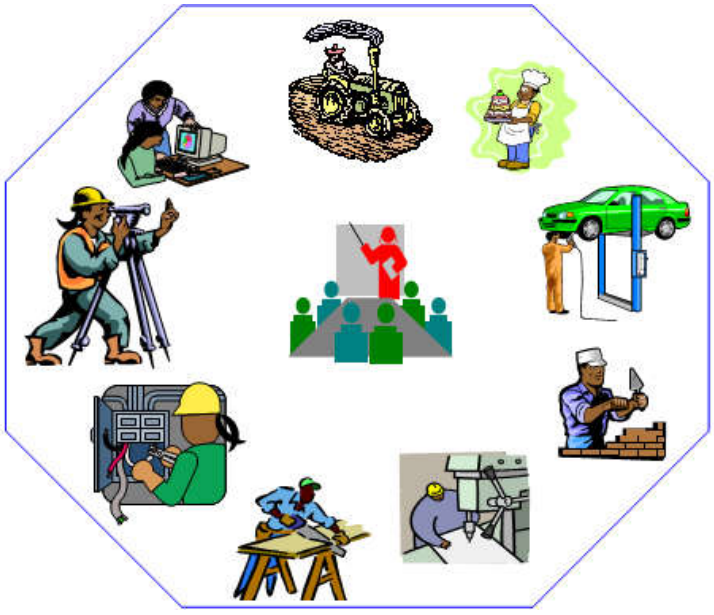
Edible Oil and Fats Processing

Level III

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



Module Title: - Operating degumming process

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LG #26	LO #1- Prepare the degumming equipment and process for operation

Instruction sheet

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

- Confirming available materials
- Confirming available services
- Identifying and confirming cleaning and maintenance requirements
- Entering production/process parameters
- Checking and adjusting degumming 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
- Confirm available services
- Identify and confirm cleaning and maintenance requirements
- Enter production/process parameters
- Check and adjust degumming equipment performance
- Carryout pre-start checks

Learning Instructions:

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

Information Sheet 1- Confirming available materials

1.1. Introduction

One of the key steps in the refining process is the elimination of impurities from crude vegetable oils especially the phosphatides or so-called gums. They are mainly present in oils extracted with solvent from soya beans, sunflower seed and rapeseed. They have to be removed in the early refining stage for two main reasons; they are responsible for high refining losses due to their emulsifying properties and they decompose, darkening the oil due to their thermal instability.

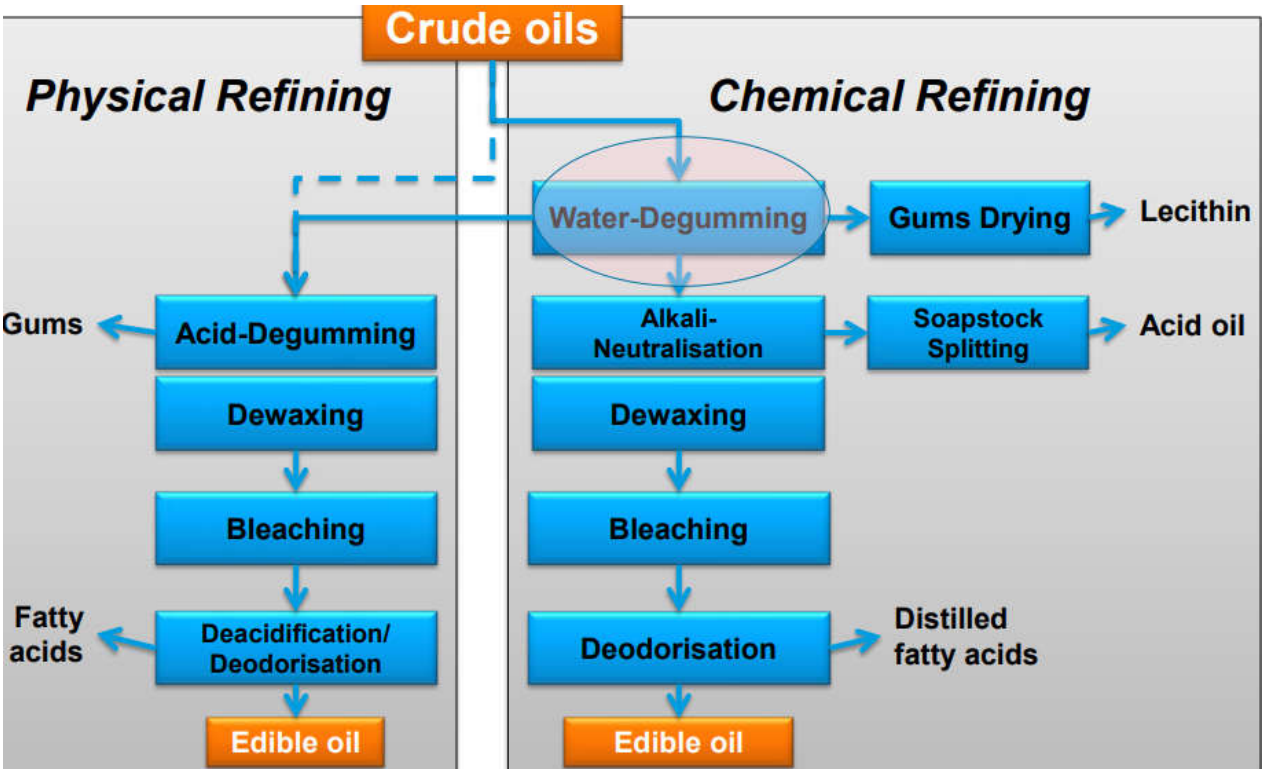

Figure 1.1. Integration of degumming in refining processes

1.2. Materials use during degumming process

Crude oil

Crude oil which are untreated and unrefined and received from the extraction plant contain several non-triglyceride components which must be removed. The crude fats and oils recovered from oilseeds, fruits, nuts, and animal tissues can vary from pleasant-smelling products that contain few impurities to quite offensive-smelling, highly

impure materials. Only a few of the crude fats and oils are suitable for edible purposes until they have been processed in some manner.

Soft hot water

Water washing-refined oil from the primary centrifuge is washed with hot softened water or recovered steam condensate proportioned into the oil at a rate of 10 to 20% of the oil flow. Softened water must be used to avoid the formation of insoluble soaps. A single wash is usually sufficient; however, two washes may provide savings in bleaching earth and hydrogenation catalyst usage as well as a reduction in wash water volume. The water temperature should be 185 to 195°F (85 to 90°C), preferably 10 to 15°F (5 to 8°C) warmer than the oil temperature.

Phosphoric acid and citric acid

Apart from water, citric acid or phosphoric acid can also be used to facilitate non-hydratable phospholipid removal.

For fats obtained by pressing and water, which are low in phosphatides, (20 ppm of phosphorus), such as soybean oil, palm oil, palm kernel oil, olive oil, the degumming process is quite simple: it suffices to mix the fat with a small quantity of a strong degumming acid such as phosphoric or citric acid to dissociate the nonhydratable phosphatides (NHP) into phosphatidic acid (PA) and calcium or magnesium bi-phosphate salt. Phosphoric acid is used only in small quantity (0.1-0.3%) of an 85% solution because excess is not adsorbed onto the earth causing problem of hydrolysis or causing the phosphorylation of mono- or diglycerides during physical refining.

Self-check 1	Written test

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

Short Answer Questions

1. List important materials use for edible oil degumming process?(2point)

2. Write the important of soft hot water during degumming of crude oil?(3point)

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

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

Score = _____

Rating: _____

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

Answer sheet

1._____

2. _____

Information Sheet 2- Confirming available services

2.1. Service

The services such as power steam, water, compressed and instrumentation air are essential that play a vital role to edible oil and fat processing industry.

- **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.

- **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).

- **Lighting**

Adequate lighting should be provided in all processing areas to facilitate crude oil degumming process.

- **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.

Self-Check – 2	Written test

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

Short Answer Questions

1. List the service use during crude oil degumming process?(4)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

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

Score = _____

Rating: _____

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

Answer sheet

1._____

_____

Information Sheet 3- Identifying and confirming cleaning and maintenance requirements

3.1. Equipment use for degumming process

- **Centrifugal separators**

The Alfa Laval range of disc stack centrifuges consists of units with capacities ranging from 50 t/day up to 1,500 t/day. For example, the extensive PX range of disc stack centrifuges features semi-hermetic technology and is equipped with the unique Alfa Laval centrizoom adjustable paring disc. This enables you to deal with a wide range of gums and soaps tocks, and undertake rapid, variable adjustment via remote control. It also reduces energy consumption dramatically.

A solid bowl range of disc stack centrifuges is also available, featuring a hermetically sealed design. This protects the product against oxidation, which helps ensure high quality. The hermetically sealed, bottom-fed inlet ensures gentle, non-destructive acceleration of the feed up to full bowl speed. This improves separation efficiency and minimizes power consumption. Alfa Laval supplies disc stack centrifuges with a range of different drive systems:

- ✓ Traditional gear-drive and belt-drive systems that provide well-proven reliability and efficiency.
- ✓ Innovative edrive direct drive system. Compared with traditional solutions, this provides additional energy savings and longer service intervals.

Figure 3.1. Centrifugal separators

- **Mixers**

Adding the correct types of reagents in the right quantities is important, but correct mixing is crucial for the efficiency of the subsequent refining processes. Alfa Laval has long-term practical experience in dealing with a wide range of mixing requirements, from the gentle “hydration” mixing in the degumming process to the high-intensity mixing required in the Alfa Laval Multi Mix process. The range of mixers is designed on the basis of the micro merge concept. This features separate chambers for dispersion and mixing to ensure effective mixing and the most efficient utilization of additives. Combined with a frequency control drive, this gives you unparalleled flexibility in all mixing duties.

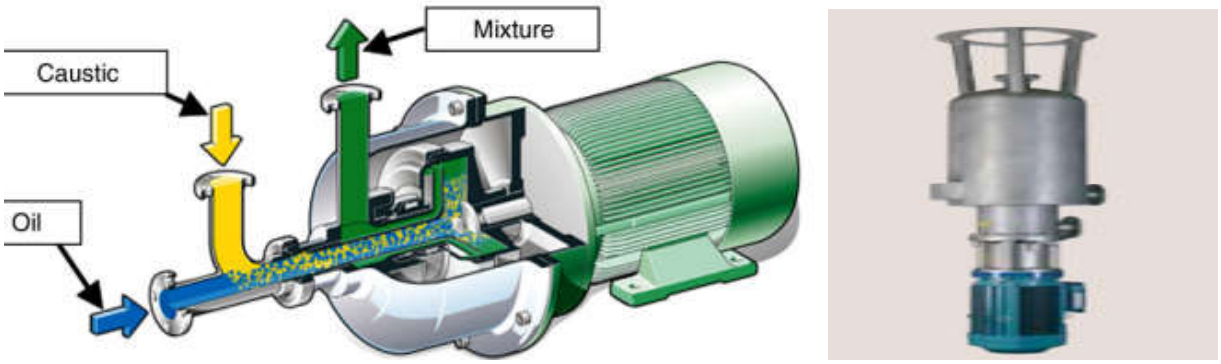

Figure 3.2. Mixers

- **Heat exchanger**

Heat exchangers are designed to make heat transfer more energy-efficient. The corrugated plates provide the largest possible surface area through which the heat can pass from one gas or liquid to another medium. This substantial heat transfer area is available within a relatively compact footprint. The design of the channels also provides maximum turbulence, which ensures peak efficiency in transferring thermal energy from one medium to the other. Alfa Laval plate heat exchangers have the added advantage that completely standard units are normally fully capable of handling all requirements within the fats and oils industry.

