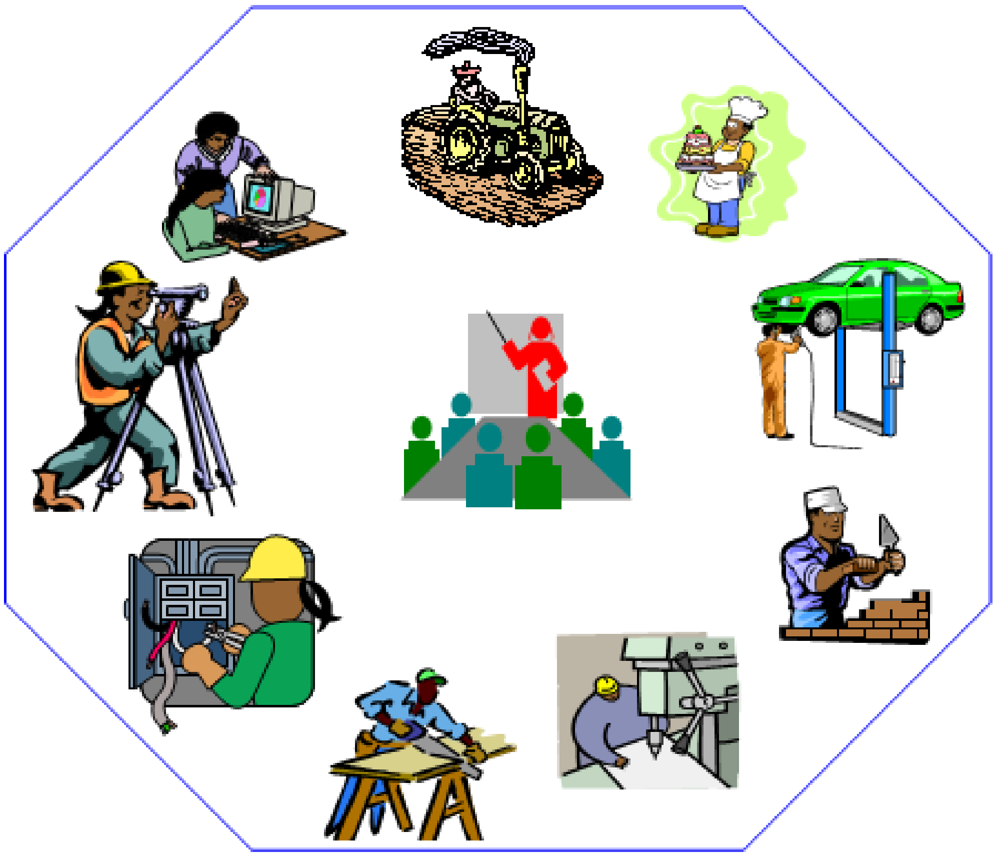
Edible Oil and Fats Processing Level III

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



Module Title: - Operating margarine production process

LG Code: IND EOP3 M16 LO (1-3) LG (53-55)

TTLM Code: IND EOP3 TTLM 0321v1

March, 2021

With the support of

United Nations Educational, Scientific and Cultural Organization

Republic of Korea Funds-in Trust

Contents

LG#53	LO #1- Prepare margarine equipment for operation

Instruction sheet

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

- Confirming Materials**.**
- Identifying and confirming Cleaning and maintenance service requirements and status.
- Adjusting and fitting Machine components and related attachments.
- Confirming Different ingredients and services.
- Entering Processing /operating parameters to safety and production.
- Checking and adjusting margarine equipment performance.
- Caring out Pre-start Check by workplace 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:

- Confirm Materials**.**
- Identify and confirm Cleaning and maintenance service requirements and status.
- Adjust and fit Machine components and related attachments.
- Confirm Different ingredients and services.
- Enter Processing /operating parameters to safety and production.
- Check and adjust margarine equipment performance.
- Check Pre-start carried out by workplace 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” which are placed following all information sheets.
5. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
6. If your performance is satisfactory proceed to the next learning guide,
7. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Confirming Materials

1.1 – Introduction

Margarine is a flavored food product containing 80% fat, made by blending selected fats and oils with other ingredients, fortified with Vitamin A, to produce a table, cooking, or baking fat product that serves the purpose of dairy butter but is different in composition and can be varied for different applications. Margarine was developed to fill both an economic and a nutritional need when it was first made as a butter substitute. The ability to be physically altered to perform in many varied applications was a major factor in the growth of margarine.

There are over ten different types of margarine produced today, including regular, whipped, soft tub, liquid, diet, spreads, no fat, restaurant, bakers, and specialty types, which are packaged in as many different packages. These margarines are made from a variety of fats and oils, including cottonseed, soybean, palm, corn, canola, safflower, sunflower, lard, and tallow. Margarine products cater to the requirements of all the different consumers; retail, foodservice, and food processor. Margarine is an emulsion of edible oils and fats with water. Physical properties of margarine are similar to butter. It shall be free from mineral oil and animal body fats. It may contain common salt not exceeding 2.0 per cent, permitted emulsifying and stabilizing agents, BHA or TBHQ up to a maximum limit of 0.02 per cent.

Figure 1.1.Margarine

1.2 Margarine type

Just like butter, margarine is a water-in-oil emulsion, a mixture of two immiscible phases involving a continuous liquid fat phase surrounded by water droplets as the dispersed phase held together as a homogenous phase by compounds known as emulsifiers. A number of different types of margarines are produced: soft, whipped, liquid and spreadable stick margarines.

- Soft margarines are soft, contain about 50 percent less solid content than regular margarines and spreadable at refrigeration temperatures. Soft margarines are made with higher percentages of liquid oils containing as high as 70 percent polyunsaturated fatty acids. These margarines cannot be formed into firm sticks, hence, packaged in tubs made of plastic or coated paperboard.

- Whipped products are produced by whipping or incorporating nitrogen into margarine. The product has 50 percent more volume to the pound, softer and easier to spread at refrigeration temperatures. Due to the lower density of the whipped products, the consumption of equivalent volume servings of whipped product provides one-third fewer calories than regular margarine.

- Liquid margarines are packaged in a squeeze bottle and is pourable at refrigerator temperatures. This product provides convenience to both home consumers and commercial users. It is easy to use for pan frying and spreading on cooked foods or foods to be frozen. For commercial users, it is packaged in drums and can be easily metered and pumped. Some products are stable for long periods of time at room temperature as well as at refrigerator temperatures.

- Table margarine (fat content of at least 80% and a maximum of 16% water): there are a large number of specific types falling into this category, including soft, tub, diet, and high in polyunsaturated fatty acids; table margarines tend to be used for spreading, frying and baking;

- ✓ Industrial margarines for baking
- ✓ Reduced fat spreads: these contain 60–70% fat and are used for frying and baking, although they can also be used for spreading;
- ✓ Low-fat spreads: these contain a maximum of 40% fat and can be used for spreading only;
- ✓ Very low-fat spreads: these typically have a fat content of 3–25%; there are a growing number of these available on the market.

1.3 Conforming materials

Margarine can be made from a variety of substances. The first of these is any edible animal or vegetable oil such as corn oil or sunflower oil. Its liquid component can be made from milk, water, or sometimes a liquid protein mixture derived from soybean. Materials may include:

I. RBD oil

Edible oils purchased in stores are known as "RBD" oils. These are oils that have been Refined, Bleached and Deodorized. Each of these steps is used to create final oil that is consistent in taste, color and stability. As a result, these oils are generally tasteless, odorless, and colorless regardless of the original oilseed type or quality. While this is the intent of the processing, locally produced oil may not need to meet the same expectations as the mass-marketed oils.

Small-scale pressed oil that has not been processed or is minimally processed retains flavors and smells common to the original oilseed.

II. Hydrogenated oil

Hydrogenated oil is made from edible oils extracted from plants, such as olives, sunflowers, and soybeans. Because these oils are typically liquid at room temperature, many companies use hydrogenation to get a more solid and spreadable consistency.

During this process, hydrogen molecules are added to alter the texture, stability, and shelf life of the final product.

Hydrogenated vegetable oils are also used in many baked goods to improve taste and texture. Additionally, these oils are more stable and resistant to oxidation, which is the breakdown of fats when exposed to heat. Thus, they're easy to use in baked or fried foods, as they're less likely to become rancid than other fats.

III. Sterilized water

Sterilized water is used for mixing dry ingredients. Sterilized water is used in margarine production in this way insulated tanks are supplied for the production of the water phase. A flow meter doses the water into the tank where it is heated to a temperature above 45ºC. Dry ingredients such as salt, citric acid, hydrocolloids or skimmed milk powder may be added into the tank using special equipment such as a powder funnel mixer.

IV. Lecithin

Lecithin, a natural fat derived from egg yolk, soybean, or corn, is one typical emulsification agent used in margarine manufacturing.

V. Sorbic acid

Sorbate is used as a preservative in a wide range of products. Sorbic acid is active against yeasts, molds, and many bacteria. Microbial inhibition by sorbate is variable and depends on species, strains, composition of food, pH, a_w, food-processing treatments, temperature of storage, and concentration of sorbate.

VI. BHT,BHA and TBHQ

Antioxidants are food additives in oil and fat products usually to decrease the process of rancidity by preventing the oxidation such as in margarine. BHA, BHT, propyl gallate, and TBHQ are commonly used antioxidants. Combinations of antioxidants are generally used in the food product.

TBHQ: TBHQ, like many food additives, is used to extend shelf life and prevent rancidity. It's a light-colored crystalline product with a slight odor. Because it's an antioxidant, TBHQ protects foods with iron from discoloration, which food manufacturers find beneficial. It's often used with other additives like propyl gallate, butylated hydroxyanisole (BHA), and butylated hydroxytoluene (BHT).

BHQ can't account for more than 0.02 percent of the oils in a food because the FDA doesn't have evidence that greater amounts are safe. While that doesn't mean more than 0.02 percent is dangerous, it does indicate that higher safety levels haven't been determined.

BHA and BHT: Food manufacturers add butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) to foods like cereal and other dry goods to help their fats stay fresher longer. Both BHA and BHT are antioxidants, which means they can protect other compounds from the damaging effects of oxygen exposure. In a way, BHA and BHT are similar to vitamin E, which is also an antioxidant and often used as a preservative as well.

Figure1.2 TBHQ powder

VII. Colorants

While butter that cows produced had a slightly yellow color, margarine had a white color, making the margarine look more like lard, which many people found unappetizing. Around the late 1880s, manufacturers began coloring margarine yellow to improve sales. Color additives (pro-vitamin A (beta-carotene) is considered a color additive).

VIII. Vitamins

Add vitamins A and D to margarine and spreadable fats, this contributes about 20% of the recommended intake of vitamin A and about 30% of vitamin D for some groups of the population.

IX. Skimmed milk

Milk is used as the liquid base; it is joined with salt and an emulsifying agent in a chamber. The emulsifying agent ensures that the emulsification process chemically defined as a suspension of small globules of one liquid in a second liquid takes place. An emulsifier works by decreasing the surface tension between the oil globules and the liquid mixture, thereby helping them form chemical bonds more easily. The result is a substance that is neither wholly liquid nor wholly solid but rather a combination of the two called semi-solid.

Self-check 1	Written test

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

Test I Short Answer Questions

1. Discus types of margarine?
2. List and discus materials used for margarines production?

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

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

Score = ___________

Rating: ____________

Information Sheet 2- Identifying and confirming Cleaning and maintenance service requirements and status

2.1 Identifying and confirming cleaning and maintenance

2.1.1 Identifying cleaning requirements

Thorough cleaning and disinfection of the equipment are essential parts of margarine operations to ensure optimal hygienic conditions. Combined with proper processing such as pasteurization, proper cleaning procedures help to ensure optimal product shelf life. Extensive development has and is taking place in the area of cleaning and disinfection techniques. A wide range of detergents and disinfectants is available today, complicating the choice of suitable cleaning agents for particular food processing operation. Economic pressures have speeded up the mechanization and automation of the cleaning operations.

The degree of cleanness can be defined by the following terms:

- **Physical cleanness**: removal of all visible dirt from the cleaned surfaces.
- Chemical cleanness: removal of all visible dirt as well as microscopic residues, which can be detected by taste or smell but are not visible to the naked eye.
- **Bacteriological cleanness**: obtained by disinfection that kills all pathogenic bacteria and most, but not all, other bacteria.
- **Sterility:** destruction of all microorganisms.

Even today, some items of equipment in the margarine production can be found not to be designed for easy cleaning and draining. Tanks with flat bottoms and inadequate drainage points can be found. Pipes are found with unnecessary bends, blank ends, and unsatisfactory valves. Such installations are very difficult to clean and could lead to the buildup of stagnant products.

During the design and erection phase of new plants, full consideration should be given to problems of cleaning. Cleaning operations must be performed strictly according to a carefully planned procedure in order to achieve the required degree of cleanness. The cleaning cycle in a margarine operation usually comprises the following steps:

- Removal of residual fat and milk solids in the plant by means of drainage and forcing product out with water or compressed air.
- Preliminary wash with warm water about 49_C (120_F) for loosening fat and milk solids adhering to the sides of the equipment.
- Cleaning with alkaline detergent solution at 60–70C^0 (140 –158F^0) for approximately 30 min to remove all traces of fat, milk solids, and other residues from the interior of the production line. All blank ends and valves not suitable for CIP should be removed and washed by hand.
- Post rinsing with clean, warm water to remove the last traces of detergent.
- Disinfection by means of heating with steam or hot water, alternatively disinfecting with chemical agents such as chlorine and other halogen compounds, benzoic acid washing, or quaternary ammonium salts. In the latter case, the cycle is concluded with a final rinse.

Cleaning in place (CIP) can be defined as circulation of cleaning liquids through machines and other equipment in a cleaning circuit. This method of cleaning has replaced the older practice of stripping down valves and other difficult to clean equipment in many margarine factories.

The passage of the high-velocity flow of liquids over the equipment surfaces generates a mechanical scouring effect that dislodges dirt deposits. This only applies to the flow in pipes, heat exchangers, pumps and valves, etc. The usual technique for cleaning of tanks is to spray the detergent on the upper surfaces and allow it to run down the walls. The mechanical scouring effect is often insufficient but can to some extent be improved by the use of specially designed spray nozzles or cleaning turbines. Tank cleaning requires large volumes of detergent that must be circulated rapidly.

CIP cleaning plants (CIP = cleaning in place) are also part of a modern margarine facility since margarine production plants should be cleaned on a regular basis. For traditional margarine products once a week is a normal cleaning interval. However, for sensitive products like low fat (high water content) and/or high protein containing products, shorter intervals between the CIP are recommended.

In principle, two CIP systems are used: CIP plants which use the cleaning media only once or the recommended CIP plants which operate via a buffer solution of the cleaning media where media such as lye, acid and/or disinfectants are returned to the individual CIP storage tanks after use. The latter process is preferred since it represents an environmentally-friendly solution and it is an economical solution in regard to consumption of cleaning agents and hereby the cost of these.

In case several production lines are installed in one factory, it is possible to set up parallel cleaning tracks or CIP satellite systems. This results in a significant reduction in cleaning time and energy consumption. The parameters of the CIP process are automatically controlled and logged for later trace in the GS Logic system.

2.1.2 Maintenance requirement determination

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

- **Functional analysis.**

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

- **Maintenance determination**

Once the failure modes and the effect of failure have been determined, they are used as inputs for determining the corrective and preventative maintenance requirements. The corrective maintenance determination is focused on identifying the necessary repair actions required to return an item to serviceability. The preventative maintenance outcome is identified by the application of reliability centered maintenance (RCM)-based methodologies.

- **Maintenance task analysis (MTA).**

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

- ✓ Repairable and breakdown spares.
- ✓ Trade skills and training.
- ✓ Packaging handling and transport.

- ✓ Procedures required performing the task.
- ✓ Facilities.
- ✓ Support and test equipment.

•Level of repair analysis (LORA)

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

•Logistic support analysis record.

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

•Promulgation.

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

•Performance monitoring and analysis.

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

2..2 Maintenance requirements

The maintenance requirements associated with healthcare technology have to align with the manufacturer specifications, the organization's medical equipment management plan, and regulatory bodies. The manufacture specifications and maintenance requirements are critical and can be used as a "starting point." The service manual should provide specific instructions and steps toward ensuring the device is properly maintained and operating optimally.

