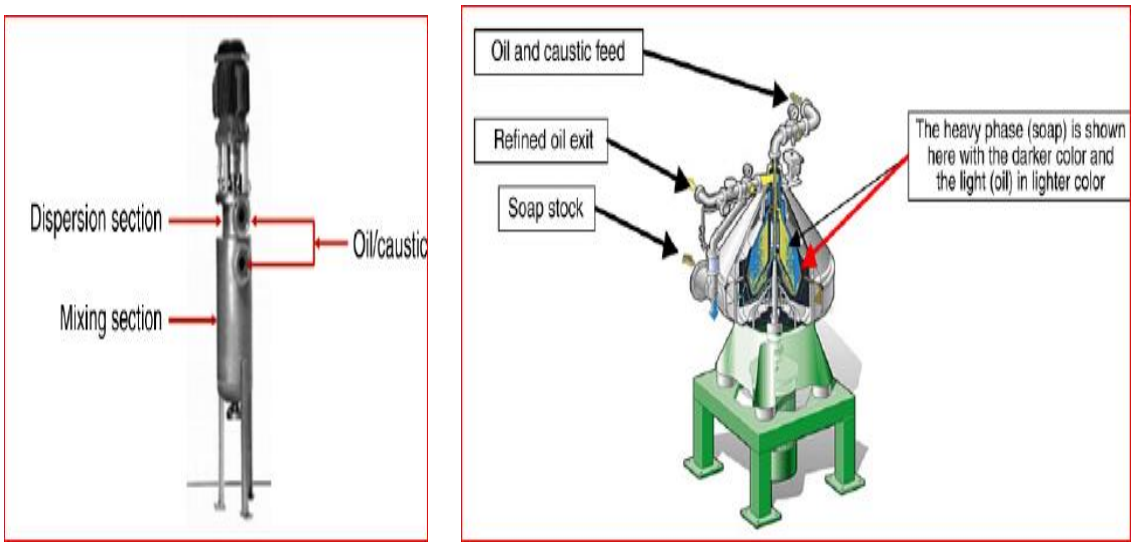


Figure 28: Process flow in centrifugal separator

Operation Sheet 2: Operating procedure/step for Chemical neutralization process edible oil

Objective: To remove FFA from degummed oil using (caustic soda) Chemical neutralization process

Sequence for Chemical neutralization process edible oil

1. Wear personal protective equipment's
2. Collect measured amount of crude oil into a refining kettle.
3. Add silica gel or aluminum oxide to adsorption of FFA from edible oil
4. Set the pressure of centrifuge >30 bar to split soaps formed
5. Rotates/centrifuge the bowl at 400-5000 rotations/min and the soap solution is continuously discharged.
6. Mix the two liquid in the high shear mixer until the caustic solution is dispersed into micro droplets to provide large specific surface area for the reaction between the caustic and the FFA, as well as other impurities in the oil.
7. Heat the oil by hot water to 185–195°F (85–90°C) and add 10%–15% of hot deionized water into the refined oil.
8. Increase agitator speed for obtaining intimate mixing between the refined oil and the water for improved soap removal.
9. Turnoff agitator and allow the soap in the oil to settle into the bottom of the tank.
10. Collect a sample of oil from the top and analyze for soap.
11. Continue the process of water washing and draining of the soap until the soap content is <400 ppm.

N.B: Use the Process flow of centrifugal separator in Figure – 26.

LAP TEST	Practical Demonstration

Name…… ID …….. Date……

Time started: _____ Time finished: _____

I- Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hour. The project is expected from each student to do it.

Task- 1: Conduct /operate physical neutralization process of edible oil

Task- 2: Conduct /operate chemical neutralization process of edible oil

LG #37	LO#3 - Shut down the neutralization process

Instruction sheet

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

- Identifying appropriate shutdown procedure
- Shutting down the 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:

- Identify appropriate shutdown procedure
- Shut down the process
- Identify and reporting maintenance requirements

Learning Instructions:

Read the specific objectives of this Learning Guide.

1. Follow the instructions described below.
2. Read the information written in the information Sheets
3. Accomplish the Self-checks

Information Sheet 1- Identifying appropriate shutting down procedure

1.1 Identifying shutting down procedure

Shutdown procedure which will be done after extracting oils may include but not limited to:

- Workplace procedures in the process of shutting.
- Equipment is dismantled and prepared for cleaning.

1.2 Seven steps/procedures 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, Mixers and blenders, Motors, Piping, Pumps, and 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.

1.3 Advantage of appropriate shut down procedure

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

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. Write the seven steps/procedures for a successful shutdown (7 points)
2. Write the advantage of appropriate shut down procedure(6points)

Note: Satisfactory rating – 13 points Unsatisfactory - below 13

You can ask you teacher for the copy of the correct

Information Sheet 2- Shutting down the 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 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

During oil mixing operation, after extracting the oil and separating the by-product (cake or meal) you have to shut down the extraction process. This process are;

- First switch off power of mixer
- Un-plug power socket
- Clean external parts of mixer
- Clean internal parts like, agitators
- If maintenance are needed, list out damaged parts in maintenance check list and report to maintenance operators or supervisors.

1.3 Uses of Shutdown Processes

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

Self-Check # 2	Written Test

Name… ..... ID…..... Date…….....

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

Test –I. Short answer questions

1. Define shutdown process mean (4 points)
2. Shut down the process includes (6points)

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

You can ask you teacher for the copy of the correct

Information Sheet 3 - Identifying and reporting maintenance requirements

3.1 Definition of maintenance

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.

3.2 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.

3.3 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).

3.4 Uses of Maintenance

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

3.5 Routine maintenance checklist

An example of a checklist used for maintenance request was given below:

Table 7. Routine maintenance checklist

Date	Tool	Maintenance check points	Signature	Maintenance required	Signature
14-10 /2020	mixer	agitator	Mr. A	Agitator	
		Shaft	Mr. A	Shaft	Mr. B
		Screw	Mr. A	None	

Maintenance performed were reported using a checklist below.

Table 8. Maintenance report checklist

Maintenance Performed	Date	Signature
The dies was replaced	16-10/2020	Mr. C
The shaft was replaced		

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 - Short Answer Questions

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

Operation Sheet - 1: Procedures of Shutting down the process

Sequence for procedures of shutting down the process

1. Wear personal protective equipment's
2. First switch off power
3. Un-plug power socket
4. Clean working area
5. Conduct maintenance or , list out damaged parts in maintenance check list and report to maintenance operators or supervisors.
6. Record all activities

LAP TEST # 1	Practical Demonstration

Name…… ID …….. Date……

Time started: _____ Time finished: _____

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

Task- 1: Conduct shutdown process

Reference

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2. DPPH antioxidant assay revisited. Om P. Sharma and Tej K. Bhat, Food processing
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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 Bureau, 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 March 2021 at Bishoftu Management Institute Center.

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