Edible Oil and Fats Processing

Level-III

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Module Title: Operating a Soap Splitting Process

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LG # 32	LO #1 Prepare the Equipment and Soap Splitting Process for Operation

Instruction Sheet

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

- Confirming available materials to meet operating requirements.
- Adjusting machine components to meet operating requirements.
- Confirming different services in required quantities.
- Entering operating parameters to meet safety and production requirements.
- Checking and adjusting soap splitting/acidification 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 to meet operating requirements.
- Adjust machine components to meet operating requirements.
- Confirm different services in required quantities.
- Enter operating parameters to meet safety and production requirements.
- Check and adjusting soap splitting/acidification equipment performance
- Carry out pre-start checks.

Learning Instructions:

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

Information Sheet 1- Confirming Available Materials

1.1 Introduction

Soap in the refined oil must be as low as possible, preferably <500 ppm. Normally, the water wash centrifuge reduces the soap in the refined oil by a factor of ten (50 ppm or so). High soap in the refined oil makes it harder for the water wash centrifuge to remove it from the oil. Thus, high soap in the oil increases oil loss in the wash water from the centrifuge and also leaves high level of soap in the water washed oil. High soap in the water washed oil has numerous detrimental effects on the oil quality, as well as in the subsequent stages of oil processing, such as bleaching, hydrogenation, and deodorization.

Materials for soapstock splitting are:

- Soapstock
- Sulfuric acid
- Salt

1.1.1 Soapstock

Soapstock is submitted to a so-called splitting procedure, with the aim of stabilizing it and reducing weight for shipment. It is treated with sulfuric or hydrochloric acid, to recover FFAs and partially hydrolyze the residual oil, affording oleins, also known as high-acid oil or acid oil or acidulated soapstock. The concomitant generation of acidic wastewater with high content of either sulphates or chlorides represents a major concern in the waste management of the refinery, constituting the greatest contribution to environmental pollution and to the waste disposal costs of the entire refining process. The product resulting from acid splitting is a dark colored mixture of triglycerides containing FFAs, with small amounts of mineral acids, phospholipids and sterols. It is separated from the acid water by settling and/or centrifugation.

1.1.2 Sulfuric acid

Soap stock containing the afore-mentioned non-triglyceride components and has to be split prior to its disposal in order to recover the fatty acids contained therein, and to obtain an effluent (acid water) containing low levels of total fatty matter (TFM), that is material soluble in ether. During the splitting of the soap stock using a soap splitting acid, such as sulphuric acid, at PH 2 and a soap splitting temperature of 95° C., an emulsion may be formed.

The emulsion formation occurs especially when splitting maize- or sunflower soap stock. Soap stock is mixed with sulphuric acid which liberates fatty acids and unreacted glycerides in the form of oily mixture known as Acid Oil. Acid oil is washed with hot water which makes it free from mineral acidity.

1.1.3 Salt

A method and an apparatus for continuously splitting of soap stock formed in the alkali refining of crude glyceride oil, in which an inorganic acid is intensively mixed with steam in a Venturi tube, and subsequently the acid steam mixture is intensively mixed with soapstock in a second Venturi tube. The soapstock had a temperature of 80-95 °C and was passed through a separation zone comprising a packed bed of filling material. Discloses a process for treating a solution comprising soapstock, sulphonate salt and an inorganic salt for the recovery of fatty acid and a sulphonate salt solution therefrom. This mixture is 40 acidified at 80 °C to pH 2,5 using sulphuric acid.

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. List available materials for soapstock splitting process
2. Write reasons for soapstock splitting

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

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

Information Sheet 2- Adjusting Machine Components to Meet Operating Requirements

2.1 Equipment used for operating a Soap Splitting Process

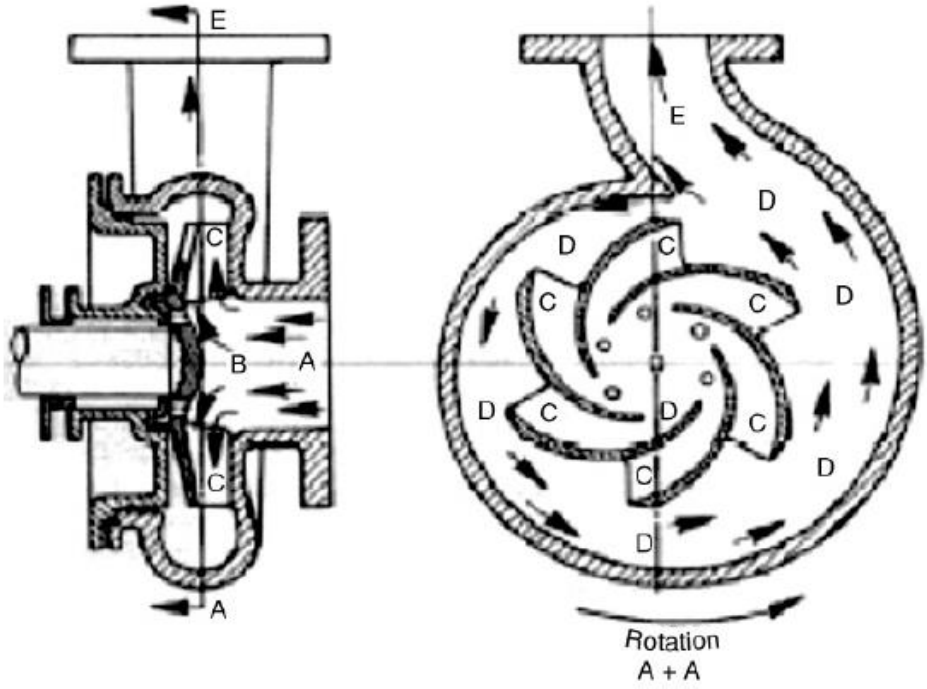
- Pumps
- Reactors
- Acid and steam addition systems
- settling tanks
- Storage tank

2.2.1 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. There are two groups of pumps used in the oil processing plants, namely;

- Non-positive displacement pumps
- Positive displacement pumps

The non-positive displacement pump generates the motive force through the centrifugal force created by an impeller, for example, centrifugal pump. A positive displacement pump pumps liquid with the help of the motive force generated by the rotating action of the gears or by the reciprocating motion of pistons in the pump.



- The liquid enters at A
- It enters the impeller B
- Impeller vanes C picks up the fluid
- The vanes accelerate the liquid flow
- The liquid velocity reaches that of the impeller vane tips
- The liquid slides up the casing and discharge through E
- Some of the velocity head is converted to pressure head

Figure 1 Centrifugal pump

- **Guidelines for Proper Pump Operation**

Following are some recommendations regarding proper pump operation:

1. The pump suction must always be flooded. The centrifugal pump cavitates when the suction is not flooded. This damages the pump impeller and the seal.

2. Previous recommendation applies for positive displacement pump which can get overheated or even may siege. Waukesha pump can run for a while without any feed because there is no metal-to-metal contact in the gears.
3. The pressure drop in a modulating control valve must be taken into account in designing the pump size and the discharge head and motor horse power requirement. The pump must be started with the controller set at the desired flowrate on the flow controller otherwise the pump will discharge higher volume of liquid. This will draw more horse power for the motor.

2.2.2 Reactors

The soap splitting process utilized reactors:

- Continuous tubular flow reactor with inline mixing, and
- Pressurized agitated batch reactor.

The continuous reactor is chosen and designed to give insight into the flow and transport behavior of the feedstock at temperature and pressure as well as give insight into inline addition/injection and mixing of acid with feedstock through inline static mixers. The batch reactor is chosen and designed to give better control and flexibility of the factors and factor levels. Specifically, the separation time, agitation speed and time, and acid addition ratio factors are much better controlled in the batch system as will be seen after insights made from the initial experiments with the continuous flow tubular reactor.

All connection to the reactor head are made including,

- Coolingconnections from cooling water supply to the internal cooling coil and the instrument cooling jackets,
- Nitrogen pressure connection to the reactor body and acid vessel, and
- Pressure relief line down to a collection bucket filled with water.

The system is then pressure tested by charging the reactor with nitrogen gas to the desired operating pressure and allowing the reactor to sit for 15 minutes. The desiredoperating pressure is determined from the factor level conditions and pressure testing is performed at the expected operating pressure. After pressure testing, the reactor is depressurized to a predetermined initial pressure. At this time the mantle

heateris powered on and the external temperature (i.e. the reactor surface temperature) isset to 250 deg. C. The set point reaction temperature is predetermined. The mixer is turned on with the mantle heater and is set to 50 RPM.Once the reactor contents reaches ~20 deg. C below the set point temperature, the external temperature set point is reduced down to ~10 deg. C above the desired reactor contents temperature. Generally, 130 deg. C is consistentlyachieved within 45 minutes. Set point of 150 deg. C is achieved within 10 minutes following that. Thetemperature varies within the bounds of ±3deg. C due to the glass insert and thermowell resistances.

2.2.3 Acid and steam addition systems

To reduce weight and stabilize the product for storing and handling, raw soapstock is commonly acidulated with sulfuric acid. Traditionally, soapstock acidulation has been done in a batch process, where soapstock is charged to a corrosion-resistant tank. Wooden tanks fitted with copper or bronze coils are still used, although more recent installations are likely to be Monel metal, stainless steel, or fiberglass-reinforced plastic.