Keep in mind that with time and experience, HTM professionals can add additional steps to the manufacturer recommendations and even modify the recommended testing frequency, with justified historical maintenance data and information that show the change or modification in testing frequency or procedure, for example, does not increase the risk of failure or harm.

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

Self-Check – 2	Written test

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

Test I: Short Answer Questions

1. Discus cleaning in margarine production?
2. What are the degrees of cleaning?

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 5 points**

Score = ____________

Rating: _____________

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

Information Sheet 3- Adjusting and fitting machine components and related attachments

3.1 Adjusting and fitting machine components

- **Scraped surface heat exchanger**

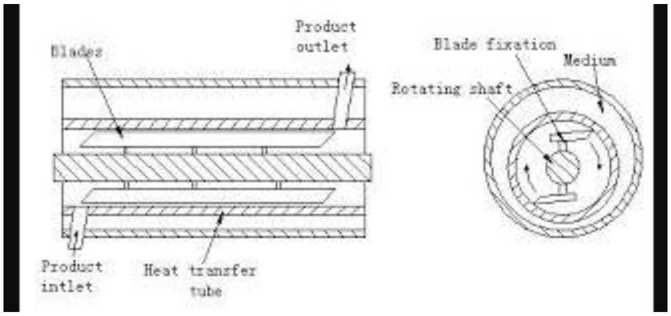


Figure1.3 component of scraped surface heat exchanger

Adjustment of SSHE

- In the scraped surface heat exchanger, spring loaded rotating blades scrape the surface and effectively remove liquid from it.
- Alternatively, the blades move against the heat transfer surface under the influence of the rotational forces.
- At the same time as liquid layers are removed, any fouling substance deposited on the surface is also removed, thus ensuring that contamination of the process liquid is reduced to a minimum this can be crucial where taste and texture are important product qualities

Principle of the scraped surface heat exchanger

Number of scraper blades shown is four, but any number of blades may be employed, although as the number of blades is increased the capital cost rises.

Furthermore, a large number of blades are not necessary, since the time internal between successive scrapes is relatively short, i.e., the residence time of particles of liquid on the surface is low.

The choice of the number of blades is an empirically based compromise between capital cost, acceptable speed of rotation and liquid viscosity. Because of the rotating parts, maintenance charges may be relatively high. Scraped surface heat exchangers can either run full of liquid or the liquid may enter the exchanger as a peripheral stream.

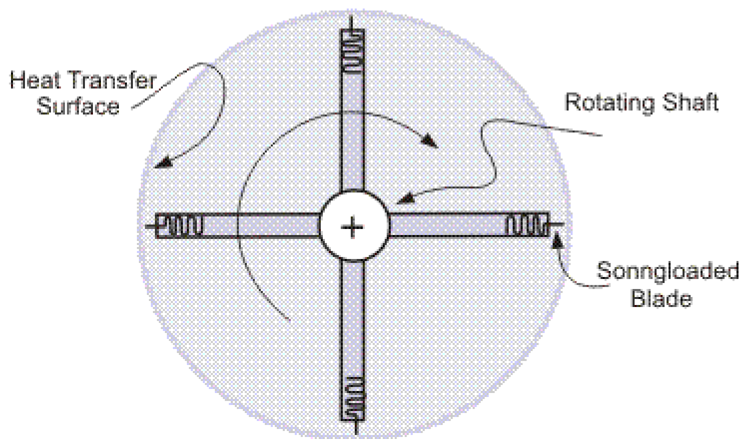


Figure 1.4 The principle of the scraped surface heat exchanger.

- **Pin worker unit**

The Pin Worker consists of a hot water jacketed cylinder with a row of fixed static pins (optional 3 rows) and a concentric shaft carrying pins in a helical or straight pattern. The Pin Worker consists of a hot water jacketed cylinder with a row of fixed static pins (optional 3 rows) and a concentric shaft carrying pins in a helical or straight pattern. The rotating shaft pins intermeshes with the static pins to provide the necessary kneading function for softening the shortening.

The shaft is driven by a variable frequency geared motor for flexibility. The very high operating pressure mechanical seal is the same as SSHE for standardization.

All wetted surfaces are made of stainless steel (304 or 316L), internal surface polished to food grade application, external finish dry honed with welds grounded. All seal parts, 'O' rings, gaskets and non-drive end bush compatible with product. The unit is hot water jacketed and insulated, with optional individual temperature controlled hot water circulation tank.

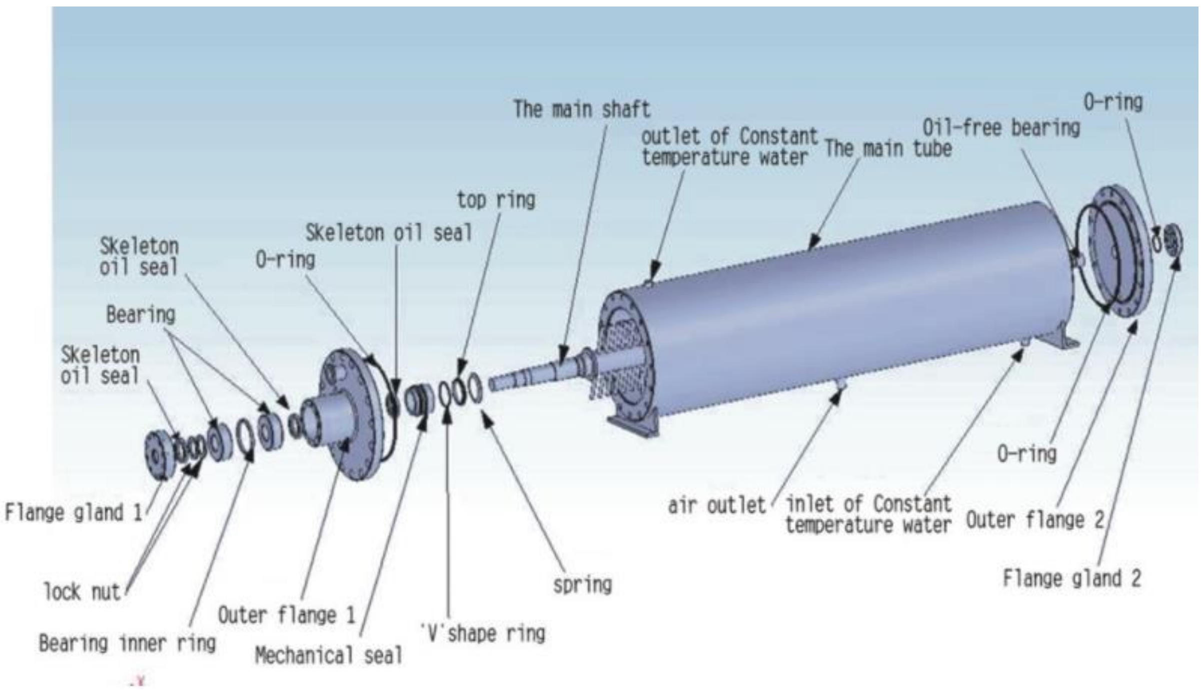


Figure 1.5. component of pin worker unit

Self-Check – 3	Written test

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

Test I: Short Answer Questions

1. List component of scraped surface heat exchanger ?

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

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

Score = ____________

Rating: _____________

1.1 Different ingredients

Margarine is a non-dairy product created as a substitute for butter. While originally made from animal fat in the 1800s, today the primary ingredients include vegetable oil, water, salt, emulsifiers, and some also include milk. Margarine can be found in both sticks and tubs. It's important to know that not all margarine is created equal. There are variations from brand to brand, so it's important to read the label. Unlike butter, margarine isn't something that can be made at home.

Like butter, regular margarine must also have a minimum fat content of 80 percent by law. Anything less is considered a "spread." The margarine and spreads found in the dairy aisle can range from 10 to 90 percent fat. Depending on the fat content, the levels of vegetable oil and water will vary, with those containing a lower fat content having a higher percentage of water. Since margarine's primary component is vegetable oil, it lacks the cholesterol and saturated fat found in butter, and has a higher percentage of polyunsaturated and monounsaturated fats. It may, however, contain trans-fat although, many brands have reduced or totally eliminated this from the ingredient lineup, using palm oil and palm kernel oil in its place.

- **Milk Products or Protein**

The optional ingredients of the aqueous phase include water, milk, or milk products. Initially, cow's milk was used, but now water can be used with or without an edible protein component. The suitable edible protein components include whey, albumin, casein, caseinate, or soy protein isolate in amounts not greater than reasonably required to accomplish the desired effect. The factors controlling the protein choice are primarily flavor considerations and, to a lesser extent, performance in frying and cooking similar to butter. Initially, the margarine standards promulgated in 1941 required that the aqueous system contain 10% milk solids; however, that requirement has been removed, and most margarine produced with milk or another protein contain considerably lower levels, usually less than 1.5%. A high level of the margarine produced currently is milk free, which presents fewer microbial problems and helps conform to the requirements of several religious diets.

- **Emulsifiers**

Several different food-grade emulsifiers are allowed as optional ingredients for margarine. Emulsifier systems are used to hold the fat and the water phase together and impart specific performance characteristics to the finished product. Originally, only lecithin and mono- and diglycerides were allowed at limited use levels, but the standards were opened to any surfactant with a GRAS (Generally Recognized as Safe) designation at a level required to provide the desired effect or within the restrictions for the specific surfactant. Nevertheless, consumer margarines normally still rely on a two-component emulsifier system of lecithin and mono- and diglycerides. Lecithin is usually added at levels of 0.1 to 0.2% for its anti-spattering and natural emulsifying properties and it helps affect a quicker salt release in the mouth. Mono- and diglycerides are added to most margarine for emulsion stability or protection against weeping, usually at levels below 0.5% α-monoglyceride.

- **Flavoring Materials**

Salt, sodium chloride, is added for flavor and also acts as a preservative. Potassium chloride can be substituted for sodium chloride in sodium-free margarines. Flavoring substances approved for food use and nutritive carbohydrate sweeteners or sugars are considered optional ingredients by the margarine standards. Many synthetic butter flavors are available for use in margarine. These are usually based on mixtures of compounds that have been identified as contributing to the flavor of butter, such as lactones, butyric fatty-acid esters, ketones, and aldehydes. Diacetyl, a primary constituent of many butter flavors, is formed in butter during the culturing process at concentrations of 1 to 4 ppm.

Flavor perception is influenced by mouth feel, which is determined by the rate at which a margarine product melts in the mouth. Mouth feel is controlled by the melting characteristics of the fat portion and the tightness of the emulsion, which is a function of the emulsifier, protein, and stabilizer selections, as well as the processing techniques. Ideally, these characteristics should be balanced to allow the margarine to melt in the mouth and release the flavors to provide a pleasant eating sensation, rather than a pasty, waxy feeling that masks the flavor system or an immediate release that is overpowering and of short duration.

Flavor and color for bakery margarines are one of the major differencing characteristic between margarine and shortening for baking applications. The flavor and color additives for baker's margarine are usually more intense and must be more heat stable than for consumer margarines formulated for table use. Some of the commercial flavor compounds available contain butyric fatty acid or lactones to improve the buttery flavor in baked products. Most bakers' margarines are also formulated with higher salt levels, usually 3.0% versus the 1.5 to 2.0% used in consumer margarine products.

- **Preservatives**

Preservatives, also optional ingredients permitted by the margarine Standard of Identity, protect against spoilage or deterioration. Margarine preservatives fall into three categories: antimicrobial, antioxidant, and metal scavenger. The standards list sorbic acid and benzoic acid and their sodium and calcium salts and allow use levels of 0.1% individually or 0.2% in combination. These compounds protect margarine against microbial spoilage. Benzoic acid is more active against bacterial action, whereas sorbic acid gives better protection against yeast and mold. Salt is also a preservative, although it is usually added for flavor enhancement. The salt level in most margarines ranges from 1.5 to 3.0%. Because the moisture level in margarine usually ranges from about 16 to 19%, the salt concentration in the aqueous phase is 8 to 19%. In most cases, the concentration of salt in the water phase will provide sufficient antimicrobial activity, but without other preservatives or acidulants mold can develop.

- **Vitamins and Color**

Fortification of all margarine products with vitamin A is mandatory; it must contain not less than 15,000 international units (IUs) per pound. The use of vitamin D is optional, but when added it must be at a minimum level of 1500 IUs per pound of finished margarine. Vitamin E addition is excluded under the Standards of Identity; however, the natural antioxidants in vegetable oils tocopherols are major sources for vitamin E, and variable amounts survive in processed margarines.

The mandatory vitamin A level for margarine is usually attained by the addition of beta-carotene for colored margarines, with vitamin A esters used to adjust for the required potency. The colorless vitamin A esters are used for the entire requirement for uncolored margarines. Natural extracts containing carotenoids, such as annatto, carrot oil, and palm oil have also been used to color margarines. Apocarotenal is a synthetic pigment that is used primarily as a color intensifier for beta-carotene.

- **Margarine Oils and Fats**

The physical and functional aspects of a margarine product are primarily dependent on the characteristics of the major ingredient: margarine oil. Margarine consistency, texture, spreadability, color, appearance, flavor, mouth feel, and emulsion stability are all functions of the crystallized fat. In the United States, hydrogenation has been the preferred process utilized to change the solids/liquid relationship of margarine base stocks. Recently, formulations to limit or eliminate *trans* fatty acids have precluded the use of most of the partially hydrogenated basestocks.

Modification of margarine oil basestocks has been converted to interesterification, fractionation, and/or blending of selected source oils to provide the desired characteristics. The formulation rules used with the hydrogenated basestocks apply to the other modification processed fats and oils with some adjustments. A direct relationship exists between the solids fat content and the structure, consistency, and plasticity of the finished margarine. SFI or SFC values at 50, 70, and 92°F (10, 21.1, and 33.3°C) are utilized by most margarine manufacturers for margarine consistency control. The SFI and SFC values indicative of the crystallization tendencies and finished product qualities for consumer margarines.

Notes*:* SFI = solids fat index, SFC = solids fat content.

Table 1. Common permitted food additive for margarine production

Natural food colours	
Beta carotene	25 mg/kg (maximum)
Annatto extracts (as bixin/norbixin)	20 mg/kg(maximum)
Curcumin	05 mg/kg (maximum)
Antioxidant (Singly or in combination)	
Lecithin	GMP
Ascorbic acid	GMP
Propyl gallate, ethyl gallate, Octyl gallate, Dodecyl gallate or a mixture thereof	200ppm (maximum)
Butylated Hydroxy Anisole (BHA)	200ppm (maximum)
Natural and synthetic tocopherols	-
Citric acid, Tartaric acid, Gallic acid	GMP
TBHQ	200ppm (maximum)

Antioxidant Synergist	
Sodium citrate	GMP
Emulsifying agents	
Mono and di glycerides of fatty acids	GMP
Lecithin	GMP
Mono and di glycerides of fatty acids esterified with acetic, acetyl tartric, citric, lactic, tartaric acids and their sodium and calcium salts	10g/kg (maximum)
Polyglycerol esters of fatty acids	5g/kg(maximum)
Preservatives	
Sodium/ Potassium/ benzoate expressed as Benzoic acid	1000 mg/kg(maximum)
Sorbic acid	1000 mg/kg(maximum)
Sodium/ Potassium/ Calcium sorbate expressed as Sorbic acid	1000 mg/kg(maximum)
Benzoic acid	1000 mg/kg(maximum)
Acidity regulators	
Lactic acid	GMP
Citric acid	GMP
Flavours	
Natural flavours and natural flavouring substances/ Nature identical flavouring substances/ Artificial flavouring substances	GMP
Diacetyl	4 mg/kg (maximum)

1.2 Different services

May include but not limited to:

- **Power**

Electric power is the most important in any processing industry. Without electric power it is impossible to operate or produce any product using machine. It provides energy to operating equipments and machines which helps to process the feed raw materials in to new products. If power shortages happen during processing, it may cause many damages to raw materials, product and machine. Recommended for use in countries with frequent power outages must be ;

- ✓ Highly flexible, modular crystallizer
- ✓ Recovers ammonia in case of electrical breakdown
- ✓ Prevents clogging inside the machine

Figure1.6 Power source

- **Steam**

Steam is water in the gas phase. It is commonly formed by boiling or evaporating water. Steam that is saturated or superheated is invisible; however, "steam" often refers to wet steam, the visible mist or aerosol of water droplets formed as water vapour condenses. It is useful in:

- ✓ Cleaning ,heat, and cook process of oil seeds
- ✓ Cleaning of oil processing equipment
- ✓ Internal combustion engines and part
- ✓ Cleaning floors

- **Gases**

Gases are more advantages for margarine production .For example during Whipped products are produced by whipping or incorporating nitrogen into margarine. The product has 50 percent more volume to the pound, softer and easier to spread at refrigeration temperatures. Due to the lower density of the whipped products, the consumption of equivalent volume servings of whipped product provides one-third fewer calories than regular margarine.