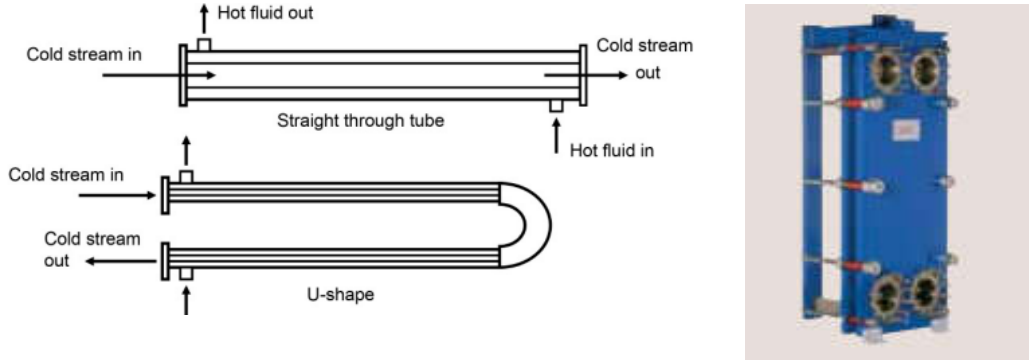

Figure 3.3. Heat exchanger

- **Evaporators and condensers**

All the technical advantages of Alfa Laval plate heat exchangers are also available in Alfa Vap and Alfa Cond semi-welded units, specially designed for evaporation and condensation duties, respectively. Alfa Vap evaporators are especially efficient at high concentrations and viscosities, and can work with temperature differences of as little as 3-4°C (37-39°F). This is a big advantage in mechanical or thermal vapour recompression systems (such as waste water evaporation systems). Alfa Cond condensers are tailored to achieve the most efficient vacuum condensation under all conditions. Their unique configuration and plate pattern make it possible to maximize heat transfer efficiency and minimize fouling as well as maintaining a low load on the vacuum system.

Figure 3.4. Evaporators and condensers

Tank

The tank must have side mounted agitator with baffle arrangement to prevent the meals from settling to the bottom of the tank. The agitator must have a low oil-level cut-off switch to protect the agitator shaft against bending as well as from undue whipping of air into the crude oil. The tank must have a temperature indicator, preferably a temperature control and temperature monitoring device. It is recommended that these tanks be heated with hot water and not with steam. This prevents undue overheating of the oil and rise of FFA due to high temperature or possible leak in the steam coil. There should be a thermodynamic trap on the steam coil to maintain proper condensate discharge temperature to control the oil temperature. The tank must have a man head for tank entry for the purpose of repair, cleaning, etc. Atmospheric vent at the top of the tank for the passage of air in and out of the tank as the tank is filled or emptied.

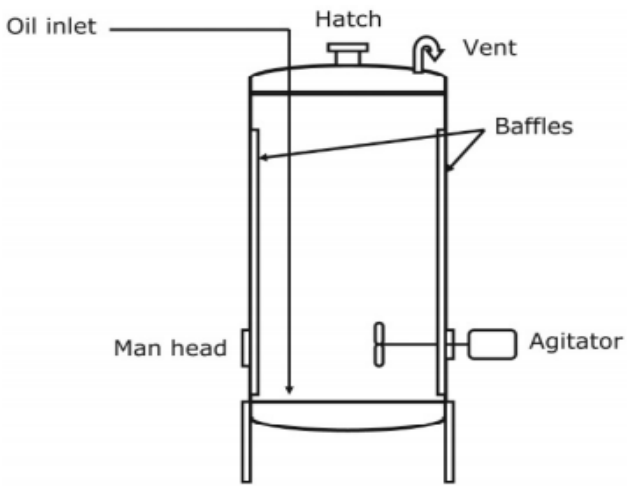

Figure 3.5.Tank

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 liquids 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.

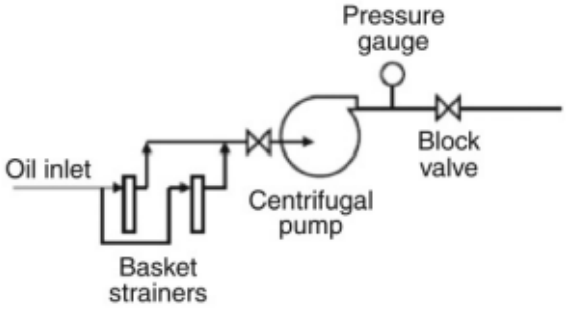

Figure 3.6. Centrifugal pump

3.2. Cleaning equipment

Degumming equipment should be cleaned and sterilized according to the manufacturer's specifications, enterprise procedures and regulations. This is used to increases life span of equipment and avoids scarcity of equipment at critical periods. Different organic debris builds up on parts of equipment that are in regular contact with produce. This organic debris will cause corrosion of metal parts, reducing the life of the equipment and the sharpness of the cutting blades of different machineries. Equipment should be designed to facilitate cleaning and disinfection with little or no water and when wet cleaning is required, to allow thorough drying before reusing the equipment for oil processing. Alternatively the design should allow disassembly such that parts can be taken to a room designed for wet cleaning and disinfection, when applicable. The equipment design should be as simple as possible, with a minimal number of parts and with all parts and assemblies easily accessible and/or removable for inspection and cleaning. Equipment should not have pits, cracks, corrosion, crevices, recesses, open seams, gaps, lap seams, protruding ledges, inside threads, bolt rivets, or dead ends. Hollow areas of equipment as well as cracks and crevices should be eliminated whenever possible or permanently sealed. Items such as bolts, studs, mounting plates and brackets should be continuously welded to the surface and not attached via drilled and tapped holes. Welds should be ground and polished smooth. Push buttons, valve handles, switches and touch screens should be designed to ensure product and other residues (including liquid) do not penetrate or accumulate in or on the enclosure or interface.

3.3. Maintenance of equipment

Maintenance of all equipment should be carried out in accordance with the manufacturer's recommendations.

3.3.1. Types of maintenance

Breakdown maintenance

This refers to the maintenance strategy, where repair is done after the equipment failure/stoppage or upon occurrence of severe performance decline. This concept has

the disadvantage of unplanned stoppages, excessive damage, spare parts problems, high repair costs, excessive waiting and maintenance time and high trouble shooting problems.

Preventive maintenance

Preventive maintenance (PM) comprises of maintenance activities that are undertaken after a specified period of time or amount of machine use. This type of maintenance relies on the estimated probability that the equipment will breakdown or experience deterioration in performance in the specified interval. The preventive work undertaken may include equipment lubrication, cleaning, parts replacement, tightening, and adjustment. The production equipment may also be inspected for signs of deterioration during preventive maintenance work.

Predictive maintenance

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

Corrective maintenance

This is a system in which the concept to prevent equipment failures is further expanded to be applied to the improvement of equipment so that the equipment failure can be eliminated (improving the reliability) and the equipment can be easily maintained (improving equipment maintainability). The primary difference between corrective and preventive maintenance is that a problem must exist before corrective actions are taken. The purpose of corrective maintenance is improving equipment reliability, maintainability, and safety, design weaknesses (material, shapes); existing equipment undergoes structural reform, to reduce deterioration and failures, and to aim at maintenance-free equipment.

Emergency maintenance

Emergency maintenance is that work which is required to be performed without delay due to a failure of a component which, if not implemented, would lead to further failures or even permanent damage, resulting in the total loss of the plant and equipment. Plant and equipment in such a condition may also be dangerous to personnel.

When carrying out maintenance activities remember:

- Turn the equipment off and disconnect from the electricity before starting work
- Do not put your head and hands into moving machinery
- Replace the safety guards are cleaning
- Only work on tasks and machinery that you are authorized to work on
- Account for all equipment on completion of the job.

Self-Check – 3	Written test

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

Short Answer Questions

1. List degumming process equipment?(4pts)
2. List types of maintenance?(5pts)

Note: **Satisfactory rating – 9 points** **Unsatisfactory - below 9 points**

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

Score = _____

Rating: _____

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

Answer sheet

1._____

_____

Information Sheet 4- Entering production/process parameters

4.1. Entering processing/operating process

Edible crude oil degumming process processer must have the ability to plan, organize, prioritize, calculate and handle pressure. The individual must possess reading, writing and communication skills. In addition, the individual must have personal and professional hygiene. The primary objective of degumming crude oil is to recover the phospholipids to make lecithin. During degumming of edible crude oil, enterprise work procedures describe how to do the various degumming of the crude oil (reduce the phospholipids content in the crude oil before refining) tasks should be based on degumming parameters (quality, flavor, phosphorus content, level of FFA, impurities, color and etc). In most large processing area the procedures are documented to ensure that all operators know what to do and that work is done using the correct procedures. Your supervisor or line manager will be able to provide advice and guidance about the procedures to use and your role will be organizing activities and ensuring that all the enterprise work procedures are followed correctly by yourself and your supervisor.

The requirements of the client and the target market will determine the standards to be used for various degumming process, e.g**.** quality of raw materials, produce accepted and type of processing to be used. For some markets these requirements may be defined in Law but for others buyer preference dictates the price and raw material producer respond to their requirements to secure good price. For contract sales, client requirements will be listed in the contract. In a large processing area the owner of manager will meet with the buyers and the processer manager will be informed of the standards to be used for produce processing. These requirements will then be explained to all supervisors and quality assurance staff involved and this team will be responsible to explain to workers and ensure that the required standards are achieved.

Self-Check – 4	Written test

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

Short Answer Questions

1. List the parameters considered during degumming process?(3pts)

Note: **Satisfactory rating - 3 points** **Unsatisfactory – below 3 points**

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

Score = _____

Rating: _____

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

Answer sheet

1._____

_____

Information Sheet 5- Checking and adjusting degumming equipment performance

5.1. Checking degumming equipment and machinery

The checking of degumming equipment parts such as valves, control , rotors, float, thermostatic, flow meter, pumps, centrifugal separators, mixer and heat exchanger and etc is important to identify whether the equipment can be operated, adjusted and maintained safely with any deterioration detected and remedied before it results in a health and safety risk. Inspection and checking is necessary for any equipment where significant risks to health and safety may arise from incorrect installation, reinstallation, deterioration or any other circumstances. The need for inspection and inspection frequencies should be determined through risk assessment.

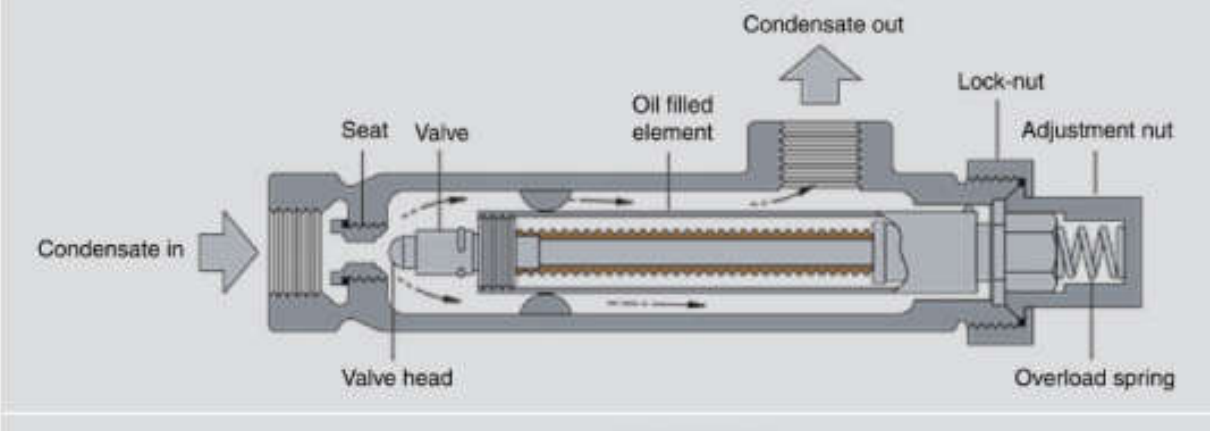

Figure 5.1. Thermodynamic parts

The importance of checking equipment and machinery is important to;

- Perform degumming operation without any interruption
- Separating functional & un functional equipment
- Repaired & maintenance
- Care for environmental condition
- Disposing or sale out of depreciated/ retied equipment
- Know loss equipment
- Separate well cleaned & un-cleaned tools
- Maintain personnel health and safety.
- For kaizen application

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: EO = E/O × 100% (10.1) 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).

5.3. Adjusting degumming equipment and machinery

Adjustments; 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, flow meter, pumps, centrifugal separators, mixer, chemical addition system and heat exchanger and etc.) 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.

Self-Check – 5	Written test

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

Short Answer Questions

1. List the importance of checking degumming equipment?(3)

2. Define operational efficiency of equipment?(2)

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

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

Score = _____

Rating: _____

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

Answer sheet

1._____

2. _____

Information Sheet 6- Carrying out pre-start checks

6.1. Pre-start checks of equipment and machine

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, confirming availability of space, selecting appropriate settings and/or related parameters, cancelling isolation or lock outs as required, confirming that equipment is clean and correctly configured for degumming process 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 equipment before you start a day work happens in three stages.