2.2.4 Settling tanks

Settling tanks must be either glass lined or epoxy coated carbon steel tanks or fiberglass tanks. The composition of the fiberglass tanks must be suitable to withstand a temperature of 260°F (127°C) or higher. These tanks are maintained at 180–190°F (82–88°C) and the reaction mixture is allowed to stand for the separation of the acid oil and the acid water. Typically, sulfuric acid diluted to ca. 10% is added in excess to the soapstock charge and the mass is boiled with sparge steam for 2 to 4 h. The tank is then settled, and the acid water layer drawn off. The acid oil is water-washed by adding 25 to 50% water, boiling for a short time, and settling thoroughly on the settling tanks. After the water layer is drawn off, the acidulated soapstock will be stored or shipped in steel tanks. Detailed practices may vary considerably from plant to plant and even from charge to charge.

2.2.5 Storage tank

Soap stock is obtained as a by-product of the chemical neutralization of oils and fats. This stock could be split into fatty acids and water through acidification with strong acids like sulphuric or hydrochloric acid. Inside the splitting tank, the pH value is reduced with the addition of a tough acid.

Figure 2 Storage tank

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. List equipment used for operating a soap splitting process
2. Write the difference between positive displacement pumps and non-positive displacement pumps? (5 points)
3. ---------- is drawn off, the acidulated soapstock will be stored or shipped in steel tanks? (5 points)

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

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

Information Sheet3-Confirming different services in required quantities

3.1 Services for soap splitting

All services or utilities that could impact on product quality and process should be qualified and appropriately monitored. Oil soap splitting processing requires such utilities as:

- Compressed air
- Power
- Lighting
- Water
- Open steam and vacuum

3.1.1 Compressed air

Compressed air is an important element for many processes within the petrochemical and oil processing industries. First, compressed air acts as a medium for the transfer of energy, which is critical to power equipment such as drills, jack hammers and air-powered tools, among others. Compressed air is also used elsewhere in refineries to move material such as paint, oils, cylinders for industrial and automation, and brakes on large equipment. Compressed air is also utilized in a refinery for breathing gas when operations face confined space requirements. Additionally, it controls precise measurements and calibration in the production of gases and liquids during operation of specific machinery and instrumentation. Due to its nature, compressed air is a stable process for process equipment needed for drilling, pneumatic tools, power machinery and generators that produce light without combustible fuels.

3.1.2 Power

The overall system power factor, inclusive of reactive power losses in transformers and other distribution system equipment shall not be less than 0.85 lagging at rated design throughout of the plant. The power factor shall be determined at the terminals of the generator(s).

3.1.3 Lighting

Adequate lighting should be provided in all processing areas to facilitate edible oil soap splitting process.

3.1.4 Water

Water used in the manufacture of oil industry should be demonstrated to be suitable for its intended use. Where water used in the process is treated by the manufacturer to achieve a defined quality, the treatment process should be validated and monitored with appropriate action limits. Unless otherwise justified, process water should, at a minimum, meet World Health Organization (WHO) guidelines for drinking (potable) water quality. If drinking (potable) water is insufficient to assure oil industry quality and tighter chemical and/or microbiological water quality specifications are called for, appropriate specifications for physical/chemical attributes, total microbial counts, objectionable organisms and/or endotoxins should be established.

3.1.5 Open steam and vacuum

The heart of the drying installations is a vacuum dryer, which the oil to be dried enters via a pressure relief valve. The large oil surface created in the dryer enables an optimum evaporation of the moisture from the oil in the vacuum which is normally produced with a multi-stage steam jet vacuum pump with mixing or surface condensers. The use of liquid ring pumps with upstream surface condenser is also possible. The dried oil is conveyed out of the dryer by a self-priming pump, whereby a partial stream is recirculated through a three-way control valve that is connected to a level controller in the dryer to ensure a constant level in the dryer. A high-level switch ensures that no oil overflow into the vacuum system can happen. For visual checking of the oil level in the dryer, the latter is equipped with sight glasses and sight glass illumination. The vacuum is monitored with a contact vacuum meter which triggers an alarm if a certain pressure is exceeded.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: Give the correct answer

1. ---------- is an important element for many processes within the petrochemical and oil processing industries? (5 points)

A, Water B, Power C, Compressed air D, all

2. -------- is utilized in a refinery for breathing gas when operations face confined space requirements? (5 points)

A, Water B, Power C, Compressed air D, all

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

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

Information Sheet 4- Entering operating parameters to meet safety and production requirements

4.1 Soap splitting operating parameters

Soap splitting operating parameters, such as:

1. PH and temperature of reactors
2. PH and temperature of acid water
3. Acid addition
4. Tank levels
5. Color of acid oil
6. Color of acid water

4.1.1 PH and temperature of reactors

Soapstock splitting - Reaction stage

- Splitting temperature min. 90°C
- Acidulation by sulphuric acid to pH 2 – 3.
- Reaction time in agitated tank approx. 1 hour

4.1.2 PH and temperature of acid water

The acid water phase and oil phase formed are easily separated from one to another. preferably the high temperature is carried out:

- At a temperature of about 100-150°C
- The residence time is 15-60 min,
- At pH 2**.**

4.1.3 Acid addition

The soap stock should be converted into a useful product by a certain process which is known as **"**Soap Stock Splitting". This soap stock is treated with caustic lye to saponify neutral oil and taken for splitting. The splitting is by strong sulphuric acid liberating the fatty acids and un-reacted glycerides in the form of an oily mixture, generally known as Acid Oil.

The quantity of acid addition depends on the Total Fatty Acid (TFA) present in the soap stock. General quantum is in the range of 10 to 14%. The acid water is subjected to treatment with wash water thereby dropping the pH level of the acidic water. This resulting mixture is passed into the effluent treatment plant and that completes the acid oil plant process.

Finally, the acidic fumes generated from the reaction vessel are passed through water circulation and scrubbed by fumes scrubber to prevent corrosion in plant. The Acid oil is further washed by hot water and made free from mineral acidity. The Free Fatty Acid content in Acid oil ranges from 60 to 85% and total fatty matter content about 96%. The reason for giving open steam to the soap stock is to evaporate the moisture content from the mixture to the maximum possible content. This also helps on the terms of minimizing acid consumption for splitting.

4.1.4 Tank levels

Soap stock is obtained as a by-product of the chemical neutralization of oils and fats. This stock could be split into fatty acids and water through acidification with strong acids like sulphuric or hydrochloric acid. During the separation phase the phosphatide has a significant effect on the splitting process, specifically during the formation of stable emulsions. This could be prevented in a large extent with secondary saponification. The soap stock is exposed to higher-than-normal temperatures and pressures. During the reaction time under these types of conditions, a portion of the phosphatide is produced as by-products of the neutral oil in the soap stock saponify.

After saponification, dilution water may be added in the intermediate tank before the soap stock is actually conveyed to the splitting process. Inside the splitting tank, the pH value is reduced with the addition of a tough acid. The soap stock breaks down into fatty acid and water, which are then distributed into a static decanting vessel. The split fatty acid might be directly processed. The acid water is then conveyed to a fat separator with an upstream flotation chamber. The de-fatted water is finally neutralized along with caustic soda.

4.1.5 Color of acid oil

The product Acid Oil is brown in color and the color of acid oil mainly depends on:

- The type of oil from which the soap stock is generated.
- The mineral acid used for splitting process.

Figure 3 color of acid oil

4.1.6 Color of acid water

The product resulting from acid splitting is a dark colored mixture of triglycerides containing FFAs, with small amounts of mineral acids, phospholipids and sterols. It is separated from the acid water by settling and/or centrifugation. A sustainable production process should reduce waste significantly.

Figure 4 acid water

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. List soapstock splitting operating parameter
2. The color of acid oil mainly depends on----------and----------? (5 points)
3. ----------is obtained as a by-product of the chemical neutralization of oils and fats? (5 points)

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

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

Information Sheet 5- Checking and adjusting soap splitting/acidification equipment performance

5.1 Adjusting soap splitting equipment

Various adjustments are required before starting machine operation. The machine is to be installed on clean level ground and is to be set according to task conditions. Any piece of equipment (tanks, pumps, settling tanks and storage tanks) are identified as unsafe, either in normal day-to-day activities or during a safety inspection, must be promptly tagged using a tag out. Then further action must be taken for repair or disposal.

Equipment identified as faulty should be disconnected and tagged, and appropriate service people contacted to arrange repair or replacement to improve the performance. In theacidulationindustry, and for emulsion destabilization in general, pH adjustments are very common. However, the degree to which pH isadjusted is somewhat ambiguous in theliterature. Recommendations are often the opinion of the authorand are highly dependent on the soapstock composition and typeand on the suggested“best”process. Ranges on pH adjustment vary from1 to 4butthe majority of the reviewed literature suggests a pH range of 2to3.Splitting temperature min. 90^0C and reaction time in agitated tank approx. 1 hour

5.2 Equipment performance

Equipment manufacturers specify the capacity of their equipment as an hourly or 24-hours production volume. This section gives an estimation of annual production capacities, starting from the hourly capacity as specified by the equipment manufacturer. First, the effective production time is estimated by the following analysis:

- The total time in a year (T) is 365 × 24 = 8760 hours (the extra day every 4 years is not taken into account).
- The available production time (A) is total time minus unavailable time. Unavailable time is statutory and religious holidays, weekends, shifts not worked and enforced factory shutdowns.