- **Refrigeration**

The term refrigeration means cooling a space, substance or system to lower and/or maintain its temperature below the ambient one (while the removed heat is rejected at a higher temperature). In other words, refrigeration is artificial (human made) cooling. Energy in the form of heat is removed from a low-temperature reservoir and transferred to a high-temperature reservoir. The work of energy transfer is traditionally driven by mechanical means, but can also be driven by heat, magnetism, electricity, laser, or other means. Refrigeration has many applications, including household refrigerators, industrial freezers, cryogenics, and air conditioning. Heat pumps may use the heat output of the refrigeration process, and also may be designed to be reversible, but are otherwise similar to air conditioning units.

- **Sterilized water**

Water is used in various processes and sub processes of margarine production as a raw material (part of the final product). It is also used for different heating and cooling processes (in any process of pasteurization after heating, the product is cooled to the required temperature), cleaning and cleaning-in-place (CIP) processes.

- **Compressed and instrumentation air**

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

Self-Check – 4	Written test

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

Test I: Short Answer Questions

1. Distinguish the difference ingredient and services used for margarine production?

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

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

Score = ___________
Rating: ____________

Information Sheet 5- Entering Processing /operating parameters to safety and production

5.1 Processing /operating parameters

I. Emulsion temperature

Margarines made from refined, bleached, and deodorized palm oil at different emulsion temperatures showed no significant difference in their consistency, polymorphic behavior, and solid fat content (SFC) during storage, although differences were observed during processing. The emulsion temperatures studied were 40, 45, and 50°C, with other parameters such as emulsion flow rates, tube cooler temperature, and pin rotor speed kept constant. The SFC developed during processing and storage at 28°C was measured to evaluate the quality of margarine.

The emulsion contained no SFC at any emulsion temperature studied. However, the amount of SFC in the perfector or tube cooler unit increased to 15.9, 13.9, and 15.6% in margarine produced at emulsion temperatures of 40, 45, and 50°C, respectively. At 40°C, the lowest SFC was developed during storage even though this margarine had the highest consistency.

The softening point of this sample was moderately high and closely related to the type of crystal developed, which was a mixture of β′ and β crystals. Emulsion at 45°C gave the most stable margarine consistency and SFC with crystal in the β′ form even after the fourth week. At 50°C, moderately soft product was produced, which might be undesirable for some applications, although the crystals were in the β′ form.

II. Flow-rate

The consistency of margarine during storage was high at low emulsion flow-rates and low at high flow rates. The flow rates with other parameters such as emulsion and tube cooler temperature, speed of the tube cooler, intermediate crystallizer and pin worker unit kept constant.

The margarines were significantly different in their consistencies, solid fat content (SFC) and polymorphic behavior during processing and storage at 28C. The SFCs in the tube cooler and the pin worker units corresponded with the flow rates, while crystallization affected the temperatures of the product during processing.

Effect of Emulsion Flow Rate

The speed at which the margarine emulsion passes the scrape-surface tube cooler and pinworker system will affect the end product: too slow, the margarine becomes hard and brittle as the emulsion is cooled too rapidly; too fast, the crystals attach to each other instead of orientating themselves in a better position (Timms, 1994). On the other hand, too high a feeding rate gives insufficient cooling, promoting post-crystallization and hardening, especially in packet margarines.

III. Product temperature

The temperature of the scraped-surface tube-cooler is the most important parameter in margarine processing. High temperature will produce a hardened product with formation of beta-crystals during storage.

IV. Pin-worker speed

High temperature will produce a hardened product with formation of β-crystals during storage. The speed of the pin-worker is responsible for inducing crystallization but, at the same time, destroys the crystal agglomerates, resulting in melting.

Effect of Pin-Worker Speed

The pin-worker, besides further crystallizing the emulsion, also physically breaks up and works the crystals to improve the texture of the final product. Heertje (1993) reported that high pin-worker speed gives a soft and overworked product in spreads. The mechanical work also raises the temperature of the margarine in the pin-worker by 2°C or more by the heat generated, and the latent heat of crystallization released (Hui, 1996).

Self-Check – 5	Written test

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

Test I: Short Answer Questions

1. Briefly discus operating parameters of margarine production ?

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

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

Score = ___________

Rating: ____________

Information Sheet 6- Checking and adjusting margarine equipment performance

1.1 margarine equipment

The type of oils or fats used has a considerable influence on the crystallization characteristics during the margarine processing, which has to be considered when choosing the equipment involved in the processing line. The criteria involved in choosing this equipment are to a certain extent based on the knowledge about product characteristics, polymorphism, and crystal structure of the margarine and related products. May include but not limited to:

- **Emulsion tankers**

An emulsion tanker is tank used for emulsion preparation mixes the water phase and the oil phase. The function of emulsification tank is to dissolve one or several materials into the liquid, and mix them and stabilize the emulsion .It is widely used in the raw materials mixing and emulsification of edible oil, powder processing and sugar processing.

Figure1.7 emulstion tank

- **Scraped surface heat exchangers**

Used to crystallize fat for making margarine and shortening. Scraped surface heat exchangers (SSHEs) are commonly used in the food, chemical, and pharmaceutical industries for heat transfer, crystallization, and other continuous processes. They are ideally suited for products that are viscous, sticky, that contain particulate matter, or that need some degree of crystallization. Since these characteristics describe a vast majority of processed foods, SSHEs are especially suited for pumpable food products.

During operation, the product is brought in contact with a heat transfer surface that is rapidly and continuously scraped, thereby exposing the surface to the passage of untreated product. In addition to maintaining high and uniform heat exchange, the scraper blades also provide simultaneous mixing and agitation. Heat exchange for sticky and viscous foods such as heavy salad dressings, margarine, chocolate, peanut butter, fondant, ice cream, and shortenings is possible only by using SSHEs.

Their application includes:

- ✓ Low temperature for crystal generation.
- ✓ Low heat transfer due to the nature of the application.
- ✓ High operating and maintenance cost.
- ✓ Low cross-contamination.
- ✓ Easy to clean.

Figure 1.8. Scraped Surface Heat Exchanger System

* **High pressure pumps**

Transfers the emulsion in the high-pressure section, to the crystallizer. High pressure pump used for margarine. The conveying pump is a 3 piston pump with 3 suction and pressure valves. The margarine emulsion is usually fed from a holding tank to the scraped-surface. heat exchanger (A unit) by a high-pressure positive-displacement pump of the plunger or piston type with product contact parts in 316 stainless steel. Pumps with ceramic pistons are available for special applications. Normally, pumps with two or three plungers or pistons are standard in order to minimize discharge pressure pulsations in the process line. A high-pressure piston pump for margarine production.


Figure 1.8 High pressure pumps

* **Compressor system**

Compressor is a mechanical device used to increase the pressure of compressible fluid, either gas or vapour, by reducing the fluid specific volume during passage of the fluid through compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both transport the fluid through a pipe. As gases are compressible, the compressor reduces the volume of the gas. But the Liquids are relatively incompressible, while some can be compressed, the main action of a pump is to pressurize and transport liquids.

The benefits of operating the gas at higher pressures includes the ability to transmit larger volumes of gas through a given size of a pipeline, lower transmission losses due to friction, and the capability to transmit gas over long distances without additional boosting stations.

APPLICATIONS

- ✓ Gas lift
- ✓ Reinjection of gas for pressure maintenance
- ✓ Gas gathering
- ✓ Gas processing operations (circulation of gas through the process or system) Transmission and distribution systems
- ✓ Reducing the gas volume for shipment by tankers or for storage

- **Filter**

Filter system is pre-treatment for the water used for water phase. That should be a good drinking quality. If drinking quality water cannot be guaranteed, the water can be subjected.

Figure 1.9 Filter

- **Ingredient addition systems**

Water and ingredients blending that mixes emulsifiers, coloring and flavouring with water. By using Mechanical agitators are very common pieces of equipment used in the oil processing plant.

Figure 1.10 .mixer or agitator

- **Uv-sterilizer**

UV Food Sterilizer (Ultraviolet Sterilization Machine) is mainly used for sterilizing various foods and packaging products, which can be widely used in hospitals, food processing industries, tea and beverage processing, and packaging plants. The UV food sterilizer machine can sterilize all kinds of foods according to the ultraviolet irradiation sterilization method, and can effectively kill various microorganisms (such as Escherichia coli and mycete) and bacteria therein, and can greatly reduce the bacteria in the food, thereby serving as food sterilization.

This high-efficiency food sterilization equipment uses high-frequency C-band ultraviolet rays to destroy DNA of various microorganisms in foods in 20 seconds to 1 minute and can kill 99% of bacteria and viruses, including influenza, hepatitis virus, salmonella, Escherichia coli, Staphylococcus aureus, Bacillus subtilis var, spores, and various mildew sources, allergens, etc. The ultraviolet food sterilizer machine is particularly suitable for the rapid sterilization of foods, medicines, cosmetics, tableware, personal and public goods, and other articles.

Figure 1.11 UV Food Sterilizer

- **Refrigeration system**

Refrigeration is a key operation in the margarine production plant. In the margarine industry, Freon 22 and ammonia were widely used as refrigerants. New regulations phasing out the use of chlorofluorocarbons (CFCs) are in place in many countries for environmental reasons. Plans for phasing out a hydrochlorofluorocarbon (HCFC) such as Freon 22 (R-22) are currently being made or in some countries are already in place. The layout of an ammonia compressor plant servicing an SSHE for margarine production.

Ammonia systems consist of a compressor designed to compress the low-pressure ammonia gas from the SSHE. The gas is then discharged from the compressor into the condenser. When ammonia is under a pressure of 150 psi (10 bar), it will liquefy at a temperature of $25.6C^0$ ($78F^0$). Condensers can be of the air-cooled or water-cooled type covering also evaporative condensers. From the condenser, the liquid ammonia flows to the receiver. The receiver in which the high-pressure ammonia liquid is stored maintains a constant supply of refrigerant to the SSHE.

- **Resting tube**

Resting Tube is important for final crystallization ensuring the right product consistency for packed products, especially table, cake and puff pastry margarine. The Resting Tube enables the crystal network in the fat to develop allowing sufficient time for it to form and settle prior to extrusion to the packaging machine.

Figure 1.12 Resting tube

Function and Principles of Operation

The Resting Tube is made of stainless steel AISI 316 and is equipped with a heating jacket to prevent the product from sticking. The resting tube has an internal sieving mechanism for uniform crystallization. All these attributes help ensure the constant steady flow rate necessary for a superior end product. Two different types of tubes are available, one for table margarine and one for puff pastry margarine. The resting tube is fully compatible with a wide range of different packing machine brands. Capacity up to 160 l. volume per section.

Advantages

- ✓ Secures a consistent end product
- ✓ Flexible
- ✓ Compatible with a wide range of packaging machines.

- **Pin worker unit**

Fats require time to crystallize. This time is provided in crystallizers normally called worker units, or B units. These are cylinders with larger diameters mounted with pins on the inside of the cylinder walls (stationary pins) and on the rotors (rotating pins) . The pins fixed to the concentric rotor are mounted in a helical arrangement that intermesh with the stationary pins of the cylinder wall. Worker units can be installed either between cooling cylinders of a multi cylinder. Worker units have the benefit of giving the margarine emulsion time to crystallize under agitation by the pins of the rotating rotor.

The worker unit is normally mounted with a heating jacket for tempered water on the cylinder and often also equipped with its own built-in water heater and circulation pump for the tempered water. This is advantageous in preventing product buildup on the cylinder wall and allows better product temperature control during the passage through the worker unit. Product temperature increases of $2C^0$ or more due to release of latent heat of crystallization and mechanical work can be observed in the worker unit . Worker unit cylinders usually have product volumes ranging from 35 L up to approximately 105 L per cylinder. B units with up to three worker cylinders mounted on the same support frame are available on the market. Each worker cylinder usually has its own individual drive with fixed or variable speed for maximum flexibility during processing of margarine. The design of a worker unit is illustrated.

Ensures the proper product plasticity, consistency and structure. The pin worker unit is mainly used for intensive treatment of margarine and edible fat products, in order to achieve a proper crystallization and right texture during the production process. Depending on product and desired consistency the pin worker unit can either be placed between the cooling steps or at the end of the cooling process.

Figure 1.13 Pin worker unit

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. Discus equipment of margarine production ?

Note: Satisfactory rating – 5 points Unsatisfactory - below 3 points

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

Score = ____________

Rating: _____________

Information Sheet 7- Carrying out Pre-start checks

7.1. Carrying out Pre-start checks

In an industry, there are many types of works to be operated using different machine and equipment. So before we are going to operate machine/lab equipment we have to inspect /check whether it was in a good operating condition or not. Before allowing someone to start using any machine you need to think about what risks there are and how these can be managed. Pre-start checks on machinery and equipment in used for margarine production process.conduct pre-start checks, such as

- inspecting equipment condition to identify any signs of wear,
- confirming availability of tank space,
- selecting appropriate settings and/or related parameters,
- confirming that equipment is clean and correctly configured for margarine production process requirements,
- positioning sensors and controls correctly,
- ensuring any scheduled maintenance has been carried out
- confirming that all safety guards are in place and operational
- Cancelling isolation or lock outs as required
- Confirming that required screens are fitted and related equipment is clean and correctly configured as per cleaning process requirements
- Positioning sensors and controls correctly
- Confirming that all safety guards are in place and operational
- Check that equipment is plugged in correctly
- Ensure that the electrical cords are in good condition and not frayed or broken.
- Start equipment in accordance with the organizations or manufacture's guidelines.
- Use safety guards or safety clothing (if applicable). Some equipment can have areas that can cause injury such as cutting blades and overheated areas.

Self-Check – 7	Written test

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

Test I: Short Answer Questions

1. List pre start checks requirement?

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

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

Score = ___________

Rating: ____________

Operation Sheet 1– Procedure for confirming Cleaning and maintenance requirement

Objective: To understand cleaning equipments requirement.

Purpose: To understand cleaning cycle in a margarine operation.

Steps cleaning cycle in a margarine operation

1 use personnel protective equipment

2 Remove residual fat and milk solids in the plant by means of drainage and forcing product out with water or compressed air.

3 Adhere preliminary wash with warm water about 49_C (120_F) for loosening fat and milk solids from sides of the equipment.

4 Clean with alkaline detergent solution at 60–70C^0 (140 –158F^0) for approximately 30 min to remove all traces of fat, milk solids, and other residues from the interior of the production line.

5 Remove and wash all blank ends and valves not suitable for CIP by hand.

6 Post rinsing with clean, warm water to remove the last traces of detergent.

7 Disinfect by means of heating with steam or hot water, alternatively disinfecting with chemical agents such as chlorine and other halogen compounds, benzoic acid washing, or quaternary ammonium salts. In the latter case, the cycle is concluded with a final rinse.

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

Task1. Procedure for confirming Cleaning and maintenance requirement

LG #54	LO #2- Operate and monitor the Margarine process

Instruction sheet

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

- Requiring workplace policies and procedures
- Starting and operating Margarine process.
- Identifying variation of equipment and processes in operating conditions.
- Identifying and reporting Variation in equipment operation and maintenance.
- Monitoring margarine process in specifications**.**
- Legislative requirements
- Identifying and rectifying and /or reported Out-of-specification product/process.
- Maintaining work area in housekeeping standards.
- Maintaining Workplace records.

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

- Require workplace policies and procedures
- Start and operate Margarine process.
- Identify variation of equipment and processes in operating conditions.
- Identify and report Variation in equipment operation and maintenance.
- Monitor margarine process in specifications**.**
- Legislative requirements
- Identify and rectify and /or report Out-of-specification product/process.
- Maintaining work area in housekeeping standards.
- Maintaining 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” which are placed following all information sheets. 5. If you earned a satisfactory evaluation proceed to “Operation sheets 6. Perform “the Learning activity performance test” 7. If your performance is satisfactory proceed to the next learning guide, 8. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Requiring workplace policies and procedures

1.1 What are Policies and Procedures?

Policies and procedures go hand-in-hand but are not interchangeable.
A policy is a set of general guidelines that outline the organization's plan for tackling an issue. Policies communicate the connection between the organization's vision and values and its day-to-day operations.