- Visual inspections of important features prior to starting the equipment
- Visual & function tests while the equipment is turned on
- Testing the equipment's functions during a short drive

Check all equipment before use;

- All equipment functional
- Are all free from any contaminants
- Equipment which needs maintenance
- Equipment function coincides with the given task
- Then check and report to your supervisor the condition of these equipment.

After reporting the condition of equipment, your supervisor will guide you what to do if there is problem of equipment to perform this particular processing.

Self-Check – 6	Written test

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

Short Answer Questions

1. List the three stage of pre-start check on your equipment or machine before you start a work?(3)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

Score = _____

Rating: _____

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

Answer sheet

1._____

_____

LG #27	LO #2- Operate and monitor the degumming process

Instruction sheet

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

- Starting and operating the operation process
- Monitoring operation of equipment
- Identifying variation in equipment operation and reporting maintenance requirements
- Workplace information
- Monitoring the process to confirm the product meets company policy and procedure
- Identifying, rectifying and/or reporting out-of-specification product/process outcome
- Legislative requirement for degumming process
- Maintaining work area to housekeeping standards.
- Conducting work with environmental guidelines
- Maintaining workplace records

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Start and operate the operation process
- Monitor operation of equipment
- Identify variation in equipment operation and reporting maintenance requirements
- Workplace information
- Monitor the process to confirm the product meets company policy and procedure
- Identify, rectify and/or report out-of-specification product/process outcome

- Legislative requirement for degumming process
- Maintain work area to housekeeping standards.
- Conduct work with environmental guidelines
- Maintain workplace records

Learning Instructions:

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

Information Sheet 1- Starting and operating the degumming process

1. Introduction

Phospholipids (also referred to as phosphatides) are essential components of vegetable cell structure. The phospholipids are commonly referred to as gum. These compounds, being oil soluble, get extracted from the seeds along with the crude oil and they remain in the crude oil. In the oil processing industry, the phospholipids content in the oil is expressed in terms of parts per million of phosphorus. This is because there is a relationship between the phospholipids content and the corresponding phosphorus level in the oil.

Crude oil is degummed to reduce the phosphorus content of the oil to a verylow level beca use the phosphorus content of the oil has a profound influence inthe flavor, color, and hyd rolytic and oxidative stability of the refined, bleached,and deodorized oil, as well as it caus reduced refining yield. Several processrelated issues are experienced when the oil contains high phosphorus in the finished oil.

Crude oil has to be degummed before storage or shipment for several reasons:

- It deposits or settles to the bottom of the storage tank, which reduces refining yield if the crude oil is stored for long without mechanical agitation.
- It deposits at the bottom of the shipping container, increasing the oil loss.
- Increases the refining loss.

The oil after initial degumming must be further treated to reduce the phospholipids (or phosphorus) to a much lower level otherwise numerous process and oil quality issues are encountered, as follows:

- The refined oil may have less than satisfactory quality and performance.
- Increases bleaching clay consumption.
- Deactivates bleaching clay, hydrogenation catalyst, interesterification catalyst, and enzymes for degumming and interesterification.
- Creates impurities in the hydrogenation reaction.

- Prematurely plugs the filters in bleaching, hydrogenation catalyst removal, and filter to remove waxes in winterization.
- Flavor regression in soybean oil.

Table1.1. Typical phospholipid and phosphorus content of most common vegetable oil

Oil type	Phospholipids content (%)	Phosphorus content (ppm)
Crude soybean oil	1–3	400–1200
Degummed soybean	0.32–0.64	79–158
Crude corn oil	0.7–2.0	250–800
Crude cottonseed oil	1.0–2.5	400–1000
Crude peanut (ground-nut) oil	0.3–0.7	100–300
Crude canola oil	0.5–3.5	200–1400
Superdegummed canola oil	0.13–0.16	52–64
Crude sunflower oil	0.5–1.3	200–500
Crude safflower oil	0.4–0.6	160–240
Crude palm oil	0.03–0.1	12–40
Crude coconut oil	0.02–0.05	8–20

1.2. Purpose of degumming

Crude oil is degummed for various reasons. Crude oil is water degummed to recover the phospholipids to manufacture lecithin. Canola oil is degummed as a general practice because the oil is sold as degummed or superdegummed crude oil. The gum recovered from canola oil is dark and does not have the same commercial value as the soy lecithin. It is used primarily in the animal feed. Sunflower oil is water degummed to make sunflower oil lecithin, which is less versatile in use compared to the soy lecithin. Corn oil, made from wet-milling process, is degummed to deliver higher quality crude oil that is easy to refine.

Discharge of plant effluents from the seed oil degumming process needed to be curbed when strict environmental regulations were imposed on in many countries. This forced the oil processors to look into refining methods other than chemical refining to reduce plant effluents that increased the biological oxygen demand (BOD) and chemical oxygen demand (COD) loadings in the plant discharge. Besides water degumming, various acid degumming processes evolved for treating crude oils that are either more difficult to refine or the phosphorus content in the oil had to be reduced to a very low level so physical refining process could be applied to these oils. Some experts claim that crude soybean can be refined through the physical refining process if the total phosphorus content of the oil is reduced to 15 ppm or less.

1.3. Hydratable phospholipids and nonhydratable phospholipids

Phospholipids in the crude oil can be broadly classified into two categories based on their removability with water and are called

- Hydratable phopholipids (HPS) and
- Non-hydratable phospholipids (NHPS).

The HPs can be separated from the crude oil by treating the crude oil with water. The water hydrates the HPs and forms a heavy phase, which is then separated from the oil with the help of a centrifuge. The NHPs require further treatment with acids, like phosphoric acid, citric acid, maleic acid, citric anhydride, etc. The acid reacts with the metal complex of the NHPs and makes them water soluble, so they can be removed from the crude oil using a centrifuge. Normally, the gums removed by the acid process cannot be used for making lecithin because of its very dark color. It is usually blended into the animal feed or can be used for industrial applications other than food manufacturing. Degummed oil produces lower amount of soap in the refining process. This reduces the load on the soap acidulation plant. This reduces the biological oxygen demand and chemical oxygen demand in the plant effluent as compared to that from the plant processing nondegummed crude oils. Cottonseed oil is mostly processed through micelle-refining process. This generates less soap in the oil refinery.

1.4. Methods for degumming

Various degumming processes are used in the vegetable oil industry.

They are:

1. **Water degumming**
2. **Acid conditioning**
3. **Acid degumming**
4. **Deep degumming**
    a. Superdegumming
    b. Combined superdegumming and neutralization
    c. TOP degumming (total degumming)
    d. Organic refining process (ORP)
    e. Soft degumming
5. **Enzymatic degumming**

1.4.1. Water Degumming

Hydratable phospholipids (HPs) absorb water and settle out from the rest of the oil. This property of the HPs is utilized in the water degumming process. Water degumming removes most of the HPs from the crude oil. A very small amount of NHP lipid is also removed as they get entrained in the HP fraction in this process. The hydratable gum from the crude oil is easily separated from the crude oil when it is fresh and especially when made from good quality soybeans using proper seed crushing and extraction process. Crude oil derived from poor quality soybeans contains higher proportion of NHPs. The oil in this case needs acid degumming or acid pretreatment for better reduction of phospholipids before the crude oil can be refined.

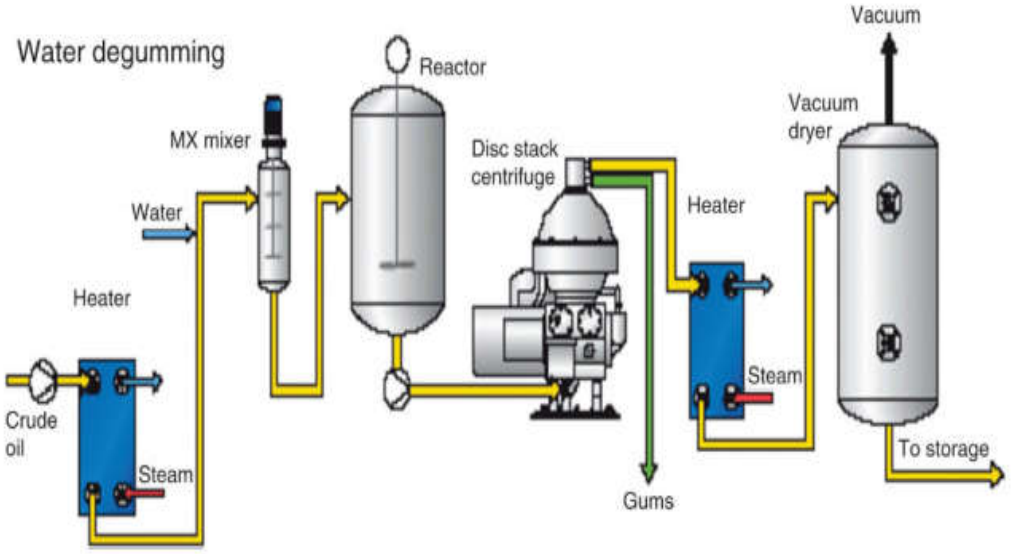

Figure 1.1. Schematic diagram for water degumming process

1.4.1.1. Critical control points in water degumming

The critical control points in water degumming are:

- Oil temperature
- Amount of deionized water
- Residence time in the hydration tank
- Agitation in the hydration tank
- Vacuum drying of oil
- Vacuum drying of the gums

1.4.1.2. Oil temperature

Temperature of oil at hydration is critical. At temperature less than 130°F (55°C) before the degree of hydration is better but the viscosity of the oil is higher which makes the separation of oil and gum difficult. Less hydration of the phospholipids occurs at temperature above 149°F (65°C). This reduces the efficiency of gum removal and higher phosphorus is found in the degummed oil. So the oil temperature should be: 75 - 90 °C

Hydration time: with static mixers 20 - 30 minutes with high shear mixing not required but recommended to increase the yield.

1.4.1.3. Amount of deionized water

The amount of water is normally equal to that of the total phospholipids content of the crude oil in percent. At lower water addition, the hydration of the phospholipids is incomplete, causing a reduction in the removal of the phospholipids. At higher water addition, the difference of density between the oil and the gum is reduced, causing poor separation in the centrifuge. This may leave more phospholipids in the oil and also increased oil loss in the gum phase.

1.4.1.4. Residence time (contact time) in the hydration tank

A certain minimum amount of contact time is necessary for the hydration of the phospholipids in the crude oil. Lower than 30 min of contact time may not allow sufficient hydration of the HPs. This reduces the efficiency of separation of the oil and the gum. A longer than 40 min contact time is not harmful but is not required. Besides, a longer contact time requires a larger hydration tank that makes the process more costly.

1.4.1.5. Agitation in the hydration tank

The agitation in the tank must be gentle to prevent any emulsion formation. Any amount of emulsion in the hydration tank will reduce separation efficiency of the process.

1.4.1.6. Vacuum drying of the Oil

The oil must be dried if it is to be stored. The moisture in the vacuum-dried oil should be less 0.05% and not greater than 0.1%. The oil does not have to be dried if it is sent immediately for bleaching before chemical refining or for physical refining. Storing wet oil can cause the following issues:

- The gum in the oil can hydrate and cause hydrolysis of the neutral oil. This will increase the FFA in the crude oil in storage.
- The hydration of the gum can increase the refining loss.

1.4.1.7. Vacuum drying of the gum

The gum goes through several steps before it becomes lecithin. It is dried to < 0.1% moisture. Crude lecithin contains 65%–70% oil. Higher moisture in the lecithin makes the lecithin very viscous and unacceptable in most applications. In addition, high moisture can produce higher FFA in the lecithin during storage.

1.4.1.8. Target water-degummed oil quality

- Phosphorus content 50–200 ppm (max)
- Moisture < 0.1% (after vac. drying)

1.4.1.9 Target quality of dried Lecithin

- Acetone insoluble (AI) 70%; (minimum)---65%

1.4.2 Acid Conditioning

This method is generally used to treat high quality palm oil and coconut oil. This is quite a very simple method but it has its limitations. The oil is treated with 400–1000 ppm of phosphoric acid using a high shear mixer. The oil is then directly sent to bleaching for physical refining.