- The used production time (U) is available time minus available unused time. Available unused time is time lost because there are no production orders.
- The operational time (O) is used time minus planned non-operational time. The planned non-operational time is scheduled maintenance and planned tests without production.
- The production time (P) is operational time minus routine production stoppages. These stoppages are startups and shutdowns, cleaning and breaks (meals, rest etc.). Startups and shutdowns are important in 5- days-a-week operations; breaks are not applicable in fully automated plants.
- The effective time (E) is operational time minus unexpected stoppages. Unexpected stoppages are unplanned repairs or breakdowns, failures of material supply, full or empty tanks, absences of operators and so on. The time difference between total and operational time can be estimated from events that can be planned in advance. The time difference between operational and effective time contains unpredictable events (cleaning, breakdowns etc.).

Thus, the operational efficiency (EO) has been introduced: E

O = E/O × 100%

EO is an average over years of experience and depends on type of equipment, operating mode (batch or continuous) and weekly working pattern (5 × 24 hours or 7 × 24 hours a week). The EO can be used as guideline for oil processing design. The estimated annual capacity can now be calculated from the hourly capacity specified by the equipment manufacturer:

Annual capacity = hourly capacity × EO × operational time (tones/annum).

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Write the difference between performance and capacity? (5 points)
2. When to adjust the equipment and machine? (5 points)

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

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

Information Sheet 6- Carrying out pre-start checks

6.1 Carrying out pre-start checks

In edible oil soap splitting process, before going to operate machine we have to inspect /check whether it was in a good operating condition or not. Checking conditions of operating equipment has a vital role for the operator's safety, quality of a product and also for equipment safety. A responsible operator, running a pre-start check on plant or machinery before you start the day is the best way to ensure the job gets done safely and without delay. Conduct pre-start checks, such as:

- Inspecting equipment condition to identify any signs of wear,
- Selecting appropriate settings and/or related parameters, correctly configured for processing requirements,
- Positioning sensors and controls correctly,
- Ensuring any scheduled maintenance has been carried out, and
- Confirming that all safety guards are in place and operational

Undertaking a pre-start check on your machine before you start a day's work, happens in three stages.

Step1 visual inspection of important features prior to starting the machine

Step2 visual and function tests while the machine is turned on but stationary

Step3 testing the machines functions during a short drive.

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. List at least four pre-start check? (5 points)

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

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

Operation Sheet – 1 Carrying out pre-start checks

Carry out pre-start checks

Objectives; To know pre-start check procedures

- **Material required;** soapstock, Sulfuric acid, Salt, water and etc.

✓ **Equipment required;**

- PPE,
- Pumps,
- Reactors,
- Acid and steam addition systems,
- settling tanks,
- Storage tank etc.

Following the steps outlined below will help ensure pre-start checks of soap splitting equipment's.

1. Wear personal protective equipment's
2. Inspect equipment condition
3. Identify any signs of wear,
4. Confirm availability of tank storage space,
5. Select appropriate settings and/or related parameters,
6. Confirm the equipment is clean and correctly configured for acidulation process requirements,
7. Position sensors and controls correctly,
8. Ensure any scheduled maintenance has been carried out,
9. Confirm that all safety guards are in place and operational
10. Record the task

LAP TEST	Performance Test

Name…… ID……

Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **40** min. The project is expected from each student to do it.

Task-1 Carry out pre-start checks

LG # 33	LO #2 Operate and Monitor the Soap Splitting Process

Instruction sheet

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

- Purpose and basic principles of soap splitting
- Starting and operating the process of soap splitting
- Monitoring operation of equipment to identify variation in operating conditions.
- Identifying variation in equipment operation and reporting maintenance requirements
- Monitoring the soap splitting process to confirm separation of acid oil and acid water streams.
- Maintaining the work area in housekeeping standards.
- Maintaining workplace records
- Workplace information

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:

- Know the purpose and basic principles of soap splitting
- Start and operate the process of soap splitting
- Monitor operation of equipment to identify variation in operating conditions.
- Identify variation in equipment operation and reporting maintenance requirements
- Monitor the soap splitting process to confirm separation of acid oil and acid water streams.
- Maintain the work area in housekeeping standards.
- Maintain workplace records
- Workplace information

Learning Instructions:

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

Information Sheet 1- Purpose and basic principles of soap splitting

1.1 Purpose of soap splitting

One of the principal purposes of the refining is to remove free fatty acids, such acids being converted to their corresponding alkali soaps and being removed with the aqueous phase. The aqueous phase will also contain some entrained triglyceride oil. The triglyceride oil represents a loss of valuable product, and the fatty acids of the soap also have considerable economic value, if they can be separated and recovered from the soapstock. The soapstock itself has relatively little value, having little use except as an additive to animal feeds.

The other purpose is to reduce weight and stabilize the product for storing and handling, raw soapstock is commonly acidulated with sulfuric acid. Traditionally, soapstock acidulation has been done in a batch process, where soapstock is charged to a corrosion-resistant tank. Wooden tanks fitted with copper or bronze coils are still used, although more recent installations are likely to be Monel metal, stainless steel, or fiberglass-reinforced plastic. Typically, sulfuric acid diluted to ca. 10% is added in excess to the soapstock charge and the mass is boiled with sparge steam for 2 to 4 h. The tank is then settled, and the acid water layer drawn off. The acid oil is water-washed by adding 25 to 50% water, boiling for a short time, and settling thoroughly. After the water layer is drawn off, the acidulated soapstock will be stored or shipped in steel tanks. Detailed practices may vary considerably from plant to plant and even from charge to charge.

1.2 Basic principles of soap splitting

The continuous acidulation process reducing the neutral oil in the soap by reacting with caustic is the basic principle in the preconditioning tank and then acidulating the mix with concentrated sulfuric acid. The neutral oil in the soapstock from the primary centrifuge should be 30% or less dry basis, and the moisture content between 45% and 50%. The quality of the final product (i.e., the acid oil) depends on how well the process operating conditions are maintained. In theacidulationindustry, and for emulsion destabilization in general, pH adjustments are very common. However, the degree to which pH isadjusted is somewhat ambiguous in theliterature. Recommendations are often the opinion of the authorand are highly dependent on the soapstock composition and typeand on the suggested“best”process. Ranges on pH adjustment vary from1 to 4butthe majority of the reviewed literature suggests a pH range of 2 to 3.Splitting temperature min. 90^0C and reaction time in agitated tank approx. 1 hour.

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. Briefly describe the main purposes of soap splitting? (5 points)
2. Write principles of soap splitting process? (5 points)

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

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

Information Sheet 2- Starting and Operating the Process of Soap Splitting

2.1 Starting and Operating soap splitting

The soapstock that is formed during the neutralisation and/or interesterification process is split into acid oil and acid water. This process can be carried out either batchwise or continuously. A strong acid is used as the splitting reagent; normally sulfuric acid. The acid oil is separated from the water by gravity. The acid water is further treated and neutralised to obtain an effluent, which is discharged in line with local regulations. This process is commonly referred to as acidulation.