A procedure explains a specific action plan for carrying out a policy. Procedures tells employees how to deal with a situation and when.
Using policies and procedures together gives employees a well-rounded view of their workplace. They know the type of culture that the organization is striving for, what behavior is expected of them and how to achieve both of these.
Work is carried out according to

- company policies and procedures
- regulatory and licensing requirements,
- Legislative requirements, and
- Industrial awards and agreements.

1.1.1 company policies and procedures

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

1.1.2 Regulatory and licensing requirements

Regulation 5 of the Environmental Protection Regulations 1987 (EP Regulations) specifies that any premises listed in Schedule 1 of the EP Regulations is a prescribed premises.

- **Environmental Protection Regulations**

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

I. Solid waste and by-products

The amount of waste generated depends on the quality of the raw materials and on process efficiency. Wastes, residues, and by-products may be used for producing commercially viable by-products or for energy generation. Other solid wastes from the vegetable oil manufacturing process include soap stock and spent acids from chemical refining of crude oil; spent bleaching earth containing gums, metals, and pigments; deodorizer distillate from the steam distillation of refined edible oils; mucilage from degumming; and spent catalysts and filtering aid from the hardening process.

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

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

- Collect residues from the raw material preparation phase for conditioning (drying) and reprocessing (grinding) to yield by-products (e.g., animal feed).
- Return waste and residues to fields to assist in soil nutrient management; for example, EFBs from oil palm plantations with tree trimmings are a valuable soil amendment and/or can be composted with vegetable oil wastewater effluent.
- Use waste and residues for energy generation in the project plant's boiler(s).
- Investigate the following options for the responsible disposal of spent bleaching 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.
    - ✓ Consider use as a feedstock for brick, block, and cement manufacturing.
- Investigate the following options for the use of distillates (e.g., free fatty acids and volatile organic compounds (VOCs)), depending on the level of contaminants (pesticides and/or residues).
- The nickel catalyst from hydrogenation should be either: o recycled and recovered for reuse as a nickel catalyst or as nickel metal, salt, or other application, or o stored and disposed of according to the hazardous waste management guidance.
- Manage filtering aid mixed with nickel in accordance with the recommendations for nickel catalyst.

- Use uncontaminated sludge and effluent from on-site wastewater treatment as fertilizer in agricultural applications or as a supplemental boiler fuel.

II. Water consumption and management

Oil facilities require significant amounts of water for crude oil production (cooling water), chemical neutralization processes, and subsequent washing and deodorization. General recommendations to reduce water consumption, especially where it may be a limited natural resource. Sector-specific recommendations to reduce water consumption, optimize water use efficiency, and reduce subsequent wastewater volumes include the following:

- When economically viable, consider the use of physical refining instead of chemical refining to reduce water consumption.
- Replace water-based conveyor systems by mechanical systems (augers or conveyors).
- Apply Cleaning-in-Place (CIP) procedures to help reduce chemical, water, and energy consumption in cleaning operations.
- Recover and reuse condensate from heating processes.
- Upgrade equipment water sprays (e.g., to include jets or nozzles).
- Use dry cleanup techniques before rinsing floors.
- Manually clean vessels before rinsing to remove solids for recovery or disposal.
- Use high-pressure, low-volume washing systems, and auto shut-off valves.
- Vegetable oil processing wastewater generated during oil washing and neutralization may have a high content of organic material and, subsequently, a high biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

III. Energy consumption and management

Oil processing facilities use energy to heat water and produce steam both for process applications (especially for soap splitting and deodorization) and cleaning processes. Other common energy consumption systems include refrigeration and compressed air. In sector-specific recommendations include the following:

- Improve uniformity of feed to stabilize and reduce energy requirements.
- Increase efficiency of air removal in sterilization vessels to improve heat transfer.
- Identify and implement opportunities for process heat exchange; e.g., optimized oil-oil heat exchangers in continuous deodorization.
- Reduce stripping steam consumption by improving process efficiency; e.g., improve stripping tray design. Where possible, consider technologies such as dry ice condensing systems that may lower energy consumption.
- Consider co-generation (combined heat and power (CHP)) to improve energy efficiency.
- Consider more advanced approaches—such as the use of enzymes—for processes such as degumming and oil recovery.
- Where feasible, use anaerobic digestion for wastewater treatment and capture methane for heat and / or power production.

IV. Atmospheric emissions

Particulate matter (dust) and VOCs are the principal emissions from vegetable oil production and processing. Dust results from the processing, including cleaning, screening, and crushing, of raw materials, whereas VOC emissions are caused by the use of oil-extraction solvents, normally hexane.

Several sources within vegetable oil processing plants generate solvent emissions, including the solvent recovery unit, the meal dryer and cooler, leaks in piping and vents, and product storage. Additional emissions will result from the refining process if a fractionation method is used. Small quantities of solvent may be present in the crude vegetable oil if the oil has been extracted by a solvent and will volatilize during the oil refining process, particularly during deodorization. Odor emissions are produced by multiple sources (e.g., cookers, soap splitting, and vacuum generation).

V. Greenhouse gas emissions

The high nutrient loading of wastewater can be a source of methane (CH4) when treated or disposed of anaerobically. It can also be a source of nitrous oxide (N2O) emissions associated with the degradation of nitrogen components in the wastewater (e.g., urea, nitrate, and protein). Recommended measures to prevent and control non-fossil-fuel-related GHG emissions.

VI. Hazardous material

Vegetable oil processing involves the transport, storage, and use of bulk quantities of acids, alkalis, solvents, and hydrogen during extraction and refining. Their transport, storage, and handling provide opportunities for spills or other types of releases with potentially negative impacts on soil and water resources. Their flammability and other potentially hazardous characteristics also present a risk of fire and explosions.

1.1.3. Legislative Requirements

Legislative requirements means any applicable law, statute, bye-law, regulation, order, consent, permit, approval, regulatory policy, guidance or industry code, rule of court or directives or requirements of any Regulatory Body, delegated or subordinate legislation or notice of any Regulatory Body. Legislation is law which has been promulgated (or "enacted") by a legislature or other governing body or the process of making it.

Before an item of legislation becomes law it may be known as a bill, and may be broadly referred to as "legislation", while it remains under consideration to distinguish it from other business. Legislation can have many purposes: to regulate, to authorize, to outlaw, and to provide (funds), to sanction, to grant, to declare or to restrict. It may be contrasted with a non-legislative act which is adopted by an executive or administrative body under the authority of a legislative act or for implementing a legislative act.

1.1.4 Industrial awards and agreements

Industrial award: In simple terms, awards set the minimum standards that an employer in your industry is allowed to pay for your kind of work. More technically, it's a legal ruling which grants all employees in one industry or employer the same conditions of employment and wages. Awards are designed to protect employees' wages and conditions. An award is an enforceable document containing minimum terms and conditions of employment in addition to any legislated minimum terms.

In general, an award applies to employees in a particular industry or occupation and is used as the benchmark for assessing enterprise agreements before approval. Industrial agreements can contain anything that directly relates to the employment relationship between an employer and employees, such as conditions of employment, leave, training, consultation and remuneration.

Self-Check – 1	Written test

Name…………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

1. What are Policies and Procedures?

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

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

Score = ___________

Rating: ____________

Information Sheet 2- Starting and operating Margarine process

1.1 Introduction

Margarine can be made from a variety of animal fats and was once predominantly manufactured from beef fat and called oleo-margarine. Unlike butter, it can be packaged into a variety of consistencies, including liquid. No matter what the form, however, margarine must meet strict government content standards because it is a food item which government analysts and nutritionists consider to be easily confused with butter.

These guidelines dictate that margarine be at least 80% fat, derived from animal or vegetable oils, or sometimes a blend of the two. Around 17-18.5% of the margarine is liquid, derived from pasteurized skim milk, water, or soybean protein fluid. A slight percentage (1-3%) is salt added for flavor, but in the interest of dietary health some margarine is made and labeled salt free. It must contain at least 15,000 units (from the U.S. Pharmacopeia standards) of vitamin A per pound. Other ingredients may be added to preserve shelf life. From oil phase to crystallization

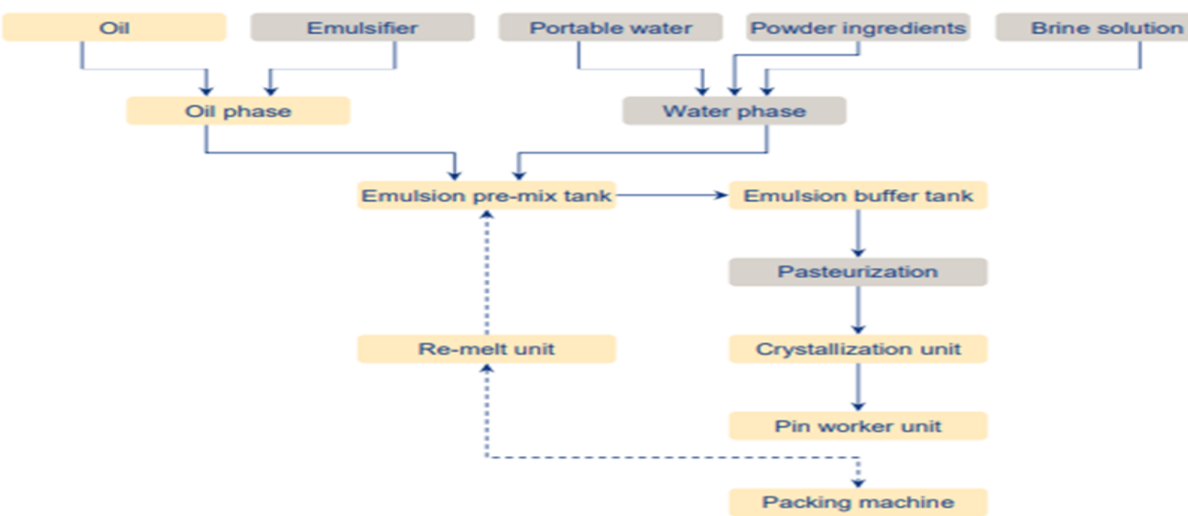


Figure 2.1 margarine production steps

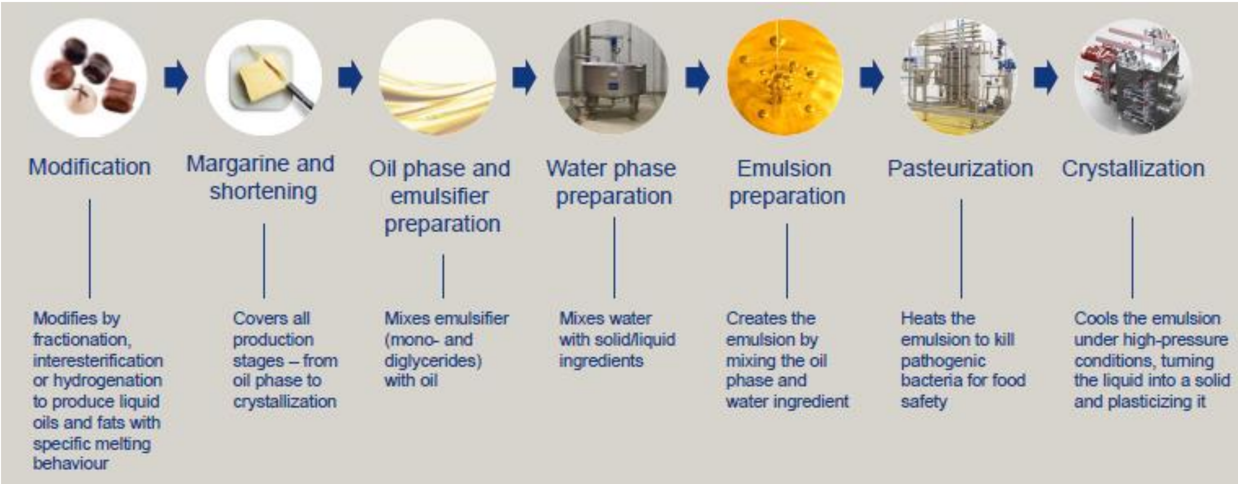


Figure 2.2 margarine process line

1.2 Margarine process

The margarine production process consists of five sections: the oil phase and water phase , the emulsion preparation, pasteurization ,chilling , crystallization and kneading and packing,. Any excess production is returned via a continuous rework unit to the emulsion tank.

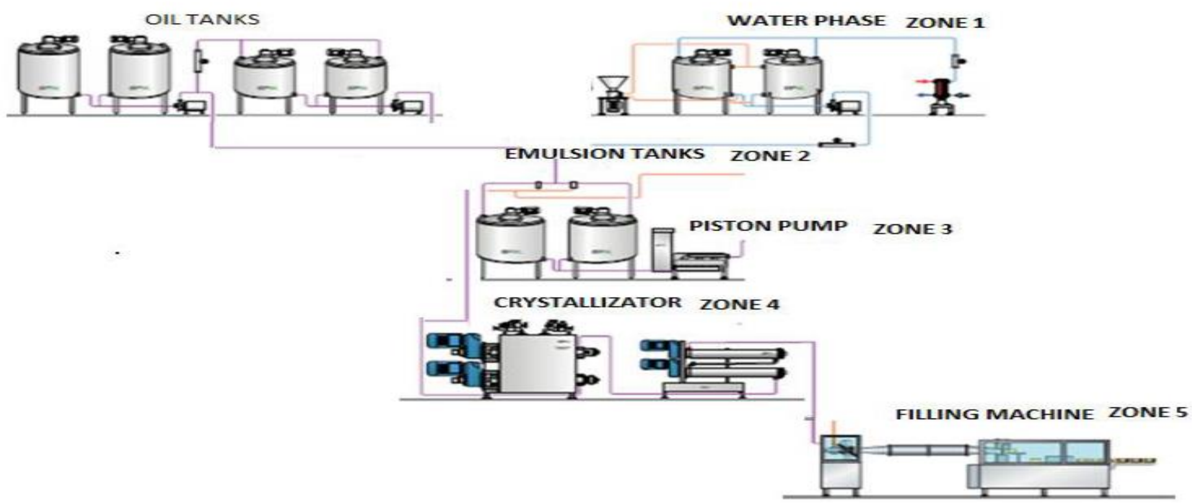


Figure 2.3: Margarine production

I. Oil phase and Water phase in margarine production

A pump transfers oil, fat or blended oil from storage tanks through a filter to a weighting system. To obtain the correct oil weight, this tank is installed above load cells. The blend oil is mixed according to a recipe.

In water phase, Insulated tanks are supplied for the production of the water phase. A flow meter doses the water into the tank where it is heated to a temperature above 45ºC. Dry ingredients such as salt, citric acid, hydrocolloids or skimmed milk powder may be added into the tank using special equipment such as a powder funnel mixer.

Apart from the water, the water phase can consist of salt or brine, milk proteins (table margarine and low fat spreads), sugar (puff pastry), stabilizers (reduced and low fat spreads), preservatives and water-soluble flavors. The major ingredients in the fat phase, the fat blend, normally consist of a blend of different fats and oils. In order to achieve margarine with the desired characteristics and functionalities, the ratio of fats and oils in the fat blend is decisive for the performance of the final product.

The various fats and oils, either as fat blend or single oils, are stored in oil storage tanks typically placed outside the production facility. These are kept at stable storage temperature above the melting point of the fat and under agitation in order to avoid fractionation of the fat and to allow easy handling. Apart from the fat blend, the fat phase typically consists of minor fat-soluble ingredients such as emulsifier, lecithin, flavor, color and antioxidants. These minor ingredients are dissolved in the fat blend before the water phase is added, thus before the emulsification process.