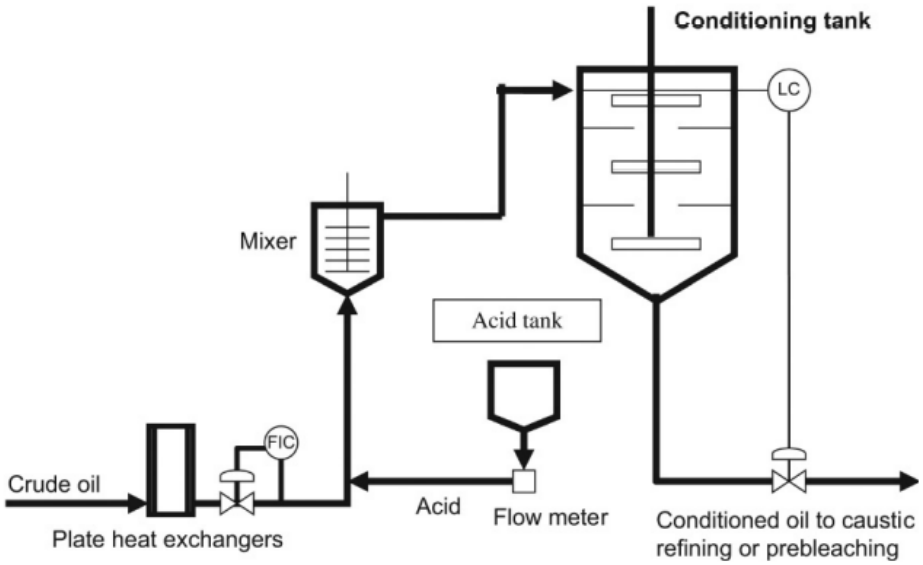

Figure 1.2. Schematic flow diagram for acid-conditioning process.

1.4.3. Acid Degumming

The acid degumming process can be considered as an alternative to the water degumming process in that it uses a degumming acid combined with water. Crude oil, either water degummed or not, is treated by an acid, usually phosphoric acid, citric acid or malic acid in the presence of water. For oils containing relatively low amounts of NHP (e.g. sunflower oil) this process can lead to degummed oil with a lower residual phosphorus content (5 to 30 ppm) than water degumming. The acid degummed oil is then dry degummed and physically refined. In the acid degumming process, phosphoric acid forms a precipitate or citric acid forms a complex with calcium and magnesium and then the acid is diluted with water. Such a dilution does not raise the pH sufficiently for the dissociation of PA so that the residual phosphorus content remains still high and then it requires post-treatment, a dry degumming step for physical refining. Acid degumming provides more complete removal of phospholipids from the crude oil. This method is especially used to treat seed oils like corn and cottonseed oils and oils that are difficult to refine because of damaged seeds or because the crude oil is old or has been heat abused or oxidized. Degumming of oil works best in this process when water-degummed oil is used as the feed stock instead of crude oil. This is an improvement over the acid-conditioning process.

- Oil temperature: 75°C – 90 °C
- Acid addition: 0,1 - 0,3 % w/w phosphoric or citric acid
- Mixing: high shear mixing
- Retention time: min. 5 minutes
- Water addition: 2 - 3 % vol.
- Mixing: dynamic mixer

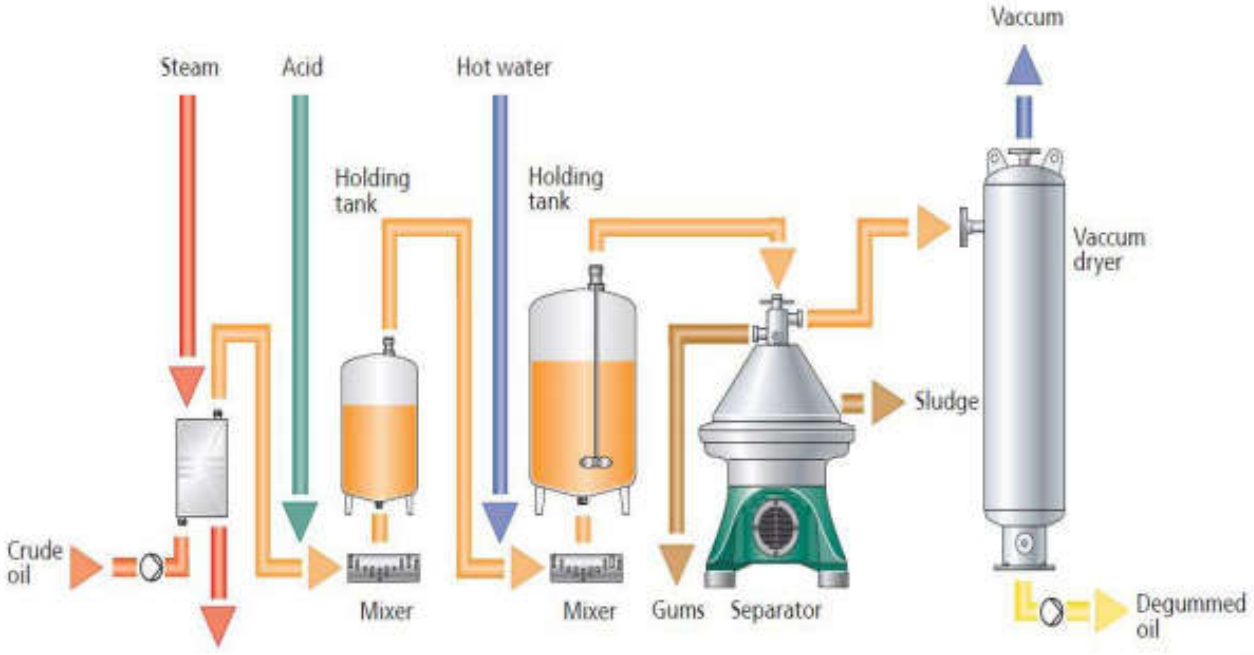

Figure 1.3. Schematic flow diagram for acid-degumming process.

Critical control points

The critical control points for this process are the same as described under water degumming and acid-conditioning processes.

Target acid degummed oil quality

Phosphorus content 20–50 ppm (max.)

Moisture <0.1% (after vac. drying).

Oil content in gums:

Measured as acetone insoluble (A.I.= phospholipids)

- A.I. variations: 65 – 72 %

1.4.4. Deep Degumming

Several degumming processes that are capable of reducing the phosphorus content of the degummed oil to 5–10 ppm are called deep degumming process.

These are:

1. Superdegumming (Unilever)
2. Superdegumming (Alfa Laval)
3. Combined superdegumming and neutralization (Alfa Laval)
4. TOP degumming
5. Organic refining process
6. Soft degumming

In the deep degumming process, acids like phosphoric acid or citric acid is used to make the acid react with the metal (calcium, magnesium, iron) of the NHPs. Chemically, this process is also referred to as chelation of the metals. These complex compounds between the acid and the NHP then become hydratable and are removed from the rest of the oil.

1.4.4.1. Superdegumming (Unilever Process)

This process was developed by Unilever to process crude oil for physical refining and also treating other seed oils that are hard to refine. This is also known as the “special degumming” process. This process works better on crude oil as compared to water-degummed oil. It is believed that the HPs help the separation of the NHPs by agglomerating them, making it easy to remove them in a centrifuge.

In super degumming process, oil is heated to 70°C with citric acid and for some specific cases with modified lecithin, reacted for 5–15 min, cooled to 25°C, mixed with water, and held in a vessel for 3 h for formation of liquid crystals of phosphatides. The oil is then again heated to 65°C, and gums are separated by centrifugation. The super-degumming process leads to lower residual phosphorous than standard acid degumming, but these levels are quite dependent on crude oil quality.

Critical control points in superdegumming process

The critical control points for the superdegumming process are:

1. Oil temperature.
2. Retention time in the conditioning tank.

3. Retention time in the hydration tank.
4. Addition of flocculant.
5. Self-cleaning centrifuge.
6. Oil flow rate (reduced). Items 1–3 are similar to those in the acid-conditioning process.

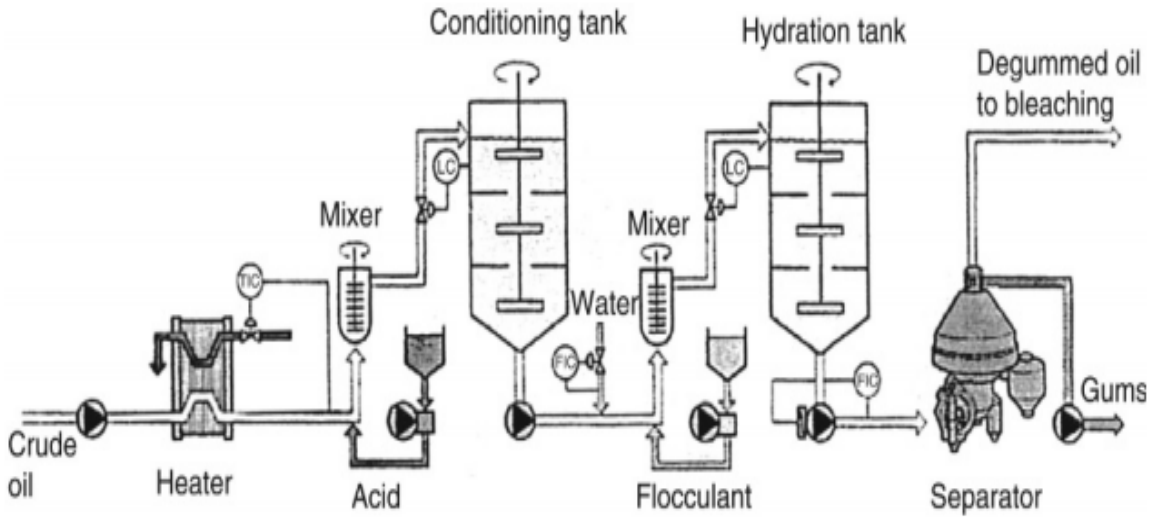

Figure 1.4. Flow schematic diagram for superdegumming process (Unilever)

1.4.4.2. TOP degumming

This process is sometimes referred to as total degumming process. This process was developed and patented by Dijkstra and Van Opstal for water degummed oil. An acid (0.4-2.0 wt.%) was added to previously water-degummed oil and was dispersed with a high shear mixer, producing 100 million droplets of aqueous acid per gram of oil. It was claimed that the acid is added to decompose the NHPs present in the oil.