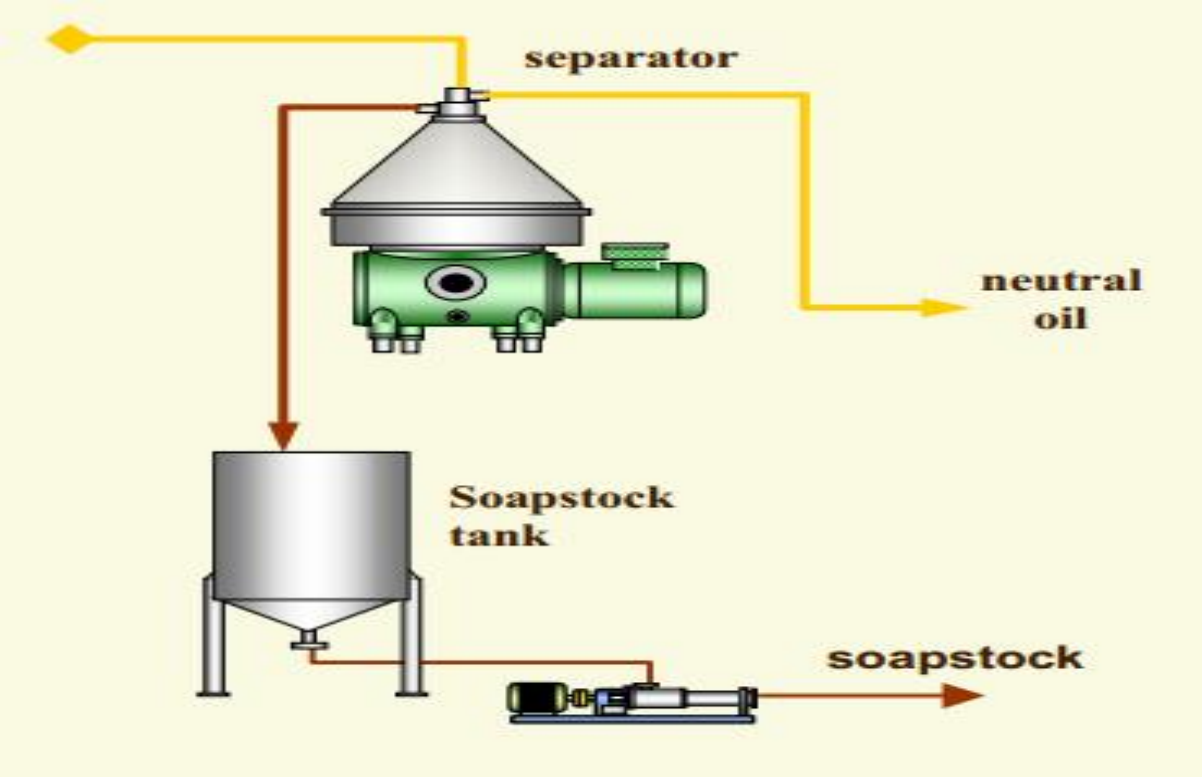


Figure 5 Soap stock separation

Soap splitting for recovering the fatty acids(acidulation of soapstock)process is commonly referred to as acidulation. In this process, the soap is mixed with concentrated sulfuric acid and heated. The strong sulfuric acid reacts with the soap forming two main streams of liquid, namely fatty acid (also called acid oil) and the acid–water, which contains sodium sulfate and many other water-soluble compounds. The fatty acid is separated

from the acid–water by allowing the reaction mass to separate into two phases in a settling tank where the fatty acids float to the top and the acid water settles at the bottom of the settling tank. In some operations the separation of the fatty acids and the acid water is done in a centrifuge. Soapstock is continuously discharged by the separator to the soap stock tank. Residual soap content in neutral oil < 500 ppm.

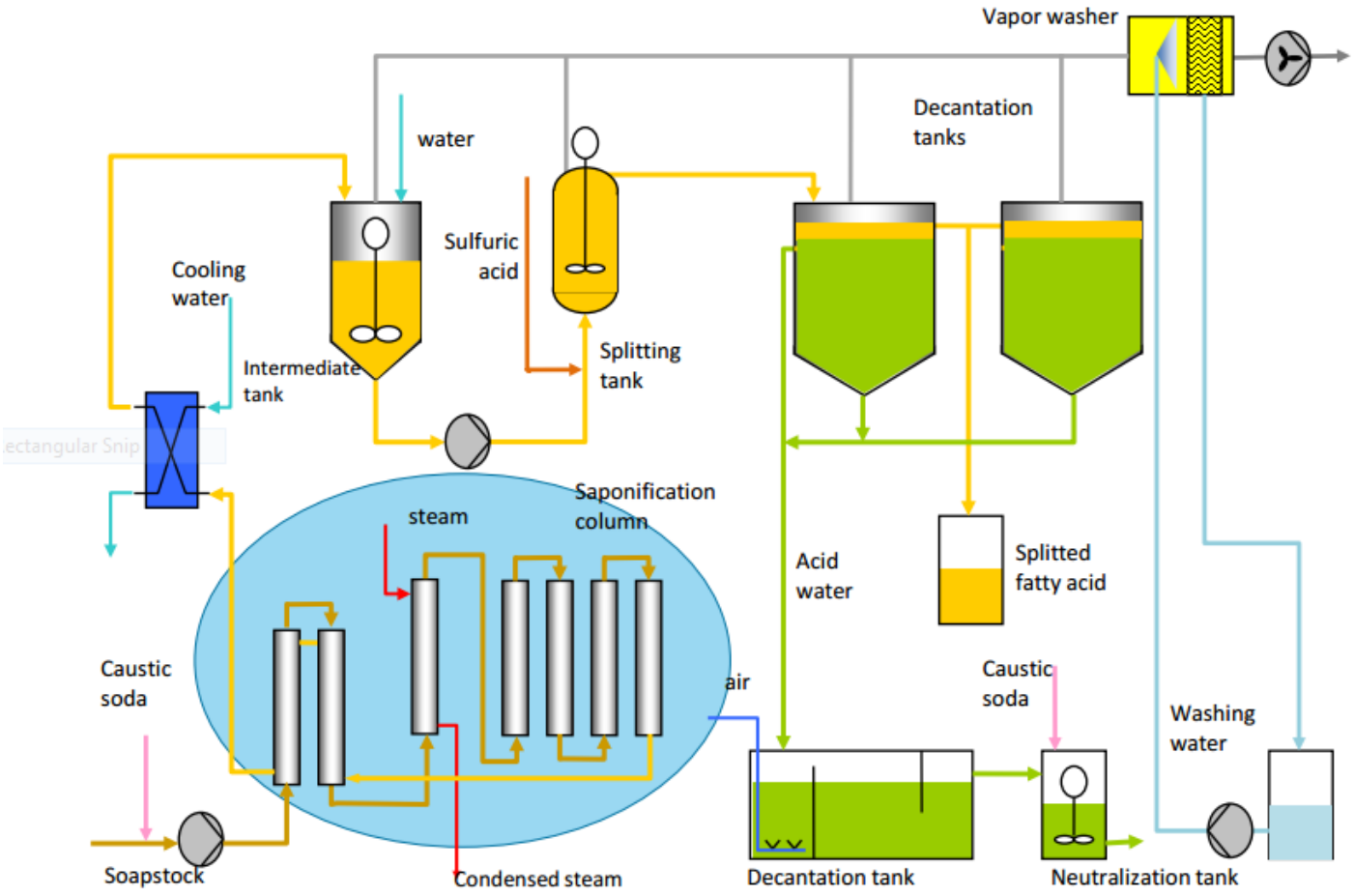


Figure 6 Soap stock splitting process

The acid oil is properly dewatered and then sold as industrial grade fatty acid, which is used in animal feed and in variousindustrial products. The acid water is neutralized with caustic solution before it can be discharged into the municipal waste water system. The soap leaving the primary separator is maintained at a moisture content of45%–50%. The moisture content should be maintained by controlling the amount of water used at the seals of the separator. At higher moisture content, the soap has lower viscosity and is easier to mix with the sulfuric acid. However, this increases the consumption of

sulfuric acid for the acidulation step and that of the caustic for the neutralization of the acid water. This increases the cost of acidulation.

Acidulation is conducted via:

- Batch process
- Continuous process

2.1.1 Batch acidulation process

The schematic flow diagram for the batch acidulation process is shown inFig.8. The step-by-step procedure for the batch acidulation process is shown:

- Soap stock from the primary centrifuge is collected in a tank. It is recommended that the amount of water to the seal of the primary separator be kept to a minimum in order for the soap stock to meet the following analyses:

Total fatty acid (TFA)	35% minimum
Moisture	Target 45% and not to exceed 50%

- The soap stock is then pumped into a steam-jacketed preconditioning tank with a high shear mixer. The mixer can be top entering or side mounted depending on the space available. A top entering agitator costs more but it also works better.
- The tank must have three or four baffles along the straight vertical wall of the tank to prevent swirling and vortex.
- The tank can also have steam coils to heat the soap stock.
- A metered amount of 50°Be (degree breaks) caustic solution is added into the soap stock in the tank. The purpose of this caustic addition is to saponify any residual neutral oil, as well as the monoglycerides and diglycerides in the soap stock. This is essential to prevent emulsion formation, which then reduces the formation of the middle phase in acidulation.