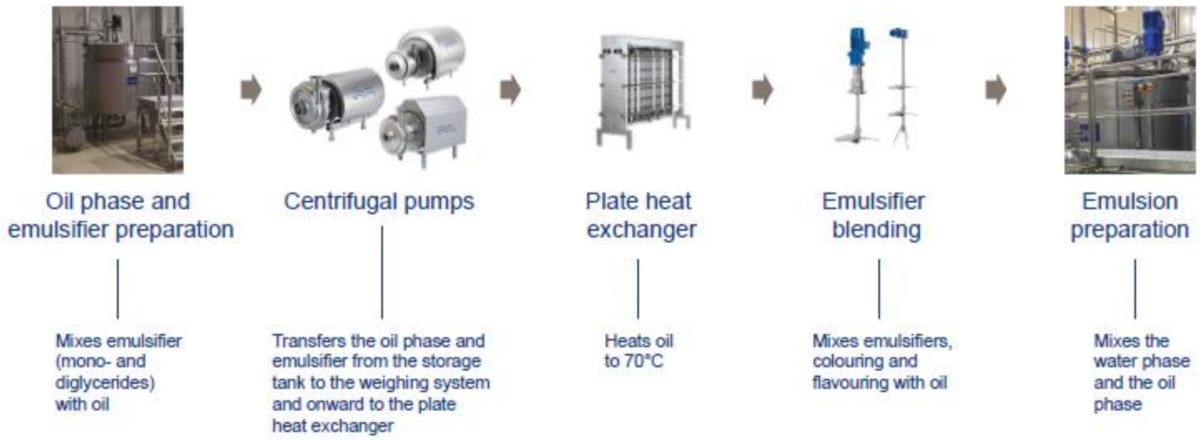


Figure 2.4 Shows oil phase

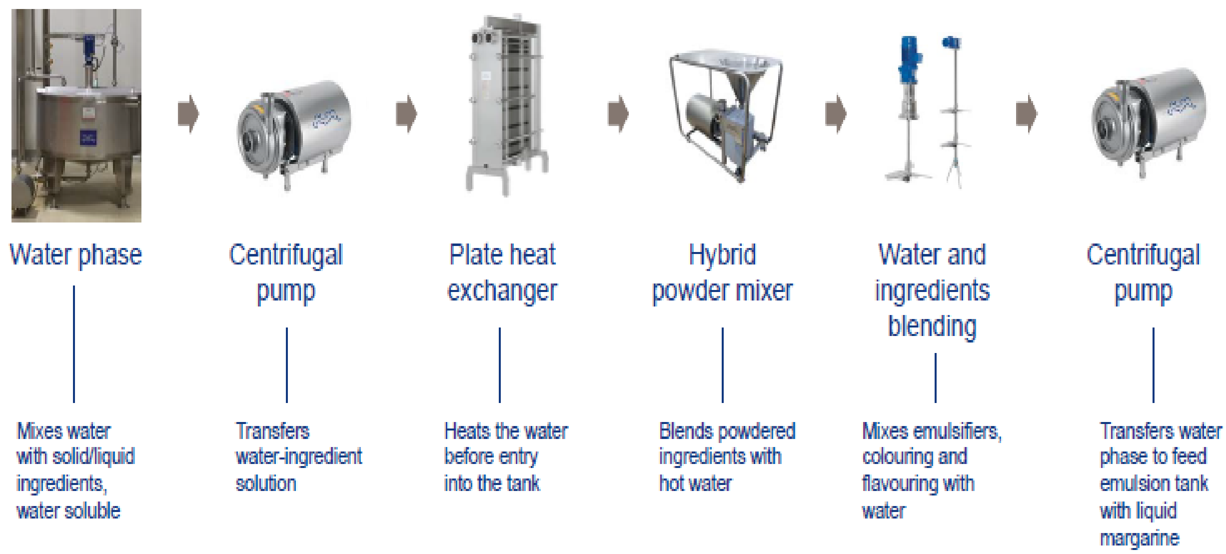


Figure 2.5 shows water phase

II. Emulsion preparation in margarine production

The emulsion is prepared by dosing oils and fats with the emulsifier blend and the water phase in the said order. Once the oil reaches a temperature of approximately 70°C, the emulsifiers such as lecithin, monoglycerides and diglycerides, usually in powder form, are manually added into the emulsifier tank. Other oil-soluble ingredients such as colouring and flavour may be added.

Mixing of the oil phase and water phase takes place in the emulsion tank. Here, other ingredients, such as flavour, aroma and colourant, may be added manually. A pump transfers the resulting emulsion to the feed tank. Special equipment, such as a high shear mixer, may be used at this stage of the process to make the emulsion very fine, narrow and tight, and to ensure good contact between the oil phase and the water phase. The resulting fine emulsion will create a high-quality margarine that exhibits good plasticity, consistency and structure. A pump then forwards the emulsion to the pasteurization area. Different systems can be used for metering the various ingredients for the emulsion of which two are working batchwise:

- Flow meter system
- Weighing tank system

A continuous in-line emulsification system is a less preferred but used solution in e.g. high capacity lines where limited space for emulsion tanks is available. This system is using dosing pumps and mass flow meters to control the ratio of the added phases into a small emulsion tank. The above-mentioned systems can all be controlled fully automatically. Some older plants, however, still have manually controlled emulsion preparation systems but these are labour demanding and not recommended to install today due to the strict traceability rules. The flow meter system is based on batch-wise emulsion preparation in which the various phases and ingredients are measured by mass flow meters when transferred from the various phase preparation tanks into the emulsion tank.

The accuracy of this system is +/-0.3%. This system is characterized by its insensibility to outside influences like vibrations and dirt. The weighing tank system is like the flow meter system based on batch-wise emulsion preparation. Here the amounts of ingredients and phases are added directly to the emulsion tank which is mounted on load cells controlling the amounts added to the tank.

Typically, a two-tank system is used for preparing the emulsion in order to be able to run the crystallization line continuously. Each tank works as a preparation and buffer tank (emulsion tank), thus the crystallization line will be fed from one tank while a new batch will be prepared in the other and vice versa. This is called the flip-flop system. A solution where the emulsion is prepared in one tank and when ready is transferred to a buffer tank from

Figure 2.6 emulsion preparation

III. Pasteurization in margarine production

A skid-mounted pasteurization unit handles in-line pasteurization. A pump transfers the emulsion through a wire mesh filter to a plate heat exchanger for pasteurization. Another pump facilitates the circulation of hot water through the plate heat exchanger. Pasteurization occurs at temperatures between 80°C and 85°C; the process takes several seconds. Heating the emulsion inhibits the growth of bacteria and other micro-organisms and improves the stability of the emulsion. The emulsion typically leaves the pasteurizer at a temperature of between 45°C and 50ºC. Heat processing the emulsion to eliminate bacteria and ensure food safety. Pasteurization of the water phase only is a possibility, but pasteurization of the complete emulsion is preferred since the pasteurization process of the emulsion will minimize the residence time from pasteurized product to filling or packing of final product.

In addition, pasteurization of the complete emulsion ensures that the emulsion is fed to the crystallization line at a constant temperature achieving constant processing parameters, product temperatures and product texture. In addition, occurrence of pre-crystallized emulsion fed to the crystallization equipment is prevented when the emulsion is properly pasteurized and fed to the high pressure pump at a temperature 5-10°C higher than the melting point of the fat phase.

Figure 2.7 pasteurization process

Margarine pre-cooling before crystallizations that is the application between pasteurization and crystallization .

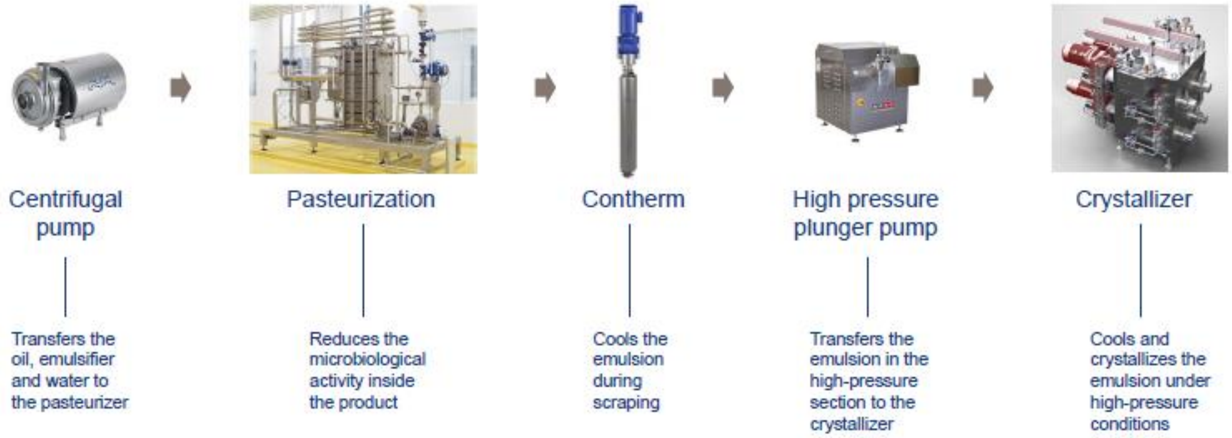


Figure 2.8 Margarine pre-cooling before crystallization

IV. Chilling ,Crystallization and kneading in margarine production

A high-pressure pump transfers the emulsion to a high-pressure scraped surface heat exchanger (SSHE), which is configured according to the flow rate and recipe. There may be various cooling tubes of different sizes and different cooling surfaces. Each cylinder has an independent cooling system into which the refrigerant (typically ammonia R717) is directly injected. Product pipes connect each cylinder to one another. Temperature sensors at each outlet ensure proper cooling. The maximum pressure rating is 120 bar.

Depending on the recipe and application, the emulsion may need to pass through one or more pin worker units prior to packing. Pin worker units ensure the proper plasticity, consistency and structure of the product. Pin rotor machine(s) and/or intermediate crystallizers are often included in the line in order to add extra kneading intensity and time for the production of plastic products.

A resting tube is the final step of the crystallization line and is only included if the product is packed. which the warm emulsion is super-cooled and crystallized on the inner surface of the chilling tube. The emulsion is efficiently scraped off by the rotating scrapers, thus the emulsion is chilled and kneaded simultaneously. When the fat in the emulsion crystallizes, the fat crystals form a three-dimensional network entrapping the water droplets and the liquid oil, resulting in products with properties of plastic semi-solid nature.

Depending on the type of product to be manufactured and the type of fats used for the particular product, the configuration of the crystallization line (i.e. the order of the chilling tubes and the pin rotor machines) can be adjusted to provide the optimum configuration for the particular product. Since the crystallization line usually manufactures more than one specific fat product the GS Nexus, GS Kombinator or GS Perfector often consists of two or more cooling sections or chilling tubes in order to meet the requirements for a flexible crystallization line. When producing different crystallized fat products of various fat blends, flexibility is needed since the crystallization characteristics of the blends might differ from one blend to another.

The crystallization process, the processing conditions and the processing parameters have a great influence on the characteristics of the final margarine and spread products. When designing a crystallization line, it is important to identify the characteristics of the products planned to be manufactured on the line. To secure the investment for the future, flexibility of the line as well as individually controllable processing parameters are necessary, since the range of products of interest might change with time as well as raw materials. The capacity of the line is determined by the cooling surface available of the GS Nexus, GS Kombinator or GS Perfector. Different size machines are available ranging from low to high capacity lines.

Also various degrees of flexibility are available from single tube equipment to multiple tube lines, thus highly flexible processing lines. After the product is chilled in the GS Nexus, GS Kombinator or GS Perfector it enters the pin rotor machine and/or intermediate crystallizers in which it is kneaded for a certain period of time and with a certain intensity in order to assist the promotion of the three-dimensional network, which on the macroscopic level is the plastic structure. If the product is meant to be distributed as a wrapped product it will enter the GS Nexus, GS Kombinator or GS Perfector again before it settles in the resting tube prior to wrapping. If the product is filled into cups, no resting tube is included in the crystallization line.

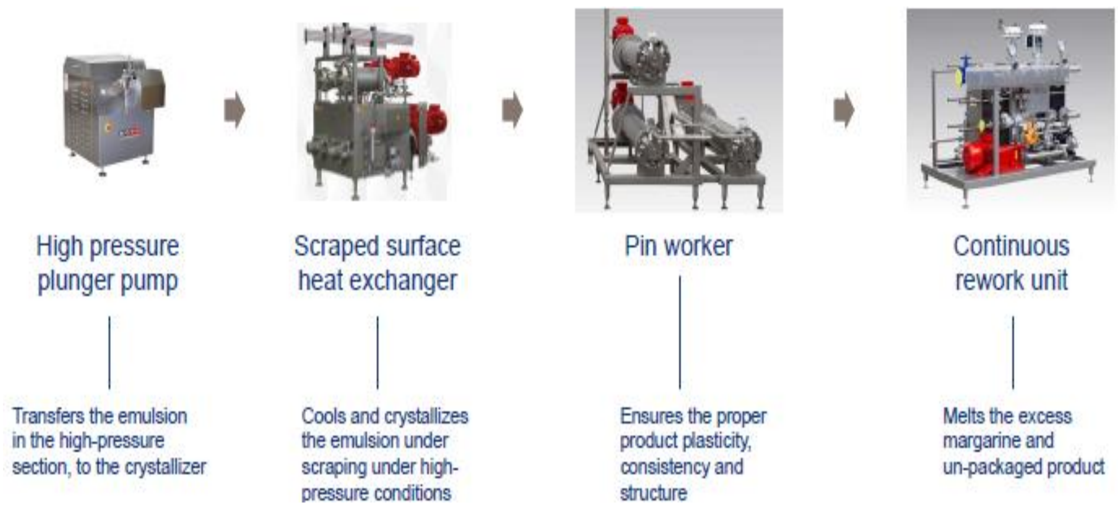


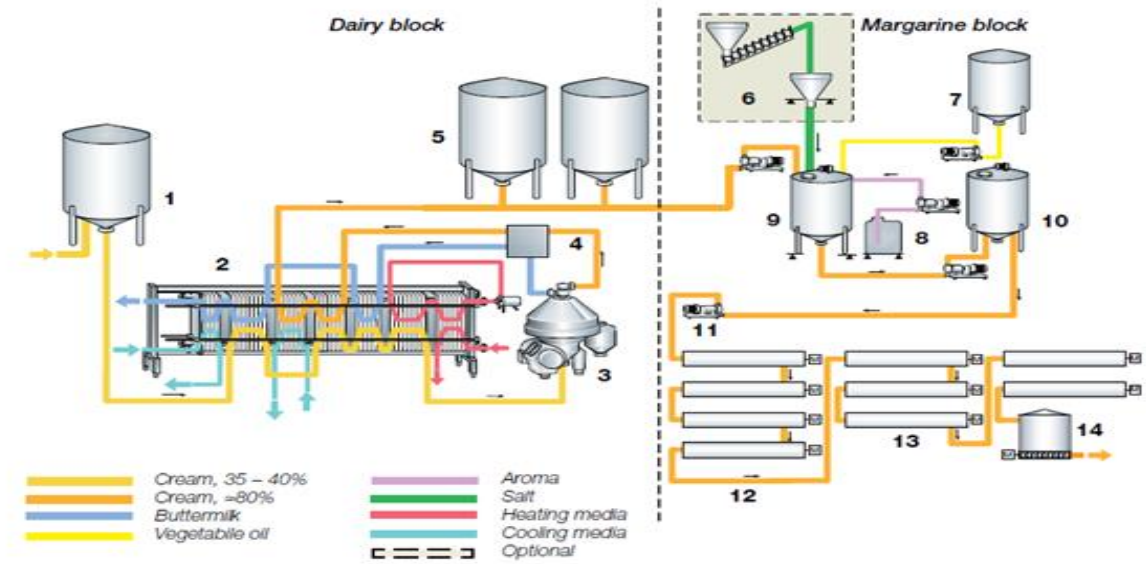
Figure 2.9 Crystallization

V. Packing, Filling And Remelting

Various packing and filling machines are available on the market. However, the consistency of the product is very different if it is produced to be packed or filled. It is obvious that a packed product must exhibit a firmer texture than a filled product and if this texture is not optimal the product will be diverted to the remelting system, melted and added to the buffer tank for re-processing. Different remelting systems are available but the most used systems are PHE or low pressure SSHE.

1.5 Margarine Process Line

It consists of two blocks one is "dairy block" wherein the cream concentration, pasteurization and cooling of cream takes place and other is "margarine block" wherein preparation of the mix and phase inversion accompanied by working and cooling takes place.