- Oil temperatures: 90 - 105 °C
- Acid addition: 0,1 - 0,3 % w/w phosphoric or citric acid
- Mixing high shear mixer
- Acid retention time: 3 minutes
- Caustic soda addition: partial neutralization of acid, not FFA
- Gums separation: by standard refining separator

- Wash water addition: 3 % vol.
- Water retention time: 3 minutes
- Water separation: by high speed nozzle separator
- Recycling: water, fine gums, oil to the first separator

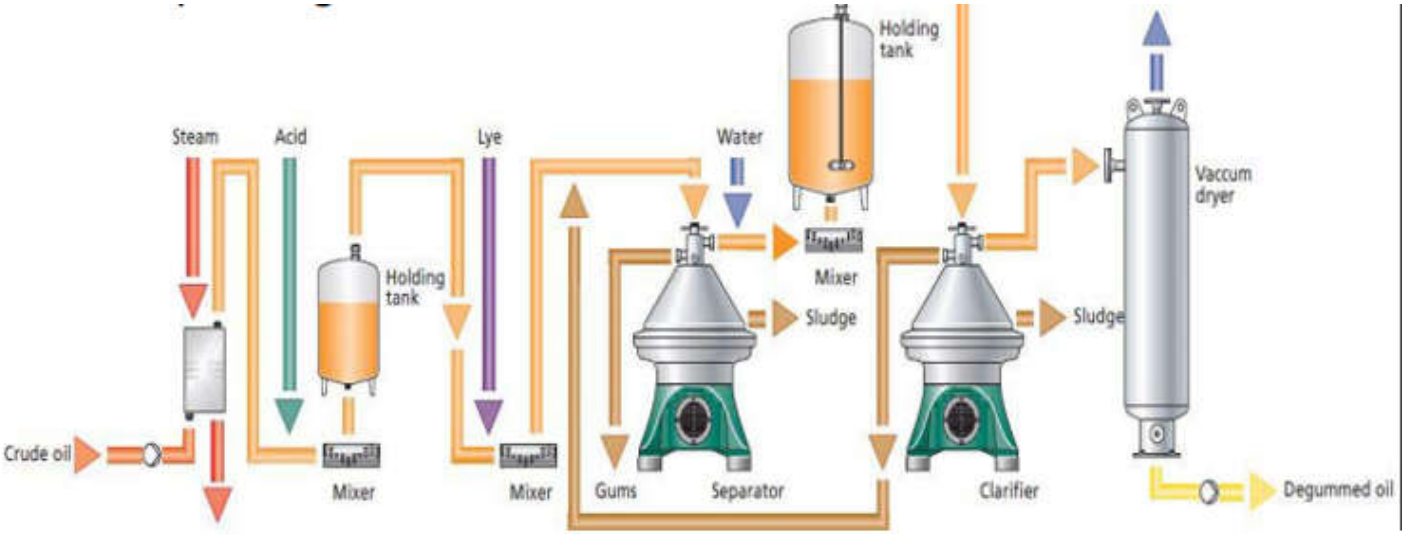

Figure 1.5. Flow schematic diagram for top degumming process

1.4.4.3. Soft degumming

In this process, the water-degummed or nondegummed oil is treated with a water-soluble chelating agent, ethylenediaminetetraacetic acid (EDTA). Soft degumming process works on the following principles when water degummed or nondegummed oil is treated with an aqueous solution of EDTA or its salts:

- EDTA forms complexes with the metals present either in the calcium, magnesium, or iron salt of the phosphatidic acid or those of phosphatidylethanolamine.
  - These EDTA/metal complexes are very stable compounds and are water-soluble. Therefore, a very effective high shear mixer is needed to bring the water and the oil phase to be in intimate contact to solubilize the metal complexes of the EDTA in a high-speed homogenizer.
  - An emulsifier, sodium dodecyl sulfate (SDS), is used to improve the solubility of the aqueous and the oil phases for the extraction of the metal complexes into the aqueous phase.

- Sometimes HPs are used as emulsifier in this process.

1.4.5. Enzymatic Degumming

Enzymatic degumming process has gained popularity because it can provide higher oil yield. The increased yield comes from:

- Increased yield of diglycerides (DAG).
- Reduced neutral oil loss in the gums.
- Reduced oil loss in the refining process.
- Oil content in the meal is reduced (for feed).

This increases the protein value of the meal that brings higher revenue. Specific phospholipase enzymes are selected to simply cleave the bonds between the glycerol backbone and those of the FA and the phosphate ester represents the concept showing the enzyme degumming process. Lecitase PLA1 is selective to all phospholipids. The process produces high level of FFA by cleaving the FA in the position 1 of the glycerol backbone of the phospholipids and releases lysophospholipid. The FFA remains in the oil phase while the latter is discharged along with the heavy phase in the centrifuge. Purifine PLA2 is selective to PC, PE, and PA. It cleaves the FA from position 2 of the glycerol backbone and the end products are FFA and lysophospholipid. Currently used phospholipase enzymes for degumming. The basic premise of enzyme degumming is based on the following critical steps:

1. Converting the PL micelle with citric acid with the help of high shear mixing. This forms reverse micelle.

2. Enzymatic hydrolysis of the reverse micelle by addition of water, high shear mixing and using small amount of caustic, if needed, and followed.

Table 1.2. Currently used commercial phospholipase enzymes

Phos-pholipase category	Commercial names	Manufac-turer	Effective on phospho-lipids	End products
PLA 1	Lecitase Ultra Lecitase NOVO A-PLA	Novozymes Novozymes Novozymes	All	FFA and lyso-phospholipids
PLA 2	Rohalase PL-Xtra	AB Enzymes	All	FFA and lyso-phospholipids
	LysoMax	Danisco	All	
	Purifine PLA_2	DSM	All	FFA and lyso-phospholipids
	Gumzyme	DSM	PA and PE	FFA and lyso-phospholipids
PLC	Purifine PLC (1G)	DSM	PC and PE	DAG and phos-phate esters
	Purifine PLC (2G)	DSM	PC, PE, and PA	DAG and FFA
	Purifine PLC (3G)	DSM	All	DAG and FFA

Key: DAG: Diacylglycerol; PA: Phosphatidic acid; PC: phosphatidylcholine; PE: phosphatidylethanolamine; PI: phosphatidylinositol; SDS: Sodium dodecyl sulfate; G:generation;PL:phospholipase.

- Oil temperature: 70 – 75 °C
- Acid addition: 0,04 – 0,1 % w/w citric acid
- Acid retention time: 10 minutes
- Oil temperature: cooling to 55 °C
- Caustic soda addition: to adjust pH 4.5 – 7 (depending on enzyme)
- Enzyme addition: approx. 30 - 100 g/t (depending on enzyme)
- Water addition: corresponding to phosphatides content
- Hydration time: 2 – 6 hours
- Oil temperature: heating to 70 °C for separation.

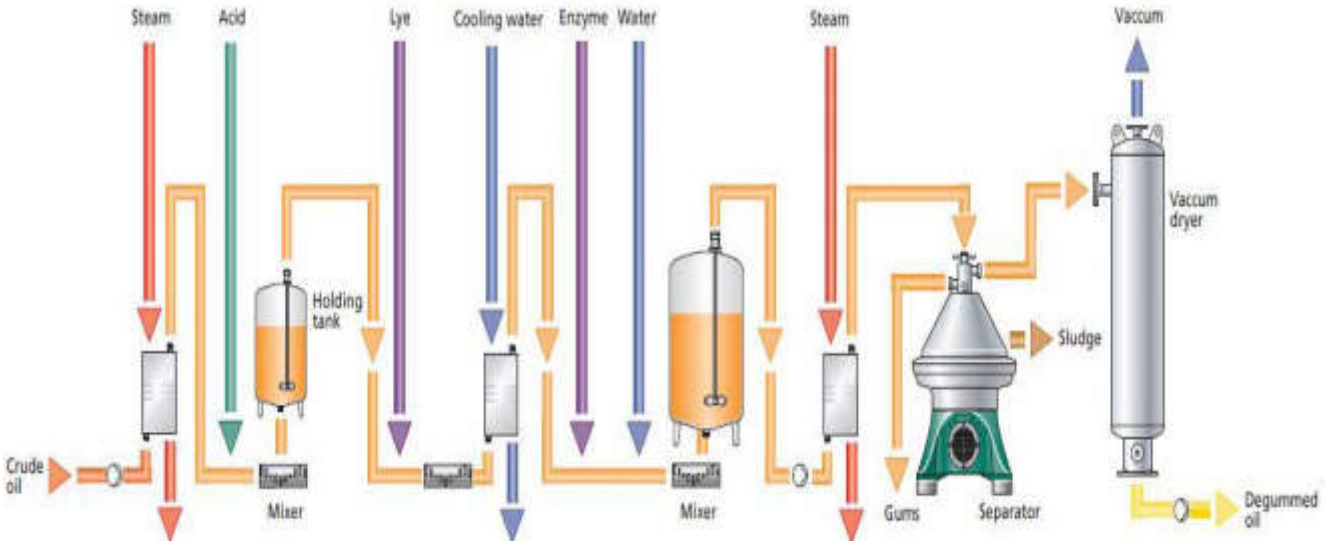

Figure 1.6. Flow schematic diagram for enzymatic degumming process

1.5. Degumming principle

Two principal degumming methods are employed: batch and continuous. Degumming can be achieved in a batch or continuous fashion.

1.5.1. Batch degumming

In batch degumming, soft water at the same percentage as total phospholipid is added to oil heated to 70C and mixed thoroughly for 30–60 min, followed by settling or centrifuging.

- Main advantages:
  - ✓ short product changeover time;
  - ✓ 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 lines for high capacity (space requirement).

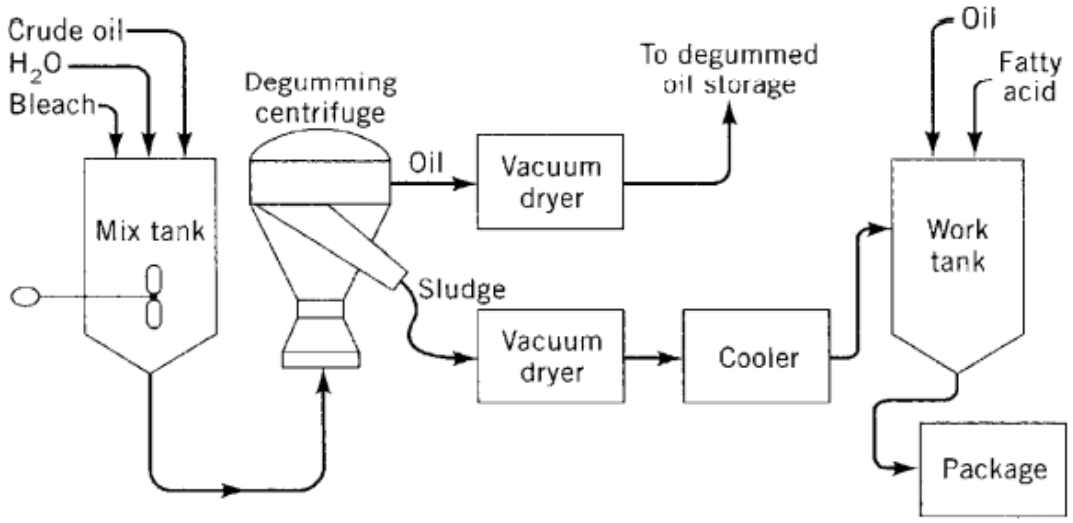

Figure 1.6. Batch degumming system for lecithin production

1.5.2. Continuous degumming

In continuous water degumming, heated oil is mixed with water by an in-line proportioning and mixing system and the mixture is held in a retention vessel for 15–30 min before centrifugation. The phosphorus content is typically lowered to 12–170 ppm. A well-degummed oil should contain less than 50 ppm of phosphorus, which is well below the 200 ppm level specified in the National Oilseed Processors Association trading rules for crude degummed soybean oil.

Degumming for physical refining, as opposed to alkali refining of soybean oil, requires more complete removal of the phospholipids to prevent darkening during fatty acid distillation. For more complete phospholipid removal, several modified degumming methods can be employed.

- Main advantages:
  - ✓ suited for high-capacity lines (low space requirement);

- ✓ input/output heat recovery;
- ✓ simple automation and control;
- ✓ low manning level.

- Main disadvantages:
  - ✓ long product changeover time;
  - ✓ complex and costly maintenance;
  - ✓ high electrical energy consumption.

Due to economic constraints, only small or specialized refineries will operate mainly with batch equipment (batch size: 5–20 tones). Fully continuous plants are used for large runs of the same products: continuous refining of seed oils on the same site as the seed oil extraction plant, for example. Product changeover in a continuous plant means a loss of production time; this loss depends on the average residence time of the oil in the equipment (oil content divided by capacity) and the product intermixing specifications.

In continuous systems, preheated crude oil (80^0C) and water are metered into an in-dwell pipeline agitator, or a large agitated tank, and held only for a short period. In both systems, the oil is then pumped to a centrifuge for separation of the lecithin sludge from the oil. Water with a low concentration of calcium and magnesium is preferred.