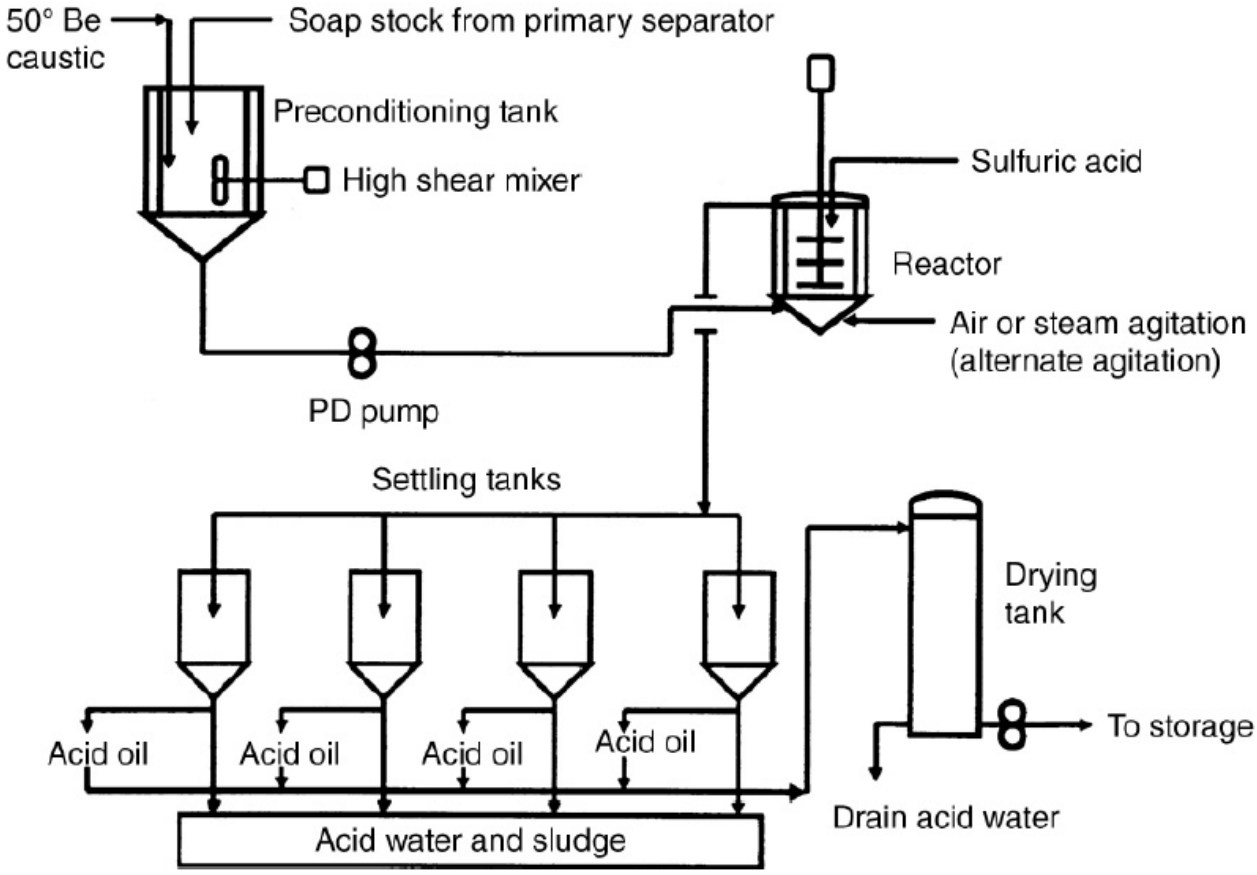


Figure 7 Schematic flow diagram for batch acidulation process

- The soapstock with the caustic solution is heated to 185–195°F (85–91°C) and is agitated for several hours until the soap stock has become very fluid. The neutral oil in the treated soap stock should be 1% or less. The pH of the soap stock may be 10.5–11. Add extra caustic solution if the neutral oil in the soap stock is higher.
- Using a positive displacement pump, the soap is then pumped into an atmospheric reactor.
- The reactor has a top entering agitator with baffles. The material of construction for all wetted parts is Carpenter 20.
- Instead of a mechanical mixer, some plants use compressed air or live steam for agitation. This method does not produce good agitation to mix the reactants.
- Concentrated sulfuric acid is added into the reactor to split the soap.
- The pH in the reactor is maintained between 1.5 and 2.5.
- The reaction takes 4–8 h to complete (sometimes longer).

- The pH is checked. Additional sulfuric acid is added to the reactor if the pH is higher than 2.5.
- The reaction is allowed to continue with agitation and the pH is checked again to make sure that proper acidity is maintained.
- The agitator is stopped and the reaction mixture is pumped into a series of settling tanks. These tanks must be either glass lined or epoxy coated carbon steel tanks or fiberglass tanks. The composition of the fiberglass tanks must be suitable to withstand a temperature of 260°F (127°C) or higher.
- These tanks are maintained at 180–190°F (82–88°C) and the reaction mixture is allowed to stand for the separation of the acid oil and the acid water.
- The acid water is drained from the bottom of the settling tanks and sent to the wastewater treatment plant where it is neutralized with caustic before it can be discharged as plant effluent. In many plants, this water goes through a primary water treatment process before it is discharged to the sewer.
- The middle phase is at its minimum when the neutral oil in the soap stock is properly saponified in the caustic pre-treatment step and it is maintained at1% or less. Sometimes there can be more middle phase even if the neutral oil is reduced in the preconditioning step for the soap stock. It is known that certain protein/lipid complexes have emulsifying property and can interfere with the separation of the acid oil from the acid water.
- The middle phase is stored in separate tanks for further acid oil recovery. Sometimes the middle phase is re-acidulated.
- The acid oil is pumped into a set of drying tanks (only one is shown inFig.3). These tanks are of relatively narrow diameter and are tall in order to facilitate the separation of the acid water. The liquid inside these tanks is maintained at 180–190°F (82–88°C). The material of construction of the drying tanks is the same as that for the settling tanks.
- The acid oil is ready to be transferred into the storage tank or shipped when the following analyses (table. 1) are met.

Table 1 Edible oil requirement analysis

Total fatty acid TFA	90% minimum
Moisture	<1%
Mineral Acid (MA)	<5%
Sediments	Balance

2.1.2 Continuous acidulation process

The schematic flow diagram for the continuous acidulation process is shown in Fig. 9. The only difference between the continuous and the batch process is that the reaction is carried out in a continuous reactor at 240°F under pressure. The separation of the acid oil and the acid water is very similar to that in the batch process. The continuous acidulation process is operated under the same principle of reducing the neutral oil in the soap by reacting with caustic in the preconditioning tank and then acidulating the mix with concentrated sulfuric acid.

Steps 1–7 under the batch acidulation process also apply to the continuous acidulation process. The rest of the steps follow.

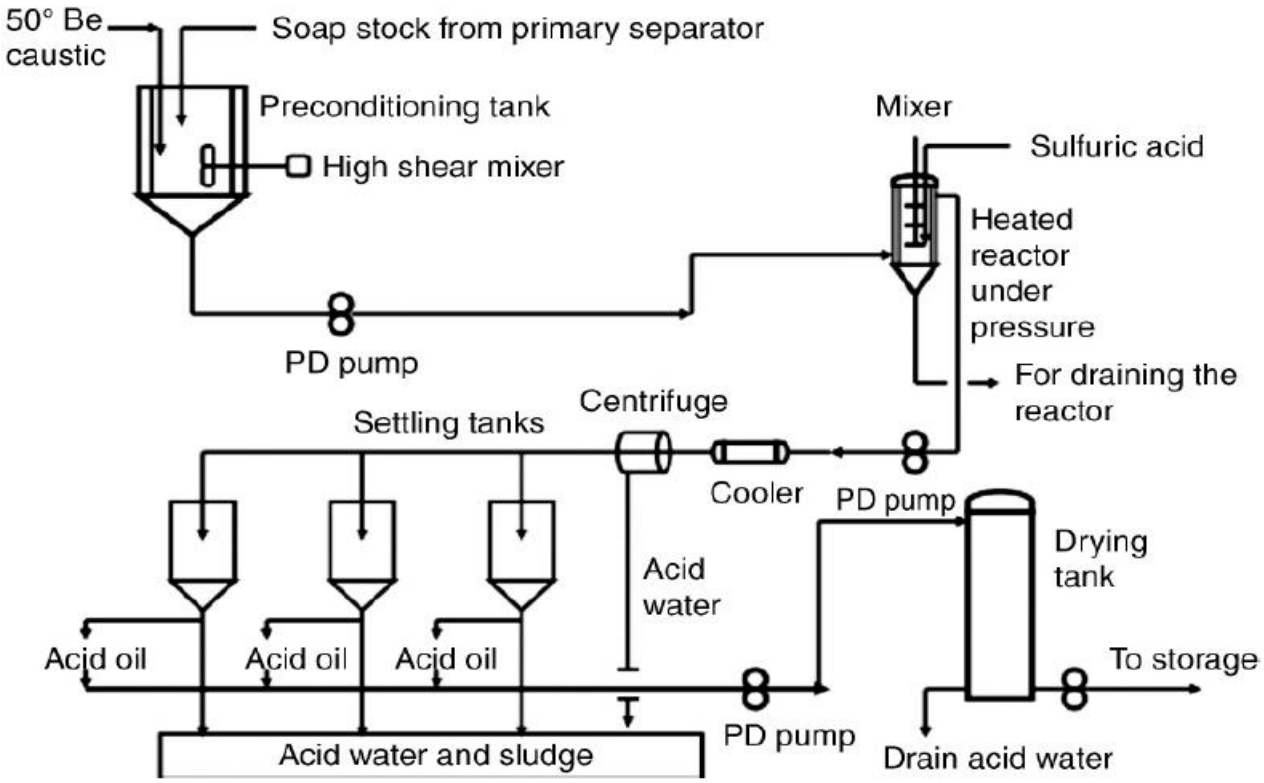


Figure 8 Schematic flow diagram for continuous acidulation process.

- The heated mixture of soapstock and caustic is metered into a reactor continuously. Simultaneously concentrated sulfuric acid is metered into the reactor continuously.
- The pH (1.5–2.5) of reaction is monitored with the help of a sensor and additional acid is added if the pH in the reactor goes above the set point.
- The reactor can also be atmospheric, operating at 185–195°F (85–91°C) or it is designed to operate at 240°F (116°C). The reactor and all wetted parts are made of Carpenter 20 alloy.
- The reactor must be a pressure vessel when it is operated at the elevated temperature 240°F (116°C).
- The reaction mixture from the reactor is pumped into a series of separating tanks as shown in Fig. 9.
- The reaction product is either separated in a centrifuge made of Carpenter 20 alloy, or it is sent directly to the separating tanks. The reaction mixture is cooled down to

190°F (88°C) before centrifuging in order to minimize cavitation. Use of a centrifuge is optional.