Dairy Black

1. Salt dosage, optional
2. Vegetable oil tanks
3. Flavour Dosage
4. Mixing
5. Buffer tank
6. High pressure pump
7. Scrapped surface cooler
8. Pin rotars
9. Silo with screw conveyor in the bottom

Dairy Black

10. Cream Tank
11. Plate Heat Exchanger
12. Centrifugal Cream Concentrators
13. Cream Standardization
14. Pre-crystallization tanks

Figure2.10 Process line for the production of Spreads

Dairy block: Starts with pasteurized cream of 35 to 40 % fat content. Temperature is adjusted to 60 – 70°C before it enters the cream concentrator. Cream fat content is automatically controlled by the continuous standardization device and 82 – 84% fat level is reached in concentrator. Cream is then cooled to 18 – 20°C, before being routed to a holding/pre-crystallization tank.

Margarine block: In margarine black product mix is prepared and various ingredients are mixed together, according to the recipe. Concentrated cream is mixed with appropriate volumes of vegetable oil, salt and water phase. After thorough mixing, the mixture is pumped into a buffer tank. The process is continuous from the buffer tank, from which the product mix is taken to the high pressure pump.

It is then fed into the scraped surface coolers, where phase inversion takes place. Before final cooling, the spread is held and worked by pin rotors. The pin-rotors, besides further crystallizing the emulsion, also physically breaks up and works the crystals to improve the texture of the final product. Product enters final cooling stage and then to storage silo. From silo, it is pumped into the filling machine, often a tub-filling machine.

1.3 Product characteristics

The consumer-directed functional aspects of spreads and margarines, which primarily depend on fat level, type of fat, and stability of the emulsion, are spreadability, oiliness, and melting properties. Spattering, this is a concern for products intended for pan frying.

- **Spreadability**

Spreadability is one of the most highly regarded attributes of margarine, perhaps second only to flavor. Products with a solid fat index (SFI) of 10–20 at temperature were found to be optimal on a consumer panel. The standard method for evaluation of hardness of fatty materials uses a conepenetrometer. For some products, hardness measurements may not correlate well with SFI because, in addition to the amount of solid fat, the fat crystal network, which is processing dependent, is also important rheologically.

The penetration is the distance, in units of 0.1 mm, traveled by a standard cone in 5 s after its release on the surface of the product. The values may be converted mathematically to a hard-ness index or to a yield value that are independent of cone weight. In an assessment of hedonic spreadability preferences of butter, margarines, and spreads as a function of temperature, correlation with penetration measurements indicated optimum spreadability in the yield value range of 30–60 kPa(kilo paschal) . Dynamic techniques involving motor driven penetrometers, extrusion devices, viscometers and a mechanical spectrometer also have been used to evaluate margarine consistency.

Although the action of a penetrometer may seem different from assessment of the spreadability with a knife, both techniques evaluate the force required to bring about a significant deformation, and conepenetrometer readings have been found, in general, to correlate with spreadability. This method has the advantage of low equipment cost, minimal sample preparation, and reproducible results. Smoothness and brittleness, which depend on the crystal network and are not measured with the conepenetrometer, were measured by means of an Instroncompression test. Compression of cylindrical samples was found to be the most sensitive method for detecting differences in textural attributes.

Constant speed penetration was the next most sensitive, whereas the cone penetrometer was least sensitive. These methods were also used to evaluate a series of soft margarines . Instrumental methods are used by manufacturers to ensure product uniformity and for comparison with competitive products. The sample is generally evaluated at a single temperature, most often in the 4.4–10C^0 (40–50F^0) range. The results are meaningful only at the measurement temperature. For example, two margarines with the same solids content at 7.2C^0 (45F^0) may have much different solids temperature slopes at that point; one has significantly greater solids at 4.4C^0 (40F^0) and less solids at 10C^0 (50F^0) than the other. One must consider this when attempting to relate spreadability measurements to consumer perception in the home, where storage and use conditions are variable.

- **Oil Separation**

Oil-off occurs in margarine when the matrix of fine fat crystals is no longer of sufficient size or character to be able to enmesh all of the liquid oil. The problem is most serious for stick products as the outside of the inner wrappers may become oil soaked, and if severe, oil will leak out of the package. Prints are also the most susceptible to oil off because of the pressures to which the product is subjected when pallets or individual packages are stacked. If the margarine is to be merchandised outside of dairy cases, the 21.1C^0(70F^0) SFI should be specified as high as possible, consistent with 10C^0 and 33.3C^0 (50F^0 and 92F^0) requirements.

Soft margarines in bowls are not as much a problem because the package supports and contains the product. Emulsion damage, that is, coalescence and settling of the milk phase, seldom will be significant as long as 3–4% solid fat remains. Oil-off testing is most often conducted by placing a margarine sample of defined geometry and weight on a wire screen or on filter paper at a temperature of 26.7C^0(80F^0), or sometimes greater, for a period of 24–48 h. The oil exuded into the filter paper or through the screen is then measured. Another test used for determining structural stability, most often for stick margarine, is slump. This involves placement of a standard size cube of margarine at 23.9–29.4C^0 (75–85F^0) for several hours. Deformation of the cube is graded according to visual reference to a standards lump chart. Results of these types of test are only directional; products are more appropriately evaluated in the package under actual distribution conditions.The harshest of such conditions would generally be a stacked, out of dairy case display as can be observed in some markets.

- **Melting**

High-quality table margarine melts quickly with a cooling sensation on the palate. Flavor and salt components of the aqueous phase are immediately perceptible by the taste buds, and there is no lingering greasiness or waxiness. The factors affecting these qualities are the melting profile of the fat, the tightness of the emulsion, and the storage conditions of the finished product. In order for a margarine to melt cleanly without seeming gummy or waxy, it should be completely melted at body temperature and contain less than 3.5% solid fat at $33.3C^0$ ($92F^0$). A cool tasting product, typified by butter, results from the almost instantaneous absorption of the heat of crystallization due to a steep melting profile between $10C^0$ and $26.7C^0$($50F\ ^0$and $80F^0$).

The cooling sensation, as measured by differential scanning calorimetry, is significant only for butter and high-fat stick margarines and spreads. When margarine is produced, quick chilling results in solid solutions of high-and low-melting glycerides. If the product subsequently is stored at higher temperatures for several days, the recrystallization of the higher melting portions of the melted solid solutions may result in a product with greater waxiness and a slower flavor release.

Emulsion tightness is a function of processing, emulsifier content, and formulation of the aqueous phase. If the aqueous droplets are uniformly small or heavily stabilized with emulsifiers, the flavor and salt release will be delayed. A margarine in which about 95% of the droplets have a diameter of 1–5mm, 4% of 5–10 mm, and 1% of 10–20 mm is described as light on the palate. Droplet size also affects the microbiological susceptibility of the product and, to some extent, the consistency. Apulsed nuclear magnetic resonance (NMR) method for determining droplet size based on restricted diffusion in droplets has been reported.

Zschaler has described a method for microscopically evaluating the size distribution of the aqueous phase in margarine. For low-fat spreads the rheological changes generally associated with melting may be more a function of the stabilizers employed and the degree of emulsification than the melting behavior of the fat blend. This is also true of some of the oil-in-water emulsion-type products containing very little fat or no solid fat that have recently appeared in the market place. Melting quality usually is assessed by oral response. Such evaluations are run under standard conditions using an established rating scale. Empirical methods also have been used in attempts to quantify melt in the mouth properties that depend on both emulsion tightness and the melting profile of the fat blend.

Moran describes a ‘‘phase instability temperature,’’ which is the temperature at which the product shows a marked increase in electrical conductivity under shear conditions similar to those that occur on the palate. A viscometer is used in the determination, which is intended for low calorie products. Cooling sensation on the palate has been estimated by recording the temperature drop in a $35C^0$ ($95F^0$) metal sensing head when placed in contact with the product for 6 s.

The rate of salt release has been evaluated by determining the chloride ion increase in water at $36C^0$ ($97F^0$) in which a margarine sample is suspended. Softening point, which may relate to how a product will melt in hot food applications, can be measure dusing a Mettler dropping point apparatus. The softening points of a series of soft and stick margarines have been determined

1.6 Affecting Parameters in Margarine Processing

For most consumers, the textural (hardness) attributes of margarines is a key factor influencing its performance in the final products (Liu et. al, 2010).

Margarines designed for such applications have to possess specific properties in order to make the final product satisfying: to be very firm and to have a good plasticity without being oily. Predetermined plasticity, hardness and solid fat content profile are the main

Requested properties. Several studies show that formulation is a key factor affecting the final product quality, and the process conditions are critical factors (Lefebure et al., 2012).

For optimum baking performance, bakery margarine should contain a minimum of 10% solid fat content (SFC) at 20C^{o} to prevent oil exudation or oiling off. In addition, it should also contain a minimum of 8% SFC at working temperature (25C^{o}) to withstand dough making. In addition, it should have a high consistency or firmness without the need for refrigeration. Another important characteristic of bakery margarine is the crystallization in the form of b‟ in order to produce cookies with a crispier and better snap texture (Cheong et al., 2009).

SFC is one of the physical parameters associated with the quality of margarine including general appearance, oil exudation, organoleptic properties, and spreadability (Saadi et al., 2011). There are a couple of different characteristics of shortening margarine, which can be classified as structure, hardness, plasticity, and spreadability (Wiedermann, 1972). These end product properties are related to a number of different parameters. The most important two main parameters are formulation of emulsion (the amount of solid triglycerides or solid fat index) and processing conditions during shortening margarine production (Haighton, 1976).

Formulation or choice of oil blend allows control of the solid content, which, for identical processing conditions, is directly related to the consistency and type of crystalline structure formed (Haighton, 1976; Thomas, 1978). Processing conditions (rate and degree of cooling, mechanical working, final product temperature, etc.) regulate the type of crystals formed and the morphology and extent of intertwining of the solid structure that holds the liquid oil (Rivarola et al., 1987).

There is a relationship between the solid fat content of emulsion and its hardness. When solid content of emulsion decreases, that is mean margarine loses some of plastic properties, the hardness of margarine is also goes down sharply (deMan, 1964). There is a strong correlation between the hardness of margarine and solid content under same process production conditions .

All of the structure levels that lead to good technological functionality, a factor that is determined by the macroscopic properties of the fats. The formulation (amount of solids), the polymorphism of the solid state (the microstructure of the network of crystalline particles) play a role in the development of the macroscopic properties, and all of these factors are influenced by processing conditions (Vereecken et al., 2007).

The physical properties of the product is the result of the complex interactions of a range of factors including the polymorphism, formulation (solid fat content, composition) margarines related to process conditions (Liu et al., 2010).

1.7 Factors Which Affects Rheological Quality of Margarine

Solid fat content (SFC): The solid attributes of a margarine fat through a temperature range is characterized by its SFC or solid fat index (SFI) profile. SFC is an important property of an oil or fat, and is the ratio of the solid to the total phase at a particular temperature. SFC is measured by nuclear magnetic resonance (NMR) spectroscopy as the number of protons in the solid state over the total number of protons in the fat, i.e. in both solid and liquid states. The consistency of margarine at any temperature can be predicted from its SFC or SFI at that temperature. The SFC and crystal components are responsible for the consistency of the margarine.

Polymorphic form: polymorphic forms are the solid phases of the same chemical composition with different crystalline structures, but which yields identical liquid phases on melting. Polymorphs are the different forms of the solid state; this is due to existence of TAG molecules in a number of crystal forms. TAGs can crystallize in different polymorphs with the four major forms being sub-α, α, β’ and β. However, the fat crystals in margarine and shortening are only in β’ and β forms. A pure TAG would be most stable in the β form, but a mixture of TAGs will be most stable in the β’ form. Transformation from one polymorph to another can occur in the solid state without melting.

The change is from the lowest to the highest melting point, that is, α to β’, β’ to β. Several factors that influence polymorphism, for example, purity of the fatty acids, temperature, rate of cooling, presence of crystal nuclei and the type of solvent used. The β'-crystal polymorph occurs as single needle-shaped crystals about 5–7 mm long, while the β-crystal polymorph is 20-30mm long. The smaller the crystal, the smoother is the product, while bigger crystals will impart a coarse, grainy and brittle texture.

FAT POLYMORPHISM (α, β' and β)

The most common types of fat crystals in edible shortening and margarine products belong to the following three categories:

- alpha
- beta prime
- beta

- **Alpha Crystals(α)**

Alpha crystals are first formed when the blended fat containing hard stock (saturated n triglycerides) or hard stock (by itself) is chilled rapidly. Alpha crystals can be characterized as:

- ✓ Randomly oriented crystals with an approximate diameter of 5 µm.
- ✓ Transparent or translucent in appearance.
- ✓ Loosely packed with an ill-defined hexagonal sub cell structure.
- ✓ Having the lowest melting point among all the three forms of crystals.
- ✓ Extremely unstable and readily transformed to beta prime or beta form.

Transformation from alpha to beta prime or beta can occur under ambient conditions. This is carried out via controlled temperature conditions in the crystallization process for manufacturing shortening or margarine.

- **Beta Prime Crystals(β')**

The beta prime crystals can be described as:

- ✓ Tiny, needle-shaped, cross-linked crystals that form three-dimensional structures.

- ✓ Large amounts of liquid oils can be held in the interstitial spaces between the crystals.
- ✓ The crystals are typically 1-μm long. The alternating fatty acid chain axes are oppositely oriented.
- ✓ Crystal diameters range from 3.8 to 4.15 μm, which is smaller than the alpha crystals. The crystal size and shape is strongly influenced by processing and packing procedure applied. These numbers are for comparison purposes.

- **Beta Crystals(β)**

Beta crystals are formed from beta prime crystals. This transformation can take place naturally with storage of the product or through thermal manipulation of the beta prime crystals. Generally, β„ polymorphic form is desirable for margarines, which gives product a smooth consistency and spreadability. But according some studies, the β„ crystal polymorph occurs in single, needle shaped crystals about 5–7 micrometers in length, whereas the β crystal polymorph is about 20–30 micrometers. The smaller the crystal size is, the smoother the product is, and thus the more β crystals in margarine make the product harder (Liu et al., 2010).

Transformation from alpha to beta with a very short duration in the beta prime state can occur when:

- ✓ The saturated triglyceride (hard stock) is strongly beta stable.
- ✓ The crystallization of product containing beta stable hard stock is cooled at a slower rate.
- ✓ When the triacylglycerol (also referred to as TAG) or the oil molecule population is very uniform and homogeneous in terms of carbon chain length and saturation.

Beta crystals exhibit the following characteristics:

- ✓ The crystals do not form three-dimensional structures like beta prime crystals.

- ✓ Unlike beta prime crystals, these fat crystals cannot hold liquid oil in the interstices.
- ✓ The crystals are 25–50 μm long and can grow up to 100 μm in length.
- ✓ The crystals have a diameter of 4.2 μm.
- ✓ The melting point is the highest among the three types of crystals.
- ✓ The fatty acid chain axes are oriented in the same direction.

Melting Points of the Three Polymorphic Phases

It was briefly mentioned earlier that the three polymorphic phases have different melting points and that the beta crystals have the highest melt point of the three types of fat crystals. The following example will illustrate the point. Crystals obtained from tristearine, where all three glyceride links are occupied by stearic acid, demonstrated the following melting points.

Polymorphic state	Melting point, °F (°C)
Alpha	129.2 (54)
Beta prime	147.2 (64)
Beta	163.4 (73)

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

1. Briefly discus margarine production process?
2. What are two blocks of margarine production line?
3. List margarine product characteristics?
4. Discus the three common types of crystals in edible shortening and margarine products?

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

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

Score = ___________

Rating: ____________

Information Sheet 3- Identifying variation of equipment and processes in operating conditions

3.1 Identifying variation of equipment

Margarine production processing has 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.

3.2 Identifying variation of processes

Manufacturing processes have many factors that influence their success, and in each, the possibility of variation is introduced.

A Raw Materials

All manufacturing processes begin with raw materials, whether it's ore 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.

B 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.

C Human Actions

Humans are by nature variable. 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.

D Environment

Changes in temperature and humidity affect various processes. Also, some manufacturing 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.

E Method

A manufacturing 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.

Self-Check – 3	Written test

Name………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

1. List cause of process variation ?

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

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

Score = ___________

Rating: ____________

Information Sheet 4- Identifying and reporting Variation in equipment operation and maintenance

4.1 Reporting variation in equipment operation and maintenance.

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

Table 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 – 4	Written test

Name……………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

1. What are causes of equipment variation?

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

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

Score = ___________

Rating: ____________

Information Sheet 5- Monitoring margarine process in specifications

.1 Monitoring margarine process in specifications
Critical control points for margarine are

- **Fatty acid composition**

The packed column method is especially suitable for analyzing hydrogenated fat because it is capable of providing fatty acids identities and compositions, and TFA and cis–cis methylene-interrupted unsaturation. This method yields slightly lower trans values as compared to the infrared spectrophotometric method (AOCS Method Cd 14-61).