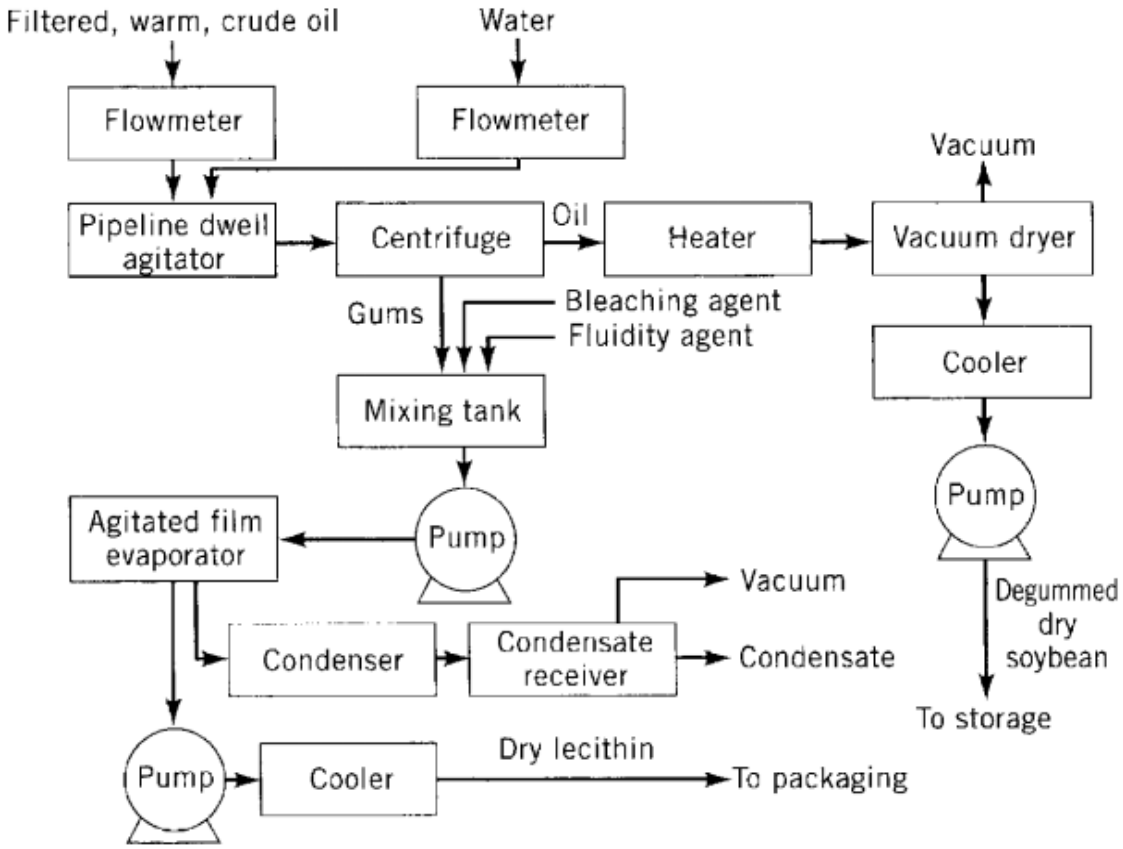

Figure 1.7. Continuous degumming system for lecithin production

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 choose the best answer among the given alternatives(4pts)

1. The degumming process provide higher oil yield.
   A. Acid degumming B. Soft degumming C. Water degumming D. all
2. ---- sometimes referred to as total degumming process;
   A. Top degumming B. Superdegumming (Unilever)
   C. Water degumming D. Superdegumming (Alfa Laval)

Test II Short Answer Questions

1. List type of degumming methods? (5pts)
2. Which degumming method provide higher oil yield? (2pts)
3. Write advantage and disadvantage of continuous degumming?(2pts)

Note: Satisfactory rating - 13 points Unsatisfactory - below 13 points

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

Score = _____

Rating: _____

Answer sheet

Test I

1._____

2. _____

Test II

1._____

2. _____

3. _____

Information Sheet 2- Monitoring operation of equipment

2.1. Monitoring operation equipment

Monitoring operation of equipment is a systematic process of observing, tracking, measuring, and testing the efficient performance of equipment use for degumming process. Information gathered through monitoring is used to analyze, evaluate the all of the equipment and equipment components in order to measure its effectiveness and to adjust it where necessary.

Equipment should not have pits, cracks, corrosion, crevices, recesses, open seams, gaps, lap seams, protruding ledges, inside threads, bolt rivets, or dead ends. Hollow areas of equipment as well as cracks and crevices should be eliminated whenever possible or permanently sealed. Items such as bolts, studs, mounting plates and brackets should be continuously welded to the surface and not attached via drilled and tapped holes. Push buttons, valve handles, switches and touch screens should be designed to ensure product and other residues (including liquid) do not penetrate or accumulate in or on the enclosure or interface. Equipment should be installed so as to allow access for cleaning and to minimize transfer of dust particles to other pieces of equipment or to the environment. The risk of contamination from equipment should be assessed and controlled.

Self-Check – 2		Written test

Name…… ID…… Date…….

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

Write true if the statement is correct and false if the statement is incorrect

1. The risk of contamination from equipment should be assessed and controlled.(3pts)

2. Hollow areas of the equipment as well as cracks and crevices should be eliminated whenever possible or permanently sealed. (3pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

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

Score = _____

Rating: _____

Answer sheet

1._____

2. _____

Information Sheet 3- Identifying variation in equipment operation and reporting maintenance requirements

3.1. Identifying variation in operation of equipment

Degumming processes have many factors that influence their success, and in each, the possibility of variation is introduced. The specific types of variation depend on what is being processed for example and adhesive is affected by factors unlike those that affect a machine. In general, however, the outcome-specific factors fit into five major areas.

3.1.1. Variation due to raw materials

All the processes begin with raw materials, whether it's from the ground or the end result of previous manufacturing processes. If the raw materials change, that change can create variations in the overall process. There might be a difference in quality from the same supplier, which may fall within the specified limits but is still enough to cause variation in the next process, or material from a different supplier may not be identical to the one from the first supplier.

3.1.2. Variation due to equipment

Whether a manufacturing process uses simple or complex equipment, changes in the equipment can cause variation. Variations occur with the use of more than one piece of equipment to complete the same task because even two pieces of equipment bought at the same time from the same company will not always behave exactly the same over time. Variations are also introduced in the performance of an individual piece of equipment, which can begin to break down or drift from the calibration point.

3.1.3. Variation due to human actions

Even with the best controls, an individual operator can have a bad day and introduce variations from one day to the next. Two different operators trained in the same way might have slightly different actions or criteria for decision making, which causes variation. Not all variation caused by human action can be considered human error, although that possibility also exists.

1.3.4. Variation due to environment

Changes in temperature and humidity affect various processes and some edible oil and fat processes require a clean room environment and the introduction of particles from outside the clean room can cause variation. Changes in the environment have the ability to trigger changes in raw materials, equipment and human action, even if the environmental changes do not directly affect the manufacturing process.

1.3.5. Variation due to method

Edible oil and fat process is defined by a series of steps. Variation can be introduced if the time between the executions of the steps changes, the order of the steps changes, one is missed or a change is made in carrying out the step for example, if the step says to heat to a certain temperature but a different one is selected. Some variations in method can be tracked to variations in human action, but others may be approved alternatives.

3.2. Reporting variation of equipment

If crude oil degumming equipment or machine loose rapidly speedy of operation, high accuracy of positioning, high structural rigidity, flexibility of operation, user friendliness and safety, you should report to your supervisor or manufacturer to maintaining according to manufacturer guiling. Each piece of equipment/machine which required maintenance should have reported to the concerned person/supervisor/manufacturer.

Table 1.2. Equipment variation reporting format

Date: Period of Report:							
S. No.	Machine/ Equipment/part Name	Location	Nature of Variation	Details of repairs carried out	Breakdown period	Work done by	Remarks

Self-Check – 3	Written test

Name…… ID……. Date…….

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

Short Answer Questions

1. List the five cause of variation? (5pts)

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

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

Score = _____

Rating: _____

Answer sheet

1._____

_____

Information Sheet 4- Workplace information

4.1. Work place information

In edible oil and fat processing, accurate records about workplace by employers /workers will give the information of the degumming operation. Different formats shall use to record for each information during crude oil degumming process. Checklists prepared to guide the recording process. Workplace information including the following points:-

- Standard operating procedures (sops)
- Specifications
- Production schedules
- Manufacturers' advice and standard forms and reports

4.1.1. Standard Operating Procedures (SOPs)

Operating standards should fulfill the first requisite of good-quality management: All operations performed and the quality requirements expected for each operation should be clearly defined and successfully communicated to all levels of management and operating personnel. Control is the main objective of the operating standards, but these standards also serve other purposes as well:

- A basis for product costing,
- A continuous record of products and process improvements,
- A record of changes with specific reasons for the changes, and
- The basis for product and process audits, among others.

Operating standards must cover all of the operational, technical, quality, and special requirements necessary to produce the desired product in the simplest, but most complete, format possible. Standard operating procedures are a set of written instructions that document a routine or repetitive activity followed by an organization. The development and use of SOPs are an integral part of a successful quality system as it provides individuals with the information 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. A standard operating procedure, in fact, defines expected practices in all businesses.

4.1.2. 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. Thus, specifications define the performance and test requirements that must be demonstrated to confirm functional compliance with a customer’s requirements. Properly designed specifications require logical thinking and program planning to produce simple, explicit, easily understood, complete instructions. 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.

4.1.3. Production scheduling

Production schedule defines what products should be produced and what products should be consumed at each point in time over a short period; hence, it defines which

run-mode to use and when to perform change overs to meet the market needs and to satisfy the demand. During degumming, a product sample is typically analyzed to ensure quality control. Various additives may be employed to increase product performance and other characteristics.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. Define production schedule? (3pts)

2. Define and discus specifications? (3pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

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

Score = _____

Rating: _____

Answer sheet

1._____

2._____

Information Sheet 5- Monitoring the process to confirm the product meets company policy and procedure

5.1. Monitoring degumming process

Monitoring is a process of determining how well our plans are being implemented. You cannot monitor something if you do not have a plan or basic structure of how something should be done, or a defined goal or target. Work operations refer to the work itself and includes systems and procedures, staff performance, and levels of service in the workplace. Many primary processing operations require skilled operators and a multi-disciplinary team to complete all the necessary operations efficiently and on time. Monitoring all degumming process are important, errors in early stages build up, becoming larger problems later, which cannot usually be corrected. Careful attention to all processing stages very beneficial in maintaining quality. Methods used to monitor the degumming process, such as inspecting, measuring and testing as required by the process. Inspection or test points (control points) in the degumming process and the related procedures and recording requirements.

Some essential attributes contributed by fats and oils cannot be directly measured with chemical or physical analytical methods. Formulating and processing for applications testing is the only means for evaluating the ability of the fats or oils product to perform the desired functions in a food product. Actual determinations of the performance qualities of edible fats and oils products are made with small-scale practical tests that evaluate how the product will perform in a finished product. Successful performance tests are designed with standardized conditions and ingredients, with critical formulations being chosen in regard to the property evaluated to highlight small differences in performance.

Performance testing is essential for the development of new products, especially for fats and oils products designed for a specific food product, formulation, or process. After development, physical or chemical analysis can be related to performance results in most situations; however, continuation of certain performance evaluations is necessary

for some products to ensure adequate performance or more timely results in some cases.

In many cases, the performance tests are developed to evaluate the fat or oil ingredient as it would be used by a specific food processor. Fats and oils performance testing is performed by most processors, but the procedures utilized have never been standardized for the industry. Performance testing is an analytical technique similar to other laboratory evaluations. The procedures must be designed to incorporate good laboratory techniques, which include standardization of equipment, ingredients, procedures, results reporting, and control of the environment. Performance results must be reproducible to be of value for comparative purposes. Reproducibility is achieved by controlling variables that can be controlled only by the use of standardized methods. The performance test procedures must be written with adequate detail and followed closely.

Monitoring oil temperature

Temperature of oil at hydration is critical. At temperature less than 130°F (55°C) before the degree of hydration is better but the viscosity of the oil is higher which makes the separation of oil and gum difficult. Less hydration of the phospholipids occurs at temperature above 149°F (65°C). This reduces the efficiency of gum removal and higher phosphorus is found in the degummed oil.

Monitoring amount of deionized water

The amount of water is normally equal to that of the total phospholipids content of the crude oil in percent. At lower water addition, the hydration of the phospholipids is incomplete, causing a reduction in the removal of the phospholipids. At higher water addition, the difference of density between the oil and the gum is reduced, causing poor separation in the centrifuge. This may leave more phospholipids in the oil and also increased oil loss in the gum phase.

Monitoring residence time (contact time) in the hydration tank

A certain minimum amount of contact time is necessary for the hydration of the phospholipids in the crude oil. Lower than 30 min of contact time may not allow

sufficient hydration of the HPs. This reduces the efficiency of separation of the oil and the gum. A longer than 40 min contact time is not harmful but is not required. Besides, a longer contact time requires a larger hydration tank that makes the process more costly.