- Separation of the acid oil from acid water is conducted in the same manner as described under the batch process.
- As in the batch process, the acid oil goes to the settling tanks, where the majority of the acid water is drawn off. The acid oil is transferred into the drying tanks. The settling tanks, as well as the drying tank, are made of either glass lined or epoxy coated carbon steel tanks or made of fiberglass capable of withstanding up to 260°F (127°C).

2.1.3 Critical control points of batch acidulation process

Following are the critical control points in the batch acidulation process:

- The soapstock from the primary separator should have 45%–50% moisture. Sulfuric acid and caustic usage increase significantly as the moisture content of the soap stock goes up.
- The soap must be reacted with the caustic to reduce the neutral oil in the soap to 1% or less to minimize the middle phase formation.
- Temperature of this reaction is maintained at 185–195°F (85–91°C). Acidulation of the soap proceeds very slowly and is less complete at lower temperatures.
- The pH of the reaction mix is maintained between 1.5 and 2.5. At higher pH the reaction is incomplete. A lower pH increases the cost of chemicals.
- The temperature of acidulation reaction is 185–195°F (85–91°C).

2.1.4 Troubleshooting acidulation process

The goal of acidulation is to:

1. Recover most of the fatty acids (FA) from the hydrolysed soap stock.
2. Convert the neutral oil present in the soapstock into fatty acids.

In order to achieve the objectives, the soapstock from the primary separator must meet the standards listed in the previous section. The neutral oil in the soapstock from the primary centrifuge should be 30% or less dry basis, and the moisture content between 45% and 50%. The quality of the final product (i.e., the acid oil) depends on how well the process operating conditions are maintained. In addition to fatty acids, soapstocks

contain glycerol (combined as glycerides) and unsaponifiables. Although these are recovered in some operations, it is not always economical to do so because of the small quantities.

Table 3 Troubleshooting Acidulation Process

Symptom	Probable cause/causes	Recommended solutions
Viscosity of the soap stock is too high	Low temperature in the soap stock storage tank	Raise the temperature in the soap stock storage tank
	The soap stock has been stored for days	Use heat and high shear mixing to reduce the viscosity
The pH of the mixture in the preconditioning tank is <10	Not enough caustic in the system	Add more caustic to bring the pH to 10.5–11
	Neutral oil in the soap stock is higher than normal and is consuming more caustic	
The neutral oil in the precon-ditioning tank is not dropping	Low caustic	Add more caustic and let the pH stabilize at 10.5–11
	Temperature <185°F	Raise the temperature
Acid oil and water are not splitting well after the reaction	Insufficient preconditioning with caustic leaving high neutral oil in the reaction mix	Make sure the neutral oil after preconditioning is 1% or less
	Reactor pH is high	Add more sulfuric acid to lower the pH to <2.5
	Insufficient mixing in the reactor	Check and make sure the mechanical agitation or air/steam agitation is satisfactory
	Low reaction temperature	Increase the temperature in the reactor
Heavy amount of middle phase is formed	Insufficient preconditioning with caustic leaving high neutral oil in the reaction mix	Make sure the neutral oil after preconditioning is 1% or less
	The crude oil is of very poor quality and had to be overrefined or rerefined	
Mineral acid in the acid oil is >5%	Incomplete separation of acid oil and acid water	Allow longer settling time and also make sure the heat is on. The temperature in the settling and the drying tank must be 180–190°F (82–88°C)
	Incomplete draining of acid water from the acid oil	
Acid oil has <90% TFA	Incomplete separation of acid oil and acid water	Allow longer settling time and also make sure the heat is on in both settling and drying tanks. The temperature in the settling and the drying tank must be 180–190°F (82–88°C)
	Incomplete draining of acid water	

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. Write the function of strong acid? (5 points)
2. Write down the main steps of batch and continuous acidulation processes? (5 points)
3. Mention and explain goals of acidulation process? (5 points)
4. Explain critical control points of acidulation process? (5 points)

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

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

Information Sheet 3- Monitoring Operation of Equipment to Identify Variation

3.1 Monitoring operation of equipment

Monitoring is the process by which the continuous activities to be done from the pre-processing to final point of the processes in edible oil refining industry. The process will involve the use of quality parameter of edible oil soap splitting process. Start, operate and adjust process equipment to achieve required outcomes, including monitoring control points and conducting inspections as required to confirm process remains within specification.

3.1.1 Techniques used to monitor edible oil refining equipment's

- ✓ Inspecting/checking
- ✓ Measuring
- ✓ Testing as required by the process
- ✓ Visual observation

Inspection or test points (control points) in the process and the related procedures and recording requirements should be recorded to make an adjustment the overall operation.

3.1.2 Operating Principles of equipment

During starting and operating edible oil refining equipment, the basic operating principles followed include:

- Selection of appropriate materials and equipment used in case of oil seed cleaning
- Checking main equipment components,
- Checking status and purpose of guards,
- Maintaining equipment operating capacities and applications,
- Purpose and location of sensors and related feedback instrumentation
- The safe operation and maintenance of oil seed cleaning materials and equipment.

- Hazard and risk identification.
- Emergency operating and defensive operating procedures ensuring working loads are secure and within specifications.
- Appropriate use, maintenance and storage of personal protective equipment.
- Protection of people in the workplace.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: Choose the best answer

1. Define equipment monitoring? (5 points)
2. Mention techniques of monitoring of equipment? (5 points)

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

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

Information Sheet 4- Identifying Variation in Equipment Operation and Reporting Maintenance Requirements

4.1 Identifying variation in equipment operation

Variations in equipment operations can be happen due to many factors. Such as:

- Lack of maintenance or poor maintenance,
- In appropriate adjustment of machine components,
- Equipment component problem,
- Temperature difference,
- pH difference,
- Amount of sulfuric acid, 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 adjust equipment parameters and perform maintenance before we are going to operate equipment.

4.2 Operation to minimize variations

There are different variables in soapstock splitting processes that must be monitored and controlled. Variables to be monitored to minimize variations in equipment operations include

- Sequences and timing of operation
- Temperature
- pH
- Acid addition
- Color of acid oil
- Color of acid water

- **Techniques of identifying equipment variations**
  - ✓ 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 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

4.3 Reporting maintenance requirements

4.3.1 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. 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.

- **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

- **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 opti mum equipment function. Individual operating parameters will help determine the appropriate maintenance intervals. 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.

- **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.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Write factors that cause variation in equipment operation? (5 points)
2. Mention variables to be monitored to minimize variation? (5 points)
3. Write techniques of identifying equipment variation? (5 points)
4. Write and explain types of maintenance (5 points)

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

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

Information Sheet 5- Monitoring the Soap Splitting Process to Confirm Separation of Acid Oil and Acid Water Streams

1.1 Monitoring the soap splitting process to confirm separation of acid oil and acid water streams

Several processes have been developed for continuous acidulation of soap stock. A mixture of soap stock and centrifuge flush water is delivered at a controlled rate into an acidulation vessel, together with a metered stream of sulfuric acid, to bring the pH to 1.5 to 2.0. The vessel is designed so that the contents are both mixed and heated with sparge steam to approximately 90°C. The mixture constantly overflows into a settling basin. In the settling basin the acid oil floats to the top and the acid water settles to the bottom. A series of valves at different levels are provided for drawing off the acid oil (fig. 10).

The acid water overflows through a standpipe, which maintains the level in the settling basin. This process has been in successful use for several years. It is limited to use on soap stock from oil that has been thoroughly degummed, before even small amounts of gums create emulsions that will not separate. The sequence of acidulation, water washing, and decanting is performed in each vessel. The acid layer from one vessel may be mixed into the soap stock charged to the next vessel to economize on acid usage. Wash water is added to the acid oil, and the water and solids are removed by centrifuging in a self-cleaning separator. The use of a surfactant, ethylhydroxyethylcellulose (50 to 100 ppm), to break emulsions is also described.

Another continuous acidulation process by using continuous centrifuging to separate the acid water and acid oil. It is claimed that this reduces the fat content of the acid water to less than 0.4%, and the acid water stream is improved over the batch process in having a higher pH and lower fat and biochemical oxygen demand (BOD) content. A further process step, to neutralize the acid water continuously with lime and clarify it

centrifugally, is said to reduce the BOD by 62 to 76% and to remove 80 to 95% of invert sugars and all of the fat.