✓ **trans fatty acid**

Applications of the two major assay methods for TFAs so far known are infrared absorption spectroscopy and capillary gas-liquid chromatography. Infrared spectroscopy is the classical method routinely used to determine TFAs in foods over the last two decades. Generally infrared spectroscopy measurements are carried out using TFA methyl ester-derivatives. A major problem is that samples analyzed by infrared spectroscopy as methyl esters produce trans levels that are 1.5%-3.0% lower for trans values from 1 to 15% (IFST, 2004). Gas-liquid chromatography seems now the most popular technique. It is widely available and allows identification of individual fatty acids when the suitable standards are available, whereas infrared absorption spectroscopy does not (ISEO, 2006).

Trans fatty acids (TFA) are the fatty acids (FA) containing one or more double bonds in the trans configuration as opposed to the cis configuration that is predominant in vegetable oils and animal fats. Because of the structurally relaxed position of trans isomers of FA, rapid trans formation occurs during industrial hydrogenation of cis unsaturated FA of liquid vegetable oils . The amount of TFA formed varies considerably depending on the hydrogenation technique and the original quantity of C18 unsaturated FA. TFA may also form during the deodorization process of fat and oil manufacturing at high temperature ($200C^0$ because of the isomerization of polyunsaturated FA (PUFA), such as linoleic (C18:2 n6) and α-linolenic (C18:3 n3). Their absolute amount in vegetable oils mainly depends on time and technological condition of deodorization.

- ✓ **Total fatty acid**

Total-fatty acids in order to assess the fatty acid composition of products independently of the total-fat content. We also calculated the ratio of stearic acid (C18:0) to total saturated fatty acids as an indicator of differences in the composition of specific saturated fatty acids.

- ✓ **Saturated fatty acid**

Saturated fatty acids are long-chain carboxylic acids generally consisting of 12-24 carbon atoms and no double bonds (Figure 2.3 and 2.4) (Christie 2009b). The term 'saturated' refers to the fact that the acid is 'saturated' with hydrogen atoms, these fatty acids are straight or linear, without any kinks in their molecular structure. Examples of saturated fatty acids include butyric, lauric, myristic, palmitic and arachidic acids.

Butyric Acid (C4:0)

Butyric acid is a short-chain saturated fatty acid consisting of a four-carbon chain. Butyric acid, also referred to as butanoic acid, is not found in significant quantities in many fats or oils. Of commonly eaten fats, butterfat contains the highest butyric acid concentration at approximately 4% of total fatty acids (Fallon 1996). Short-chain fatty acids such as butyric acid are digested faster than medium- and long-chain fatty acids. This makes them quickly available as sources of energy (Bell and others 1997).

Lauric Acid (C12:0)

Lauric acid is a major component of both coconut and palm kernel oil (41-56% and 41-55%, respectively) (Gunstone and others 1994). Lauric acid is a medium-chain fatty acid not typically found in high concentrations in animal or vegetable fats and oils with the exceptions of palm kernel and coconut oil (Christie 2009b).

Myristic Acid (C14:0)

Myristic acid is also an important component in coconut and palm kernel oil (13-23% and 14-20%, respectively) (Gunstone and others 1994). Myristic acid is found in butterfat and is a minor component of other animal fats. Myristic acid is found in most living organisms but usually at levels of 1-2% or less (Christie 2009b).

Palmitic Acid (C16:0)

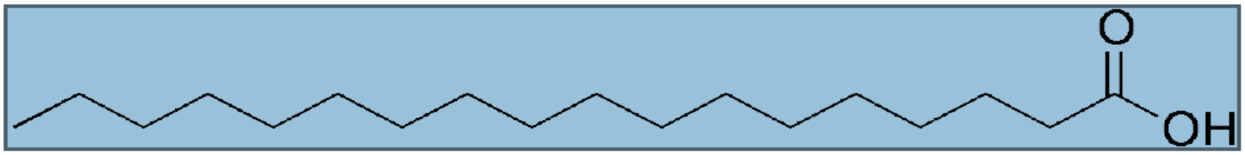
Palmitic acid is one of the most commonly found saturated fatty acids in nature although not in large amounts. It is a major component of cottonseed oil (17-31%) and palm oil (32-59%). Palmitic acid is present in almost every animal and vegetable fat and oil. Animal fats from pig, sheep, and cattle can contain 20-37% palmitic acid (Gunstone and others 1994).

Stearic Acid (C18:0)

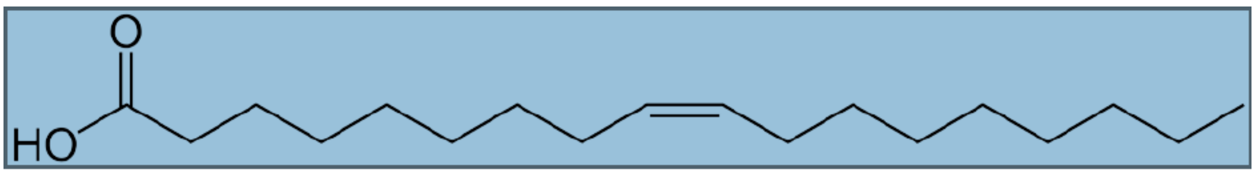
Stearic acid is found in many ruminant animal fats (tallows contain 5-40%). It can be obtained through complete hydrogenation of unsaturated C18 fatty acids. Stearic acid is less common than palmitic acid although it is a component of most vegetable fats. There are significant levels in cocoa and Shea butters which are not used in the spreads industry (Gunstone and others 1994). Apart from palmitic acid, stearic acid is the second most prevalent saturated fatty acid found in natural fats and oils (Christie 2009b). From a health standpoint, it has been found to have a neutral effect on serum cholesterol levels when compared to other saturated fatty acids (Bonanome and Grundy 1988).

Arachidic Acid (C20:0)

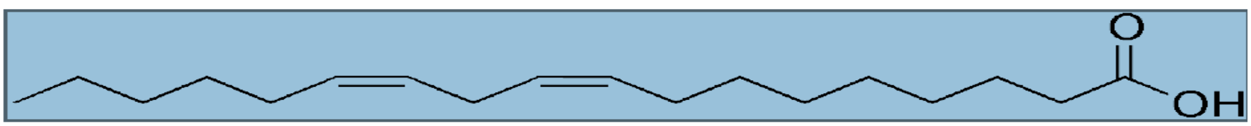
Arachidic acid is found at low levels in most animal and vegetable fats and oils. Peanut oil contains a relatively high concentration of arachidic acid at 1.1-1.7% (O'Brien 2009). This fatty acid is a precursor to arachidonic acid (an omega-6 fatty acid) (Christie 2010).



Saturated Fatty Acid (Stearic acid)



Monounsaturated Fatty Acid (Oleic acid)



Polyunsaturated Fatty Acid (Linoleic acid)

Figure 2.11 Saturated, monounsaturated, and polyunsaturated fatty acid structures

- **Moisture content**

Method indicated in IUPAC (1979) was used to determine moisture content and the result is expressed as:

$$\text{Moisture content} = \frac{m - m_1}{m} x100$$

Where, m is the mass in g of test sample and m1 is the mass in g of the fat after heating. The moisture content shall not exceed 17%.

- **Free fatty acid**

Free fatty acids (FFA) are produced by the hydrolysis of oils and fats. The level of FFA depends on time, temperature and moisture content because the oils and fats are exposed to various environments such as storage, processing, heating or frying. Since FFA is less stable than neutral oil, they are more prone to oxidation and to turning rancid. Thus, FFA is a key feature linked with the quality and commercial value of oils and fats.

- **Iodine Value**

Titration methods by 0.1 m thiosulphate solution were used for the determination of iodine value. Whereas iodine value is calculated using:

$$\text{Iodine value} = \frac{12.69C(V_1 - V_2)}{M}$$

Where:

C is the numerical value of the exact concentration in moles per liter of the standard Volumetric sodium thiosulphate

V1 is the numerical value in the milliliters of standard volumetric sodium thiosulphate Solution used for the blank

V2 is the numerical value in the milliliters of standard volumetric sodium thiosulphate Solution used for the determination of the test sample

M is the numerical value of the mass in grams of the test portion.

Example of pastry margarine

Determination of melting point (ISO 6321: 1997)

- ✓ Melt a portion of test sample as rapidly as possible to at least $50C^0$, but not more than 100C above which it is completely melted
- ✓ Cool the melted test sample with occasional stirring until its temperature is 32 to $340C^0$ and then stir continuously with stirrer allowing the fat to cool until the first signs of cloudiness appear.

- ✓ Continue stirring by hand until the fat has a pasty consistency and then transfer the fat to a 100 ml beaker at room temperature.
- ✓ Store the fat at this temperature for a minimum of 24 hour
- ✓ Push four capillary tubes into the conditioned fat until the column of fat 10 mm +2 mm long is obtained in each tube and wipe the tubes quickly with absorbent tissue to remove any fat adhering to the outer surfaces of the tubes.
- ✓ Adjust the temperature so that it can rise 10C/minute
- ✓ Put the capillary tubes in the apparatus with adjusted temperature
- ✓ Take the temperature at which the first fat droplet observed and report the average of the capillary tubes as one determination

- **Peroxide value**

This method determines all substances that oxidize potassium iodide under the conditions of the test in terms of mill equivalents of peroxide per 1000 g of sample. These substances are generally assumed to be peroxides or other similar products of fat oxidation. The method involves the titration of iodine produced by reaction of the hydroperoxides with potassium iodide added as a reducing agent.

The peroxide value (PV) is expressed as milliequivalents of iodine per kg of lipid (meq/kg), or as millimole of hydroperoxide per kg of lipid (referred to as peroxide). PV expressed as meq/Kg = 2 × PV mmol/kg.

- **Refractive index**

Abbe type refractometer was used at a temperature of $60C^0$ for refractive index determination.

$$\text{Refractive index (n) at t } (n_t) = n_{t1} + (t_1 - t)\, F \text{ if } t_1 > t$$

$$(n_t) = n_{t1} + (t - t_1)\, F \text{ if } t_1 < t$$

Where,

- ✓ t1 is the reading temperature
- ✓ t is the prescribed temperature
- ✓ F is equal to 0.00035 at t =20C^0
- ✓ F is equal to 0.00036 at t = 40C^0 and t =60C^0

- **Density**

Melting point was determined by ISO 6321: 1997 procedure .whereas IUPAC (1979) was used for density. Density was determined at a temperature of 60C^0 and reported as g/ml using the following formula:

$$\text{Density at t } (g_t) = \frac{M_1 - M_o}{V_t}$$

Where, Mo mass of empty pyknometer, M1 is the total mass of pyknometer and sample, Vt is volume of pyknometer

- **Melting point**

Differential scanning calorimetry is used to determine the melting behavior of Margarine. During melting point determination follow such as **:**

- ✓ Melt a portion of test sample as rapidly as possible to at least 50C, but not more than 100C above which it is completely melted
- ✓ Cool the melted test sample with occasional stirring until its temperature is 32 to 340C and then stir continuously with stirrer allowing the fat to cool until the first signs of cloudiness appear.
- ✓ Continue stirring by hand until the fat has a pasty consistency and then transfer the fat to a 100 ml beaker at room temperature.
- ✓ Store the fat at this temperature for a minimum of 24 hour

- ✓ Push four capillary tubes into the conditioned fat until the column of fat 10 mm +2 mm long is obtained in each tube and wipe the tubes quickly with absorbent tissue to remove any fat adhering to the outer surfaces of the tubes.
- ✓ Adjust the temperature so that it can rise 10C/minute
- ✓ Put the capillary tubes in the apparatus with adjusted temperature
- ✓ Take the temperature at which the first fat droplet observed and report the average of the capillary tubes as one determination

- **Saponification value**

Titration methods by 0.5 m hydrochloric acid solution were used for the determination of saponification value. Then saponification value is obtained as:

$$\text{Saponification value} = \frac{(b-a)}{m} x28.05$$

Where, a is amount in ml of hydrochloric acid used for the sample titration, b is the amount in ml of hydrochloric acid for balk titration and m weight of sample in g.

- **Active oxygen method (AOM) stability)**

Oxidative stability is a measure of oil or fat resistance to oxidation. Because the process takes place through a chain reaction, the oxidation reaction has a period when it is relatively slow, before it suddenly speeds up. The time for this to happen is called the "induction time", and it is repeatable under identical conditions (temperature, air flow, etc.). There are a number of ways to measure the progress of the oxidation reaction. One of the most popular methods currently in use is the Rancimat method.

The Rancimat method is carried out using an air current at temperatures between 50 and 220 °C. The volatile oxidation products largely formic acid are carried by the air current into the measuring vessel, where they are absorbed (dissolve) in the measuring fluid (distilled water). By continuous measurement of the conductivity of this solution, oxidation curves can be generated. The cusp point of the oxidation curve (the point where a rapid rise in the conductivity starts) gives the induction time of the rancidification reaction and can be taken as an indication of the oxidative stability of the sample.

The Rancimat method, the oxidative stability instrument (OSI) and the oxidograph were all developed as automatic versions of the more complicated AOM (active oxygen method), which is based on measuring peroxide values for determining the induction time of fats and oils. Over time, the Rancimat method has become established, and it has been accepted into a number of national and international standards.

The determination of this parameter with the Active Oxygen Method (AOM; AOCS Method Cd 12-57) is both very costly and labor intensive, owing to the repeated peroxide value determinations involved. The alternative rancimat method is based on the conductometric determination of volatile degradation products and features automatic plotting of the conductivity against time. The evaluation is performed graphically after completion of the experiment. The labor required for this method is considerably less as it is not necessary to perform titrations at regular intervals.

- **Acid value**

Free fatty acid was also determined by titration (IUPAC, 1979; Egan *et al*., 1981). The result is expressed as:

$$\text{Acid value} = \frac{Titration(ml)}{m} x5.61$$

Where, *m* is mass of the sample used in g

1ml of 0.1 M NaOH =0.0282g of oleic acid

Acid value = 2xFFA

The acid value shall be below 0.3%.

- **Solid fat index**

Solid fat index can be done conveniently using pulsed nuclear magnetic resonance (NMR) techniques. The SFC and SFI values can be determined by dilatometric methods or by pulsed NMR. The dilatometric method is still considered the most accurate, but NMR provides reliable information much more quickly. The solid fat index (SFI) is an analytical measure approximating the solid fat content. It is always less than the actual solid content and, to be meaningful, must be determined at several standard temperatures, usually 10C^0 (50F^0), 21.1C^0 (70F^0), 26.7C^0 (80F^0),33.3C^0 (92F^0), 37.8C^0 (100F^0), and sometimes 40C^0 (104F^0). The SFI measurements for table margarine are usually determined at 10C ^{0}(50F^0) as an indication of consistency during crystallization and refrigeration, at 21.1C^0 (70F^0) to simulate room conditions during use, and at 33.3C^0 (92F^0) to approximate ‘‘mouth feel’’ or eating quality. If the 33.3C^0(92F^0) SFI level is too high, the margarine will melt slowly in the mouth, often creating a ‘‘waxy’’ sensation.

SFI curves for stick table-grade margarine are generally steep with solids levels from about 30% at ^{0} (50F^0) to less than 5% at 33.3C^0 (92F^0) . Soft tub margarine oils have less steep SFI curves for a smooth, more plastic consistency. The SFC is a key property of fat/oil that influences its functionality. Indeed, the SFC profiles allow to predict some qualities of the final product (structure of the dough for example) and to check qualities of a blend. However SFC is not the only significant property, hardness and consistency are also an important macroscopic one for the margarine quality control.

- **Crystallization rate**

Crystallization rate can be done conveniently using pulsed nuclear magnetic resonance (NMR) techniques.

- **Crystal size and distribution**

Crystal size and distribution was first measured using polarized light microscopy but the analysis is time consuming and inaccurate. Recently, light or x-ray scattering and sedimentation methods coupled with computer analysis have provided new and improved techniques for measuring mean crystal size and size distribution. A revolving laser beam generated by a laser particle counter can be coupled with a computer using special software to measure and record crystalline information. Crystal structure can be viewed by polarized light microscopy.