Monitoring vacuum drying of the oil

The oil must be dried if it is to be stored. The moisture in the vacuum-dried oil should be less 0.05% and not greater than 0.1%. The oil does not have to be dried if it is sent immediately for bleaching before chemical refining or for physical refining. Storing wet oil can cause the following issues:

- The gum in the oil can hydrate and cause hydrolysis of the neutral oil. This will increase the FFA in the crude oil in storage.
- The hydration of the gum can increase the refining loss.

Monitoring vacuum drying of the gum

The gum goes through several steps before it becomes lecithin. It is dried to < 0.1% moisture. Crude lecithin contains 65%–70% oil. Higher moisture in the lecithin makes the lecithin very viscous and unacceptable in most applications. In addition, high moisture can produce higher FFA in the lecithin during storage. During monitoring in water-degummed oil quality; phosphorus content should be 50–200 ppm (max), moisture content should be < 0.1% (after vac. drying), acetone insoluble (AI) 70% (minimum)—65%.

Self-Check – 5	Written test

Name…… ID……. Date…….

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

Write true if the statement is correct and false if the statement is incorrect

1. Inspecting, measuring and testing are the method used to monitor degumming process?(4)

2. Higher moisture in the lecithin makes the lecithin very viscous and unacceptable in most applications?(4)

3. The amount of water is normally equal to that of the total phospholipids content of the crude oil in percent?(4)

Note: Satisfactory rating - 16 points Unsatisfactory - below 16 points

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

Score = _____

Rating:

Answer Sheet

Name: _____ Date: _____

1. _____
2. _____
3. _____

Information Sheet 6- Identifying, rectifying and/or reporting out-of-s pecification product/process outcome

6.1. Identifying and rectifying out-of-specification product/process outcome

The term out of specifications, are defined as those results of in process or finished product testing, which falling out of specified limits. The organization shall establish and maintain documented procedures that specify appropriate actions to identify and eliminate the cause of detected nonconformities, to prevent recurrence, and to bring the process or system back into control after non conformity is encountered. All out-of-specification products must be clearly identified, rectified, and reported to prevent unauthorized release. Identifying, rectifying and reporting of out-of-specification adhere to the following guidelines for control of non-conforming product.

During degumming processing, the temperature and time of conditioning, the moisture content of the raw material, and the yield of oil should be routinely checked. Quality checks on the product include correct color, flavor, odor, clarity and fill weight. Processed oil should be consistent in all aspects such as: colour, taste viscosity, acid value and melting point. In addition, the oil should be free of impurities and meet the demands placed upon it for use in cooking. Before being filled, the bottles that hold the oil are cleaned and electronically inspected for foreign material. To prevent oxidation of the oil (and therefore its tendency to go rancid), the inert (non-reactive) gas nitrogen is used to fill up the space remaining at the top of the bottle.

The, may arise due to deviations in product manufacturing process, errors in testing procedure, or due to malfunctioning of analytical equipment. When an out of specifications has arrived, a root cause analysis has to be performed to investigate the cause for. The reasons for can be classified as assignable and non-assignable. When the limits are not in specified limits called out of specifications. When out of specifications has occurred, the analyst should inform to quality control (QC) manager. Each out of specification will be identified with a unique identification number.

6.2. Reporting out-of-specification product/process outcome

Degummed edible oil call as non-conforming product when they contain more undesirable components (free fatty acids (FFA), phospholipids (gums), oxidized products, metal ions, color pigments, waxes and others) above the recommended range. Clearly label and isolate products so that they are not accidentally released and necessary controls are made and specification limits are achieved. If non-conformance does not affect the use or safety of the product, then corrective action completes the response. If non-conformance affects the safety of the product, recall is initiated with management approval. Determine the corrective action required to eliminate non-conformance of future product, i.e., through re-work or other means. Upon completion, re-check the quality of the product to ensure the elimination of the non-conformance and seek approval for shipment.

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. Processed oil should be consistent in all aspects such as colour, taste viscosity, acid value and melting point.(2pts)

2. To prevent oxidation of the oil (and therefore its tendency to go rancid), the inert (non- reactive) gas nitrogen is used to fill up the space remaining at the top of the bottle. (2pts)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

1. _____
2. _____

Information Sheet 7- Legislative requirement for degumming process

7.1. Legislative requirement

Food safety is the basis of legislative and additional requirements for edible oils. Labeling requirements also deserve special attention, especially for exporters of finished products. An important aspect to control food safety hazards is defining critical control points by implementing food management principles. Another important aspect is subjecting food products to official controls.

7.2. Legislative requirements

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

- The layout of the workplace allows and the workplace is maintained so as to allow, for persons to enter and exit and to move about without risk to health and safety, both under normal working conditions and in an emergency,
- Work areas have space for work to be carried out without risk to health and safety,
- Floors and other surfaces are designed, installed and maintained to allow work to be carried out without risk to health and safety,
- Lighting enables:
  - ✓ Each worker to carry out work without risk to health and safety, and
  - ✓ Persons to move within the workplace without risk to health and safety, and
  - ✓ Safe evacuation in an emergency,
- Ventilation enables workers to carry out work without risk to health and safety,
- Workers carrying out work in extremes of heat or cold are able to carry out work without risk to health and safety,
- Work in relation to or near essential services does not give rise to a risk to the health and safety of persons at the workplace.

Ethiopian food standard code

- mandatory oil seed standards, edible oil standards, labeling
- Weights and measures legislation
- Ethiopian Food and Drug Authority
- Environmental management (Environmental Protection Authority)
- OHS ,anti-discrimination and equal opportunity

7.3. Ethiopian food and drug authority legislation

The country's food safety regulatory system is authorized and mandated in Parliamentary Proclamation Ethiopian Food, Medicine and Healthcare Administration and Control Authority Proclamation No. 661/2009. This legislation provided the legal authorities for the government to consolidate the pre-existing food regulatory system with the aim of better 'protecting the public from health risks emerging out of unsafe and poor quality food. In particular, the Proclamation authorizes the setting of standards and regulations for locally-produced and imported foods, in areas such as production, promotion, storage, packaging and labeling, distribution, and laboratory testing.

In a subsequent Parliamentary Proclamation Ethiopian Food, Medicine and Healthcare Administration and Control Authority Regulation No. 189/2010 – the Food, Medicine, Healthcare and Control Authority (FMHACA) was established, under the purview of the Ministry of Health, as the competent authority responsible for setting and enforcing food safety standards and regulations. Under this proclamation, food is defined as "any raw, semi-processed or processed substance for commercial purpose or to be served for the public in any way intended for human consumption that includes water and other drinks, chewing gum, supplementary food and any substance which has been used in the manufacture, preparation or treatment of food."

7.4. OHS (Occupational health and safety)

Occupational health and safety performance should be evaluated against internationally published exposure guidelines. The working environment and workers health should be monitored for occupational hazards and diseases relevant to the specific work. Monitoring should be designed and implemented by accredited professionals, as well as applicable prevention or protection measures, as part of an occupational health and safety monitoring and prevention program. Facilities should also maintain a record of occupational accidents, diseases, and dangerous occurrences and other accidents.

Self-Check – 7	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. Food safety is the basis of legislative and additional requirements for edible oils.(2pts)

2. The working environment and workers health should be monitored for occupational hazards and diseases relevant to the specific work. (2pts)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

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

Score = _____

Rating: _____

Name: _____ Date: _____

Answer Sheet

1. _____
2. _____

Information Sheet 8- Maintaining work area to housekeeping standards.

8.1. Housekeeping

On sites, for example, tidying up tends to be left until the end of the shift. But that just means you're exposing yourself and others to trip hazards all day long – and that's when the accidents will happen. So here are 10 housekeeping rules for a tidy site. Implement these, and you should see a reduction in slip and trip accidents and near misses to your workforce.

1. **Designate an area for rubbish and waste:** After all, if you want your work area free from waste materials, you need somewhere to put them. This could be a skip or other waste disposal bin depending on the amount of waste. Best practice is to segregate waste types for reuse, recycle or landfill.
2. **Stack and store materials safely:** You need materials and tools for use throughout the project, store them safely. Poorly stacked materials can block access routes or topple over causing crushing injuries or damage to property.
3. **Maintaining a safe work area:** Check your work area at regular intervals throughout the day and clear up as you go along. If trip hazards and mess is starting to build up, sort it out sooner rather than later.
4. **Keep access routes clear:** A safe work area includes access and egress. Do not leave materials/tools/benches in gangways/corridors where they might impede someone's escape or cause a trip hazard (it might be you or a colleague who needs to get out in a hurry).
5. **Put tools away when you are done:** If tools or equipment are out of use, put them away. It's easy to leave items lying around, but if you won't need them again in a hurry, put them away. If it's out of use, it should be out of sight, or at least out from under your feet!
6. **Set a tidy example:** Just because it's not yours, doesn't mean it's not your responsibility. If you see anything lying on floors, stairways, passages that could cause people to trip and fall, pick it up and put it in a safe place – don't wait for someone else to move it.

7. **If it is broken, fix it:** Fix it, or ditch it. Good housekeeping is also about keeping things in good working order on site. Damaged tools or equipment must be taken out of use and immediate steps are taken to have them repaired and put them somewhere safe.
8. **Don't let cables trip you up:** Trailing leads and cables from equipment are common trip hazards, particularly when using portable equipment. You may not have a socket close the working area, but make sure you route the lead away from walkways or access points. Route cables where they do not cause a trip hazard to you or to others.
9. **Avoid fire risks:** Make sure waste or the storage of materials does not build up in fire escapes as you may need to use these escapes at some point. Don't allow waste materials to be stored close to sources of ignition. If all rubbish is regularly collected and put into the skip, in the event of the fire, the danger is confined and more easily dealt with.
10. **Make others aware:** A tidy work area requires commitment from everyone. Raise awareness on site with our free good housekeeping toolbox talk. Gets everyone practicing the same good housekeeping techniques and you will be on your way to a tidy, and safe site, for everyone.

Self-Check – 8	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. List the ten housekeeping rules to degumming processing maintain work area?(10pts)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 9- Conducting work with environmental guidelines

9.1. Introduction

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

9.2. Conducting work with environmental guild line

Environmental issue and recommended techniques of minimizing relating to operational phase of edible oil degumming processing. Environmental issues associated with the degumming operational phase of edible oil processing primarily include the following:

- Solid waste and by-products
- Water consumption and management
- Energy consumption and management
- Atmospheric emissions
- Greenhouse gas emissions
- Hazardous materials

Recommended techniques for minimizing the volume of solid waste and by-products for disposal of edible oil processing industry include the following:

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

- Return waste and residues to fields to assist in soil nutrient management; for example, oil palm plantations with tree trimmings are a valuable soil amendment and/or can be composted with edible oil wastewater effluent.
- Use waste and residues for energy generation in the project plant's boiler(s). Note, however, that relatively high atmospheric emissions (such as particulate emissions) are possible when burning crop residues, and potential fire risks (e.g., from combustible dust) may arise from handling, storing, and processing crop residues; as such, expert advice on fuel characteristics and boiler design should be solicited when planning to use biofuels in this manner.
- Investigate the following options for the responsible disposal of spent degumming earth:
  - ✓ Use as fertilizer, if not contaminated with heavy metals such as nickel, pesticide residues, or other contaminants.
  - ✓ Recover non-food-grade oils from spent bleaching earth that could be used in other applications (feedstock for conversion to biodiesel or in bio-lubricants).
  - ✓ Avoid direct recycling on agricultural land. Add spent earth to other organic waste and compost to avoid contact with air and risk of spontaneous combustion of spent bleaching earth.
  - ✓ If contaminated, manage according to the waste management guidance

9.2.1. Personal protective equipment

Use the following personal protection equipment during degumming of crude oil.

- Clothing/Overall
- Aprons
- Footwear
- Hand Protection
- Eye Protection
- Respiration.