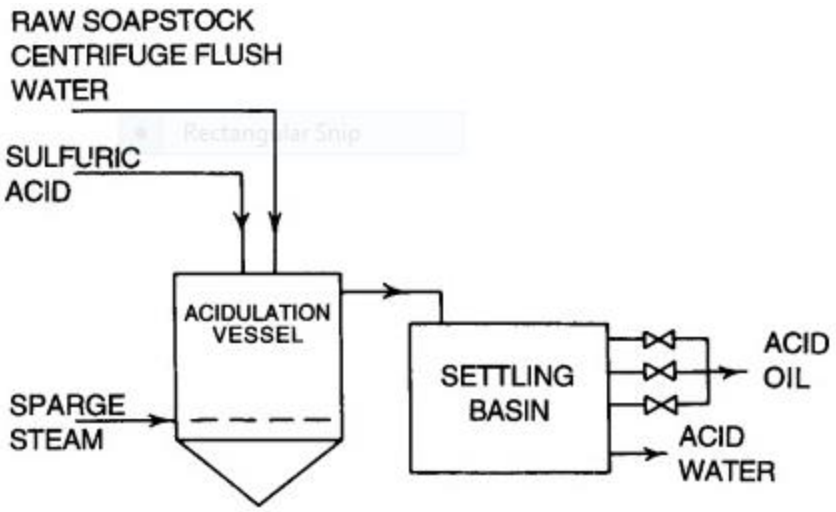


Figure 9 Continuous soapstock acidulation.

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: True/false

1. A mixture of soap stock and centrifuge flush water is delivered at a controlled rate into an acidulation vessel (5 points)
2. The use of a surfactant, ethylhydroxyethylcellulose is used to break emulsions (5 points)

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

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

Information Sheet 6- Maintaining the Work Area in Housekeeping Standards

6.2 Maintaining work area to housekeeping standards

Maintaining the work area cleanness is playing the vital role of the organizational success. It includes keeping work areas neat and orderly; maintaining halls and floors free of slip and trip hazards; and removing of waste materials and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of accident and fire prevention.

A safe work environment including facilities, Amenities and accommodation. Facilities refer to toilets, washrooms, showers, lockers, dining areas, drinking water, etc. These facilities must be in good working order, clean, safe and accessible. When considering how to provide and maintain facilities that are adequate and accessible, a person conducting maintenance 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

✓ **Work environment**

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

layout

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

Housekeeping

Good housekeeping is central to all types of effective operational and maintenance work. The quality of housekeeping also provides auditors and other outsiders with an opportunity to provide a quick evaluation of the overall operational standards in a facility. In the words of the proverb, “You don’t get a second chance to make a first impression.” And it is housekeeping that creates that first impression. Housekeeping also provides a quick check regarding culture and employee participation since everyone has an impact on the appearance of the facility.Some of the actions that help achieve good housekeeping are as follows:

- Ensure that all tools and equipment, particularly firefighting equipment, are located in the assigned placesa place for everything and everything in its place.
- Remove all dry grass, brush, or weeds to avoid the potential for a fire spreading.
- Ensure that all discarded materials, particularly those that are potential fire hazards, are disposed of properly and continuously throughout the job progress.
- Avoid accumulation of combustible items such as spilled oil, woods, and rags because they can be a fuel source during a fire. Oil-soaked rags should always be promptly disposed of in covered metal cans.
- Remove and replace damaged or oil-soaked insulation.
- Remove tripping hazards.
- Keep drain openings and free-flowing drainage systems free of debris.
- Keep aisles and walkways free and clear of maintenance equipment and tools in order to eliminate tripping hazards and to ensure that emergency evacuation is not restricted and that access to firefighting equipment is not hampered.
- Ensure that junction and switch box covers on electrical circuits are secure and tight.
- Promptly eliminate trace hydrocarbon leaks from lines, valves, and stuffing boxes (this is often a requirement of the environmental regulations).
- Clean up spills at once.

- Nails, staples, and other puncturing metals should be bent under or removed from spent packing or lumber and stacked with points on bottom.
- Ensure that all unused maintenance materials and spare parts have been removed and returned to the store.
- Dismantle all scaffolding once it is no longer needed.
- Ensure that stacked materials are secured to prevent them from falling with the heaviest objects closest to the floor.

Housekeeping includes checking that equipment and piping is in good condition. All process and utility piping should be horizontal or vertical (a few process applications require piping to be sloped). Any equipment that is in a deteriorated condition should be identified and repaired. Any insulation that is oil-soaked is a fire hazard and should be replaced and the source of the leak should also be identified and repaired

Work areas

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

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Write advantages of maintaining work area? (5 points)
2. Mention good housekeeping practices? (5 points)

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

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

Information Sheet 7- Maintaining workplace records

7.1 Workplace records

There are certain written records or kinds of documentation that are needed in order to verify that the system is working. 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.

7.2 Types of records

7.2.1 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.

7.2.2 Electronic records

Examples of electronic records include:

- E-mail messages,
- Word- processed documents,
- Electronic spreadsheets,
- Digital images and databases.

7.2.3 Recording activities

In oil processing there are many activities to be recorded:

- Equipment performance
- Equipment variation
- Maintenance activities
- Faults and problems
- Out of specification materials and products etc…

7.3 The purpose of records

Accurate record keeping is essential to the application of a preventive control plan. Your records should be sufficient to enable you to confirm easily and with confidence that your preventive control plan is implemented and working effectively. Records can also help you improve your preventive control plan by providing a means for you to, for example:

- Identify the root cause of an issue
- Analyze and improve a process or procedure
- Identify gaps in training and in training needs.

Self-Check – 7	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Mention and discus types of records? (5 points)
2. Write activities to be recorded on oil refining process? (5 points)

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

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

Information Sheet 8- Workplace Information

8.1 Workplace Information

Each workplace relies on the exchange of information to carry out its daily business.Information is passed from employee to employee, customer to employee,supervisor to team member, supplier to customer, and so on. Dealing effectively with information and records is necessary and important for all organisations.The quantity and variety of information kept by an organisation can be huge. Information needs to be sorted into related groups so that it can be stored easily and found when needed. An organisation's success depends largely on how well it manages its information. Work place information includes the following:

- Standard Operating Procedures (SOPs)
- specifications
- production schedules and instructions
- manufacturers' advice
- standard forms and reports

8.1.1 Standard Operating Procedures (SOPs)

Standard operating procedures are a set of written instructions that document a routineor repetitive activity followed by an organization. The development and use of SOPs arean integral part of a successful quality system as it provides individuals with theinformation to perform a job properly, and facilitates consistency in the quality and integrity of a product or end-result. A standard operating procedure is a procedure specific to your operation that describes the activities necessary to complete tasks in accordance with industry regulations, provincial laws or even just your own standards for running your business. Any document that is a “how to” falls into the category of procedures. In a manufacturing environment, the most obvious example of an SOP is the step by step production line procedures used to make products as well train staff. An standard operating procedure, in fact, defines expected practices in all businesseswhere

quality standards exist. Standard operating procedures play an important role in your small business. Standard operating procedures are policies, procedures and standards you need in the operations, marketing and administration disciplines within the business to ensure success.

These can create:

- Efficiencies, and profitability
- Consistency and reliability in production and service
- Fewer errors in all areas
- A way to resolve conflicts between partners
- A healthy and safe environment
- Protection of employers in areas of potential liability and personnel matters
- A roadmap for how to resolve issues and the removal of emotion from troubleshooting allowing needed focus on solving the problem
- A first line of defense in any inspection, whether it be by a regulatory body, a partner or potential partner, a client, or a firm conducting due diligence for a possible purchase
- Value added to your business should you ever wish to sell it.

8.1.2 Specifications

Specifications are integrated sequences of specific controls for materials, processes, and products based on quality aspects of customer requirements, design performance, and manufacturing process capabilities to ensure timely shipment of quality products at the lowest cost. Specifications provide specific guidelines for

- purchase of raw materials, processing aids, ingredients, and packaging supplies;
- processing of intermediates; and
- formulation of the finished product.

The finished product then becomes an ingredient or raw material for food processors that develop their own specifications. The purpose of the specifications is to define what is needed for a large cross section of people who have to buy, supply, receive, process, package, evaluate, store, ship, and use the products. Each specification should define the characteristics of the product to

the extent that possession of the document alone is sufficient to identify what is needed. Five different types of specifications are required for a rational system of controls for the complex processing of edible fats and oils into functional ingredients for prepared foods: ingredient, package, product, customer instructions, and summary specifications.

- ✓ **Specifications Format**

Each specification should be identified with the name of the company issuing the specification, the date, and the common or usual name of the ingredient, package, or product. Uniform presentation is best controlled by the adoption of a form that can be adapted for all of the specification types. Table 4 presents an efficient specification form that can effectively serve purchase and product specifications as well as other types beneficial to the quality management effort. This form has three sections, two of which require information common to all specifications.

Table 2 specification format

<table>
<tr><td colspan="3">COMPANY NAME AND LOGO
SPECIFICATION</td></tr>
<tr><td rowspan="2">PRODUCT, MATERIAL OR OPERATION
(A)</td><td>EFFECTIVE DATE
(C)</td><td>SPEC NUMBER
(B)</td></tr>
<tr><td>SUPERSEDES: (D)ISSUE SPEC NODATE</td><td>ISSUE NUMBER
(B)</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="3">DISTRIBUTION

(E)</td><td colspan="2">REASON FOR CHANGE
(F)</td></tr>
<tr><td>ORIGINATOR
(G)</td><td>DATE
(H)</td></tr>
<tr><td>CUSTODIAN
(I)</td><td>DATE
(J)</td></tr>
</table>

8.1.3 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.

Self-Check – 8	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Mention work place information's? (5 points)
2. What are standard operating procedures? (5 points)
3. Define specification? (5 points)

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

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

Operation Sheet – 1 Starting and Operating the Process of Soap Splitting

Batch acidulation process

Objectives: To know batch acidulation process

- **Material required;** soapstock, Sulfuric acid, Salt, water and etc.
  - **Equipment required;** PPE, Pumps, Reactors, Acid and steam addition systems, settling tanks, Storage tank etc.

Following the steps outlined below will help ensure pre-start checks of soap splitting equipment's.

1. Wear personal protective equipment's
2. Pump the soapstock into a steam-jacketed preconditioning tank with a high shear mixer.
3. Heat the soap stock.
4. Add a metered amount of 50°Be (degree breaks) caustic solution into the soap stock in the tank.
5. Heat the soap stock with the caustic solution to 185–195°F (85–91°C) and agitate for several hours until the soap stock has become very fluid.
6. Pump the soap using a positive displacement pump, into an atmospheric reactor.
7. Add concentrated sulfuric acid into the reactor to split the soap.
8. Maintain the pH in the reactor between 1.5 and 2.5. The reaction takes 4–8 h to complete (sometimes longer).
9. Stop the agitator and pump the reaction mixture into a series of settling tanks.
10. Maintain the tanks at 180–190°F (82–88°C) and allow the reaction mixture to stand for the separation of the acid oil and the acid water.
11. Drain the acid water from the bottom of the settling tanks and send to the wastewater treatment plant where it is neutralizing with caustic before it can be discharge as plant effluent.
12. Store the middle phase in separate tanks for further acid oil recovery. Sometimes the middle phase is re-acidulate.

13. Pump the acid oil into a set of drying tanks. These tanks are of relatively narrow diameter and are tall in order to facilitate the separation of the acid water.
14. Transfer acid oil into the storage tank.
15. Apply 5 S
16. Conduct maintenance or report
17. Record the process

Operation Sheet – 2 Starting and Operating the Process of Soap Splitting

Continuous acidulation process

Objectives; To know continuous acidulation process

- **Material required;** soapstock, Sulfuric acid, Salt, water and etc.

✓ **Equipment required;**

- PPE,
- Pumps,
- Reactors,
- Acid and steam addition systems,
- settling tanks,
- Storage tank etc.

Following the steps outlined below will help ensure pre-start checks of soap splitting equipment's.

1. Meter the heated mixture of soap stock and caustic into a reactor continuously. And simultaneously meter concentrated sulfuric acid into the reactor continuously.
2. Monitor the pH (1.5–2.5) of reaction with the help of a sensor and add additional acid if the pH in the reactor goes above the set point.
3. Pump the reaction mixture from the reactor into a series of separating tanks.
4. Cool down the reaction mixture to 190°F (88°C) before centrifuging in order to minimize cavitation. Use of a centrifuge is optional.
5. Conduct separation of the acid oil from acid water
6. The acid oil goes to the settling tanks, where the majority of the acid water is drawn off.
7. Transfer the acid oil into the drying tanks.
8. Apply 5 S
9. Conduct maintenance or report
10. Record the process
11. Review the process and record.

LAP TEST	Performance Test

Name…… ID……

Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6:00** hour. The project is expected from each student to do it.

Task-1 Operate batch acidulation process

Task-1 Operate continuous acidulation process

LG # 34	LO #3 Shut Down the Soap Splitting Process

Instruction Sheet

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

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

Learning Instructions:

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

Information Sheet 1- Identifying Appropriate Shutdown Procedure

1.1. Shut down procedure

Shut down is the act of closing equipment/machine or stopping of equipment/ machine. Refer to your standard operating procedures for the correct way to operate each type of processing unit in your workplace. The standard operating procedures for each type of equipment must be adhered to when shutting a processing down. The types of shutdowns used in oil processing equipment/machine unit are:

- Scheduled shutdown
- Maintenance shutdown
- Emergency shutdown

1.1.1. Scheduled shutdown

A scheduled shutdown is initiated by the operator during normal operation of the unit when, maintenance is required. The shutdown procedure will depend on the type of equipment and the process to be done. Some steps taken in a unit/process shutdown may include:

- Shutting off the feeds to stop processes and heat generation particularly if processes are produced heat
- Shutting off heating or cooling to the unit/ processing operation
- Shutting off refining crude oil and other mechanical operations
- Removing or flushing waste materials from the processing workplace

1.1.2. Maintenance shutdown

When maintenance to the soap stock splitting equipment is required, the equipment may need to be entered so that work can take place. The shutdown should be a scheduled or planned shut down as per standard operating procedures where equipment is:

- Isolated (process, mechanical and electrical)
- Cooled and depressurized

- Cleaned
- Electric tested on a continuous basis prior to and during entry.
- A planned unit/plant shutdown will prevent:
  - ✓ plugging of lines or equipment
  - ✓ possible damage to equipment
  - ✓ Possible injury.

1.1.3. Emergency shutdown

An emergency shutdown is initiated in the event of a fire, instrument failure, power failure, unexpected hazard or total loss of the processes. Emergency shutdown procedures must be followed during a shutdown sequence. Where a shutdown will affect upstream or downstream process units, advanced warning must be given to the appropriate personnel to allow them to prepare for, and react to, the changing conditions.

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Define shut down? (5 points)
2. Mention and explain types equipment shut down? (5 points)

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

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

Information Sheet 2- Shutting Down the Process

The soapstock splitting of edible crude oil process will be shut down after completion of work every day according to the standards and procedures of the industry. Process shutdown is temporary in nature, which means that it has a specific start and finish. There will be a preferred sequence of implementation for the shutdown tasks. The shutdown is a unique, one-time undertaking; it will never again be done exactly the same way, by the same people, and within the same environment. During normal running of the plant, experienced people usually carry out familiar tasks using well-defined procedures, but during plant shutdown, one could come across hazardous procedures and unfamiliar events. In such situations, the probability of accidents increases.

Major shutdown in process industries typically happen infrequently and take several hours to complete. In general, these shutdowns should have two objectives:

- To repair problems identified during previous major shutdowns, and
- To inspect parts of the plant not accessible during operation in order to identify problems that will be repaired during future planned shutdowns.

Major shutdown provides an opportunity for the people in the maintenance department to demonstrate how well they can perform under pressure. A well-planned and executed shutdown can be an exciting and satisfying experience. A strong operations or maintenance partnership will be a key. Finally, be sure to include all operations and maintenance activities in an integrated shutdown schedule, which should be under constant review and revision during the shutdown period.

The documentation for a major shutdown can be extensive. It may include the list of shutdown work, critical-path schedules, the process inventory plan, permits and other safety documentation, the shutdown budget, all isolation and vessel-entry procedures (complete with detailed schedules and resource plans), as well as a list of the people responsible for all aspects of the shutdown including their work schedules.

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. Write the objectives of shut down (5 points)
2. Write activities and plans documented for major shut down? (5 points)

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

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

Information Sheet 3-Identifying and Reporting Maintenance Requirements

3.1 Identifying and reporting maintenance requirement

Maintenance can be defined as working on something to keep it in a functioning and safe state and preserving it from failure or decline. Any activities which require maintenance should be identified properly and reported immediately as soon as possible. Maintenance procedures and other work-related documents should identify preconditions and precautions, provide clear instructions for work to be done, and be used to ensure that maintenance is performed in accordance with the maintenance strategy, policies and programs. The procedures should normally be prepared in cooperation with the designers, the suppliers of plant and equipment, and the personnel conducting activities for quality assurance and technical support. Maintenance systems vary, depending on the location of the plant and equipment and/or company policy. Systems can range from the complete maintenance of plant and equipment using all available methods to their replacement on failure.

3.2 Types of maintenance

3.2.1 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.

3.2.2 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.

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.

3.2.3 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.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: Choose the best answer

1. Write the main activities performed in maintenance? (5 points)
2. List the main routine maintenance tasks? (5 points)
3. Write types of maintenance? (5 points)

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

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

Reference materials

Book:

- Monoj K. Gupta, Practical guide to vegetable oil processing (second edition) (2017)
- Lin, C.-Y.; Lin, Y.-W. Fuel characteristics of biodiesel produced from a high-acid oil from soybean soapstock by supercritical methanol transesterification. Energies 2012, 5, 2370–2380. [Cross ref.] 7.
- Wang, Z.-M.; Lee, J.-S.; Park, J.-Y.; Wu, C.-Z.; Yuan, Z.-H. Novel biodiesel production technology from soybean soapstock. Korean J. Chem. Eng. 2007, 24, 1027–1030. [Cross ref.]
- Michael Bockisch Hamburg, Fats and Oils Handbook, , Germany(1998)
- Richard D. O'Brien, Fats and Oils, Formulating and Processing for Applications (third edition), (2009)
- Casimir C. Akoh and David B. Min, Food Lipids Chemistry, Nutrition, and Biotechnology Second Edition (2002)
- Wolf Hamm, *et al.* Edible Oil Processing*, (Second Edition) (2013)*

WEB ADDRESSES

- https://www.oil-refinery.com/offered-technologies/soap-stock-splitting/
- https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/soapstock

you tube links

- https://m.facebook.com/story.php?story_fbid=759614191442568&id=1906604969608593&_rdr

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