Self-Check – 9	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. Reduce product losses through better processing control? (2pts)

2. List oil processing waste which contamination environment? (2pts)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

1. _____
2. _____

Information Sheet 10- Maintaining workplace records

10.1. Maintaining workplace record

Maintaining records are essential for evaluating your primary processing performance. Furthermore, maintaining adequate documentation and records could assist in identifying or ruling out potential contributing factors of contamination if product implicated in an outbreak is traced to a particular farm or facility. Maintain operational workplace records about processing and practices can be helpful to produce quality product. First, such records help ensure consistency of processing /crude oil degumming processing operations and end-product quality and safety. They are more reliable than human memory and serve as a useful tool to identify areas where inconsistencies occur in operations and corrective actions or employee training may be needed. Every workplace is different and requires different types of information to keep it running smoothly, efficiently and profitably. Different degumming process and by using different types quality raw materials should be recorded for future use as reference. Maintaining workplace records in operating degumming of crude oil include;

- Quantity of crude oil
- Quality of crude oil
- Method of degumming
- Type of degumming
- Employee training records
- Equipment monitoring and maintenance records
- Calibration records
- Sanitation records
- Product processing batch records
- Corrective action records
- Distribution records
- Inspection records (e.g., incoming product, facility, production area)
- Microbiological contamination records (e.g., food contact surfaces, equipment).

Self-Check – 10	Written test

Name…… ID……. Date…….

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

Short Answer Questions

1. List the importance of workplace records?(3)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Operation Sheet 1– Starting and operating the degumming process

Part I: Water degumming of crude oil

Objectives; to know water degumming procedure of crude oil

Material required; crude oil, soft hot water, phosphoric acid and citric acid and etc.

Equipment required; PPE, tanks, flow meter, pumps, centrifugal separators, mixer, heat exchanger and etc.

Following the steps outlined below will help ensure water degumming of crude oil will be successful.

Step 1: Determine percent phospholipids in the crude oil by checking parts per million phosphorus.

Step 2: Crude oil is heated to 140–150°F (60–65°C).

Step 3: Deionized water, equal to percent phospholipids is added to the oil through an in-line high shear mixer.

Step 4: The oil and water are gently mixed in a hydration tank for 30–40 min. The hydrated gum separates and agglomerates.

Step 5: The oil is then gently pumped out of the tank and separated in a centrifuge.

Step 6: The heavy phase contains most of the HPs. A very small amount of NHPs is also removed from the oil as entrainment.

Step 7: The temperature of the oil leaving the centrifuge is 140–150°F (60–65°C).

Step 8: Water-degummed oil contains 0.4%–0.8% moisture. The oil is heated to 185–190°F (85–90°C) in a heater and then pumped into a vacuum dryer, maintained at an absolute pressure of 50 mm of mercury (maximum). Heating of the oil is necessary because the temperature of the oil leaving the centrifuge is too low for vacuum drying at this level of vacuum.

Step 9: Vacuum-dried oil should have moisture content of 0.05% or less.

Step 10: The oil is cooled to less than 130°F (55°C) before storage

Step 11: Hydrated gum is dried in a wiped-film vacuum dryer if the gum is to be used to make lecithin. The vacuum dryer is equipped with specially designed mist eliminator to prevent any product loss due to excessive foaming in the vessel.

Step 12: The vacuum system must be designed with noncontacting condensers to prevent any mixing of the phospholipids into the condenser water and forming an emulsion in the water tower basin.

Part II: Acid conditioning of crude oil

Objectives; to know acid conditioning of crude oil

Material required; crude oil, soft hot water, phosphoric acid and citric acid and etc.

Equipment required; PPE, tanks, flow meter, pumps, centrifugal separators, mixer, heat exchanger and etc.

Following the steps outlined below will help ensure acid conditioning of crude oil.

Step 1: Good quality edible oil is heated to 130–140°F (55–65°C).

Step 2: 400–1000 ppm of phosphoric acid is added to the crude oil and the two liquids are mixed in a high shear mixer. In some cases citric acid works better and is considered to be the preferable over phosphoric acid. For example, citric acid or maleic acid is preferred for treating canola oil.

Step 3: The oil/acid mixture enters a retention tank called conditioning tank. This tank is provided with gentle agitation.

Step 4: The oil stays in the retention tank for 15–30 min. This hydrates the phospholipids and the hydrated phospholipids separate out of the oil because the metal salts of phosphoric acid are insoluble in oil.

Step 5: The hydrated phospholipids are not separated from the crude oil before it goes to bleaching or caustic neutralization. The precipitated salts and the hydrated gums have a tendency to plug up the filter screens. This is because the metal salts of citric acid or other acids are insoluble in the oil and precipitate out. This tends to plug up the filters in bleaching. It is always recommended to precoat the filter screens with diatomaceous earth.

Part III: Acid degumming of crude oil

Objectives; to know acid conditioning of crude oil

Material required; crude oil, soft hot water, phosphoric acid and citric acid and etc.

Equipment required; tanks, flow meter, pumps, centrifugal separators, mixer, heat exchanger and etc.

Following the steps outlined below will help ensure acid degumming of crude oil.

Step 1: Deionized water (approximately 2% of the oil flow) is added to the acid/oil mixture leaving the high shear mixer.

Step 2: The composite liquid stream passes through a static mixer before it enters the hydration tank.

Step 3: The hydration tank is very similar to that in the water degumming process in terms of construction.

Step 4: The oil/acid/water mixture is gently agitated in the hydration tank for 20–30 min.

Step 5: The oil is then gently pumped out of the hydration tank and centrifuged.

Step 6: The heavy phase (acid-treated gums) and the light phase (treated oil) are separated.

Step 7: For high quality palm oil or coconut oil, the water can be added just before the acid/oil mixture enters the centrifuge. One can see that the acid degumming process contains several aspects of water degumming and acid-conditioning processes.

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 **10** hour. The project is expected from each student to do it.

Task 1. Preform water degumming of soybean crude oil
Task 2. Preform acid conditioning of soybean crude oil
Task 3. Preform acid degumming of soybean crude oil

LG #29	LO #3- Shut down the degumming process

Instruction sheet

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

- Identifying shutdown procedure
- Shutting down process according to workplace procedures.
- 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 shutdown procedure
- Shut down process according to workplace procedures.
- Identify and report maintenance requirements

Learning Instructions:

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

Information Sheet 1- Identifying 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 produce heat
- Shutting off heating or cooling to the unit/ processing operation
- Shutting off degumming crude oil and other mechanical operations
- Removing or flushing waste materials from the processing workplace

1.1.2. Maintenance shutdown

When maintenance to the degumming 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

1. Define shutdowns procedure?(3)

Test II Write true if the statement is correct and false if the statement is incorrect

1. The shutdown procedure will depend on the type of equipment and the process to be done.(2pts)

2. An emergency shutdown is initiated in the event of a fire, instrument failure, power failure, unexpected hazard or total loss of the processes. (2pts)

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

Score = _____

Rating: _____

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

Answer Sheet

Name: _____ Date: _____

Test I

1. _____

   _____

Test II

1. _____
2. _____
3. _____

Information Sheet 2- Shutting down process according to workplace procedures

The degumming of edible crude oil process will be shut down after completion of work every day according to the standards and procedures of the industry. Processing 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 days to complete. In general, these shutdown 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 provide 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.

Write true if the statement is correct and false if the statement is incorrect

1. The degumming process of crude oil should be shut down after completion of work.(2pts)

2. There will be a preferred sequence of implementation for the shutdown tasks. (2pts)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

1. _____
2. _____

Information Sheet 3- Identifying and reporting maintenance requirements

3.1. Identifying and reporting maintenance requirement

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. The benefits to be accrued from the implementation of a program of planned maintenance can be found in the efficient and economical operation of the plant and equipment and the utilization of resources (i.e. plant and equipment and manpower) while also maintaining a sound standard of safe working and environmental conditions for operators, other occupants and employees within the workplace. 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.

3.1.1. Types of maintenance

Breakdown maintenance

This refers to the maintenance strategy, where repair is done after the equipment failure/stoppage or upon occurrence of severe performance decline. This concept has the disadvantage of unplanned stoppages, excessive damage, spare parts problems, high repair costs, excessive waiting and maintenance time and high trouble shooting problems.

Preventive maintenance

Preventive maintenance (PM) comprises of maintenance activities that are undertaken after a specified period of time or amount of machine use.

This type of maintenance relies on the estimated probability that the equipment will breakdown or experience deterioration in performance in the specified interval. The preventive work undertaken may include equipment lubrication, cleaning, parts replacement, tightening, and adjustment. The production equipment may also be inspected for signs of deterioration during preventive maintenance work.

Predictive maintenance

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

Corrective maintenance

This is a system in which the concept to prevent equipment failures is further expanded to be applied to the improvement of equipment so that the equipment failure can be eliminated (improving the reliability) and the equipment can be easily maintained (improving equipment maintainability). The primary difference between corrective and preventive maintenance is that a problem must exist before corrective actions are taken. The purpose of corrective maintenance is improving equipment reliability, maintainability, and safety, design weaknesses (material, shapes); existing equipment undergoes structural reform, to reduce deterioration and failures, and to aim at maintenance-free equipment.

Emergency maintenance

Emergency maintenance is that work which is required to be performed without delay due to a failure of a component which, if not implemented, would lead to further failures or even permanent damage, resulting in the total loss of the plant and equipment. Plant and equipment in such a condition may also be dangerous to personnel.

Self-Check – 3	Written test

Name…… ID……. Date…….

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

Write true if the statement is correct and false if the statement is incorrect

1. Preventive maintenance (PM) comprises of maintenance activities that are undertaken after a specified period of time or amount of machine use. (2pts)

2. Predictive maintenance is condition based maintenance.(2pts)

3. Emergency maintenance is that work which is required to be performed without delay due to a failure of a component which. (2pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

1. _____
2. _____
3. _____

Operation Sheet 1– Shutting down edible oil processing equipment/machine

Objectives; to know successful shut down procedure of edible oil and fat processing equipment / machine.

The procedure to successful shut down equipment/machine

Following the steps outlined below will help ensure that equipment / machine next outage will be successful

Step 1: Checklist with every piece of equipment involved in the outage should be available for review.

Step 2: Machine/equipment operational function is determined and understood.

Step 3: Shut-down sequence is undertaken safely and to standard operating procedures.

Step 4: Machine/equipment is depressurized/emptied/de-energized/bled to standard operating procedures.

Step 5: Safe shut-down of machine/equipment is verified.

Step 6: Safety/security lock-off devices and signage are installed to standard operating procedures.

Step 7: Machine/equipment is left in clean and safe state.

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 **2** hour. The project is expected from each student to do it.

Task Preform successful shut down of the oil processing equipment or machine.

Reference Materials

Book:

1. Monoj, K.Gupta, practical guide to vegetable oil processing second edition.
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5. American Soybean Association andAOCS, St. Louis, 1985.
6. S. Marash, R. Gubler, and K. Yagi,Fats and Oils Industry Overview- Chemical Economics Handbook,SRI, MenloPark, California, 2001.
7. R.H PerryPerry's Chmical Engineers' Handbook,6th ed. McGraw- Hill, 1985
8. A. E. Rheineck, R. T. Holman et al Progress in the Chemistry of Fats and Other Lipids,Pergamon Press, New York1958.
9. J. G. SpeightChemical and process design handbook,McGraw-Hill Companies,2002
10. Bogdanor, J.M., Price, A.L., 1994. Novel synthetic silica adsorbents for refining of edible oils.
11. Oil Mill Gazetter 99 (12), 32–34. Chapman, D.M., 1994. Benefits and limitations of a novel chlorophyll adsorbent. JAOCS 71, 4. Erickson, D.R. (Ed.), 1995.
12. US Patent 4,734,226, March 29, 1988. Patterson, H.B.W., 1992. Bleaching and Purifying Fats and Oils, Theory and Practices.
13. AOCS Press, Champaign, IL, USA. Pryor, J.N., Bogdanor, J.M., Welsh, W.A, In press Dual phase adsorption and treatment process for the removal of impurities from triglyceride oil.
14. Welsh, W.A., Parent, Y.O., 1986. Method for refining glycoside oils using amorphous silica useful in processes for the removal of trace contaminants, specifically phospholipids and associated metal ions, from glycoside oils. US Patent 4, 629,588, December 16, 1986.

WEB ADDRESSES

1. http://www.alfalaval.com/
2. https://lipidlibrary.aocs.org/edible-oil-processing/chemical-degumming
3. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/degumming
4. https://www.asaga.org.ar/descargas/material/CURSO_REFINACION/REF1_Lopez_Brueckner.pdf

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