- **Penetration rate**

Conepenetrometer can also be used to determine hardness (AOCS Method Ce 16–60) . A cone of specified mass and dimensions is dropped into a prepared sample. The relative hardness of the sample is determined by dividing the mass of the cone by the depth of penetration. The cone penetrates farther into soft products and produces subsequently lower relative hardness values. A single temperature penetration value is not a true indication of overall relative plasticity. Narrow differences in penetration values at low and high temperatures indicate a wide plastic range while huge differences indicate a narrow range. Some products are formulated to be naturally firmer than others, depending on geographic area and intended usage.

- **Color**

Color is most frequently measured by the Lovibond procedure.

- **Plasticity ,hardness, and speardability**

Solubility

Fats and oils are insoluble in water. However, in the presence of a suitable substance known as an emulsifying agent, it's possible to form a stable mixture of fat and water to Emulsion. The Emulsion may be a Fat – in – Water emulsion e.g. Milk Or a Water – in – Fat emulsion e.g. Butter

Fats and oils are soluble in organic solvents such as petrol and carbon tetrachloride. Solvents of this type can be used to remove grease and stains from clothing.

Plasticity

Fats do not melt at fixed temperatures, but over a range of temperatures. This is because fats are mixtures of triglycerides (contain 3 different fatty acids), all with different melting points. Some of the fatty acids forming the triglyceride will stay solid for longer than others. This feature gives fat its plasticity that makes some fats spreadable.

E.g. Margarine – Has a wide range of plasticity and will spread from the fridge whereas most animal fat will have narrow plasticity and will not spread easily.

Spreadability

can be evaluated by spreading the product in a consistent manner on a suitable surface such as greaseproof paper or cardboard. The results may vary from smooth and homogeneous to very coarse and showing visible water drops . In this way hardness, softness, homogeneity, and water stability may be evaluated along with the spreadability

- **Control over fat and oil ratio in margarine processing**

Production of margarine consists of two main stages: a fat phase and a water phase. Later salt and emulsifiers might be added. In water phase, milk proteins, salt, preservatives and other water-soluble ingredients are mixed. The fat phase includes fat-soluble ingredients such as fat-soluble flavors, vitamins as well as emulsifiers and carotenes. Next, the phases are mixed together. The product is then cooled and moved to packaging. Refractometer Refractive Index measurement is used to accurately determine the correct fat and oil proportion in the fat phase. This measurement assures that:

- ✓ the correct mixture is going to emulsifier
- ✓ provides real-time continuous concentration monitoring of the product blend
- ✓ eliminates the need for sampling and laboratory tests
- ✓ helps to increase productivity
- ✓ helps to reduce batch time
- ✓ assures correct ingredients dosing
- ✓ assures the final product's desired characteristics, functionalities and consistent quality are achieved.

5.2 methods used to monitor the production process

- inspecting,
- measuring and
- testing as required by the process

Margarine process in specifications means the Finished margarines must expressed in terms such as

- The desired specifications are obtained when formulas are made for raw materials of standard quality. Fats and oils are obviously the raw materials of major importance in a margarine production. When a margarine plant is not integrated with a refinery, increased control of raw materials and stabilization of manufacturing parameters through the creation of specifications, acceptable by many fats and oils suppliers, is important.
- Quality control systems usually used for judging the quality of oils and fats or oil blends used in margarine production could evaluate color, color stability, flavor, flavor stability, free fatty acid, peroxide value, active oxygen method (AOM) stability, iodine value, slip melting point, fatty acid composition, refractive index, crystallization rate, and solid fat/temperature relationship (solid fat index), plasticity, hardness, structure, and spreadability.
- Refractive index, iodine value, AOM stability, and peroxide value provide standardized methodology for those factors affecting oxidative stability.
- Solid fat index, melting points, penetration, and viscosity are normally used to measure factors affecting consistency and texture.
- Color is most frequently measured by the Lovibond procedure.
- Determination of crystallization rate and solid fat index can be done conveniently using pulsed nuclear magnetic resonance (NMR) techniques
- These characteristics are related to a number of variable factors. These are temperature, concentration of the disperse phase or solid fat content, crystal size, crystal size distribution, crystal shape, interparticle forces of van der Waals' type and mechanical treatment.
- The two dominating factors are the amount of solid triglycerides (or solid fat index) and the processing conditions during production.
- Formulation or choice of oil blend allows control of the solid content, which, for identical processing conditions, is directly related to the consistency and type of crystalline structure formed.

- Processing conditions (rate and degree of cooling, mechanical working, final product temperature, etc.) regulate the type of crystals formed and the morphology and extent of intertwining of the solid structure that holds the liquid oil.
- The term morphology is used to denote the general relation of the physical behavior and performance of fats and oils to their crystal structure and the molecular configuration of their triglyceride components.

Table 3 physicochemical characteristics of commercial margarine

Parameters	Recommended
Density, 600C (g/ml)	0.821-0.941
Melting point (0C)	33- 44
Moisture content (%)	<17
Refractive index, 600C	1.46- 1.47
Free Fatty acid(%as oleic acid)	<0.3
Peroxide value(mEq/kg)	<10
Saponification value(mgKOH/g)	185-200
Iodine value(g I/100g)	45-60

Self-Check – 5	Written test

Name…………………………………………… ID……………………… Date…….

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

Test I: Short Answer Questions

1. List and discus Critical control points of margarine?

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

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

Score = ____________

Rating:

Information Sheet 6- Legislative requirements

6.1 Legislative requirements

Legislative Requirement means Acts, ordinances, regulations, subordinate legislation, by-laws, orders, awards and proclamations and delegated legislation (whether national, state, territory or local) applicable where the Subcontractor's Activities or any part thereof are being performed.

Legislative Requirement means legislation and subordinate legislation of the Commonwealth of Australia or any State or Territory applicable to the Supply, and any instruments made under such legislation or subordinate legislation, and the requirements of any local government, utility or other person or party having power at law to make decisions in relation to the Supply or any other matter which is the subject of the Agreement. May include but not limited to:

6.1.1 Ethiopian Food Standards Code

- **Standardization**

Standardization is a process of ensuring uniformity in products and services by use of appropriate standards. The process ensures efficient utilization of resources through reduction of wastes. Food and beverages standards are documents containing requirements, specifications, guidelines or characteristics that can be used consistently to ensure that food materials, products, processes and services produced are fit for human consumption. In any country, food and beverages standards are established by regulatory authorities and enforced by governments, food companies and retailers.

- **Food Safety Standards**

A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose. Product standards and code of practice assist manufacturers to produce commodities that meet minimum specifications for quality and safety

- **International food standard International**

Food standard (IFS) is a food safety standard which has uniform safety system that is used to qualify and select suppliers. It can be explained as one common audit standard, globally accepted by the food industry in order to continuously improve food safety for consumers. Standard helps super market chains in ensuring food safety of the product they are selling to their buyers and to monitor quality level of suppliers of their private labels. International Food Standard has been developed for the purposes of auditing suppliers who cooperate with networks of so called private label manufacturers.

- **International System of Standards**

The growing quality requirements regarding food quality and the rapidly increasing trade in food products and safety problems connected with it stimulated and stimulate the programs of international harmonization of food standards. Of the organizations and programs active worldwide in this field, first at all the International Standardization Organization (ISO) and the Joint FAO/WHO Food Standards Program should be mentioned. In 1946, ISO delegates from twenty-five countries met in London and decided to create a new international organization, the object of which would be “to facilitate the international co- ordination and unification of industrial standards.”

I. Weights and measures legislation

The Standards of Weights and Measures, enforces uniform standards of weights and measures, based on the metric system. Based on the suggestions of General Conference of Weights and Measures (CGPM), International Organization of Legal Metrology (OIML), the 1956 act was replaced by a comprehensive legislation, The Standards of Weights and Measures are administered by the ministry of Consumer affairs, Food and Public Distribution.

II. Ethiopian Food and Drug Authority

The Ethiopian Food and Drug Administration (EFDA) are mandated, in the proclamation 661/2009, to ensure the safety, quality and efficacy of medicines. To achieve this, the authority has been working on different regulatory activities. The medicine market authorization system is one of the top priority areas that have been implemented. In addition to the dedicated assessors, the authority uses a national drug advisory committee for the assessment and registration of medicines.

This has evolved through the years to improve the medicine dossier evaluation system. As the Socioeconomic development of the nation is transforming, there is a high flow of investments in the healthcare. However, the market authorization system available at this time is yet unable to satisfy and fully accommodate the demands coming into the country.

6.1.2 Environmental Protection Authority

Environment" means the totality of all resources whether in their natural state or as modified or changed by man as well as the external conditions and impacts which affect the quality and quantity of said resources and the welfare of human beings.

"Environmental Protection" means the protection of land, water, air and similar other environmental resources, factors and conditions which affect the life and development of all organisms including human beings.

"Environmental Management" means the study, protection and conservation as well as the control of the utilization of the environment in general.

"Person" means any natural or juridical person

Powers and Duties of the Authority

The Authority shall have the following powers and duties.

- To prepare environmental protection policy and laws; and, upon approval, follow up their implementation.
- To prepare directives and systems necessary for evaluating the impact of social and economic development projects on the environment; follow up and supervise their implementation.
- To prepare standards that help in the protection of soil, water and air as well as the biological systems they support, and follow up their implementation.
- To carry out studies required to combat desertification and, in cooperation with the concerned organs, create favorable conditions for their implementation.
- To make recommendations on the application of diverse encouragement and regulatory measures for the better protection of the environment.
- To provide instruction required to enhance awareness of the need for environmental protection.
- To follow up the implementation of international treaties on environmental protection to which the country is a party.
- To render advice and technical support to Regions on environmental protection.
- To own property, enter into contracts and sue and be sued in its own name.
- To carry out such other activities as are necessary for the fulfillment of its objective.

6.2 Identify OHS hazards and controls

Occupational Safety and Health is a planned system of working to prevent illness and injury where you work by recognizing and identifying hazards and risks. HAZARD is a situation in the workplace that has the potential to harm the health and safety of people or to damage plant and equipment anything that could hurt you or someone else. Three steps to manage health and safety at work:

- Spot the Hazard (Hazard Identification)
- Assess the Risk (Risk Assessment)
- Make the Changes (Risk Control)

6.3 Apply food safety procedures to work practices

Food safety is used as a scientific discipline describing handling, preparation, and storage of food in ways that prevent food-borne illness. The occurrence of two or more cases of a similar illnesses resulting from the ingestion of a common food is known as a food-borne disease outbreak. This includes a number of routines that should be followed to avoid potential health hazards. In this way food safety often overlaps with food defense to prevent harm to consumers. The tracks within this line of thought are safety between industry and the market and then between the market and the consumer.

In considering industry to market practices, food safety considerations include the origins of food including the practices relating to food labeling, food hygiene, food additives and pesticide residues, as well as policies on biotechnology and food and guidelines for the management of governmental import and export inspection and certification systems for foods. In considering market to consumer practices, the usual thought is that food ought to be safe in the market and the concern is safe delivery and preparation of the food for the consumer.

Food can transmit pathogens which can result in the illness or death of the person or other animals. The main mediums are bacteria, viruses, mold, and fungus. It can also serve as a growth and reproductive medium for pathogens. In developed countries there are intricate standards for food preparation, whereas in lesser developed countries there are fewer standards and less enforcement of those standards.

Another main issue is simply the availability of adequate safe water, which is usually a critical item in the spreading of diseases. In theory, food poisoning is 100% preventable. However this cannot be achieved due to the number of persons involved in the supply chain, as well as the fact that pathogens can be introduced into foods no matter how many precautions are taken. The five key principles of food hygiene

- Prevent contaminating food with pathogens spreading from people, pets, and pests.
- Separate raw and cooked foods to prevent contaminating the cooked foods.
- Cook foods for the appropriate length of time and at the appropriate temperature to kill pathogens.
- Store food at the proper temperature.
- Use safe water and safe raw materials.

6.3.1 Food safety practices and procedures

There are a number of reasons to follow appropriate food and health and safety practices when working within the hospitality industry. One of which is the importance of avoiding food-poisoning outbreaks. Unlike other food safety issues, this is something that only becomes known after the event has occurred when it is too late to take steps to stop it. All you can do is investigate the cause and put procedures in place to prevent it happening again. It is much better to make sure that those procedures and practices are in place from the start.

By following good food safety practices and procedures, you are likely to:

- Reduce the likelihood of a food poisoning incident/outbreak
- Reduce any consequent harm to either the customer or the business
- Be con dent that all those working within the business are aware of food safety practices and procedures, and how to implement them.

Benefits of implementing food safety practices

- Good reputation
- Happy, motivated workforce
- Effective use of resources
- Safe and secure working environment
- Good relationships with suppliers

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. What legislative requirement?

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

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

Score = ___________

Rating: ____________

Information Sheet 7- Identified and rectifying and /or reported Out-of-specification product/process

7.1 Identify Out-of-specification product/process.

- Margarine fat should have SFC lower than 3.5% at temperatures above 33 °C and should completely melt at temperatures below body temperature (37 °C) to avoid waxy mouthfeel, which is one of the important textural drawbacks of margarines.

- Products with less than 80 percent fat content cannot be labeled as margarine because they do not meet the Federal Standards for margarine. The term spreads or table spreads refers to a broad range of products categorized based on the fat content as high-fat (70 to 82 percent), medium-fat (48 to 60 percent), low-fat (35 to 42 percent) and very low-fat (less than 30 percent) spreads. In general, the low and very low-fat spreads are designed for applications similar to "spreading on a slice of bread," while the high-fat spreads are used for cooking and frying applications.
- Low-fat water-in-oil emulsions with fat contents of 40% or lower have been found to be quite sensitive to line pressures and cooling rate in the SSHE line. Fill temperatures are higher than with corresponding 50% fat products because the emulsion is more viscous. If fill temperature is too low, the product will build up in the tub with excessive lid contact causing crumbly product and water leakage. If too much crystallization occurs in the process, the shearing forces of processing and filling may break the emulsion. Therefore, low-fat products are more easily repared by use of high liquid oil content and low solid fat index (SFI) blends.
- Thickeners tend to clump, making it difficult to mix the emulsion
- Long processing times are required for complete hydration of the oil
- Poor hydration leads to an unstable product with poor texture and mouthfeel.
- Storage problems upon opening of poorly hydrated product

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. Write out of specification product?

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

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

Score = ___________

Rating: ____________

Information Sheet 8- Maintaining work area in housekeeping standards.

8.1 Housekeeping standards in work area

Housekeeping is relevant in all workplaces whether at the office, factory, shipyard, construction site, storage facility, hospital, laboratory, retail shop or industrial kitchen. Effective housekeeping can eliminate many workplace hazards and help get work done safely and properly. A clean and tidy workplace also enhances a company's image and provides immediate visible evidence of its commitment towards workplace safety and health (WSH). Housekeeping is not just about the cleanliness of a workplace. It is also about keeping workplaces in order. Workplace housekeeping may be defined as activities undertaken to create or maintain an orderly, clean, tidy, and safe working environment.

Good housekeeping entails the effective organization of the workplace and it contributes to better WSH performance, increased productivity and better quality control. It also includes good workplace traffic management, proper storage of raw materials and finished goods, neat and tidy work areas as well as adequate workplace illumination. With good housekeeping practices, workplaces can be kept safe from potentially dangerous objects or substances present in the work environment. An organised and clutter-free work area also makes it easier to respond to or evacuate in the event of an emergency.

Good housekeeping can result in more effective use of space;

- Better inventory control of tools and materials;
- reduced handling to ease the flow of materials;
- More efficient equipment clean-up and maintenance;

- reduced equipment and property damage through better preventive maintenance;
- More hygienic workplace conditions that would lead to improved workers' health;
- Improved overall look and feel of work environment; and
- Improved staff morale and wellbeing.

Poor housekeeping, on the contrary, creates workplace hazards that can lead to various accident types like Slips, Trips and Falls (STF), Caught In-between Objects (CIBO), Struck by Falling Objects (SBFO), Struck by Moving Objects (SBMO), Cut/ Stabbed by Objects (CSBO) and Struck against Objects (SAO). Additionally, poor housekeeping may create fire hazards that inevitably lead to increased fire risk.

Examples of workplace accidents caused by poor housekeeping:

- slipping on a spilled substance or oily, wet or dirty surfaces;
- tripping over loose objects on floors, stairs and platforms;
- striking against protruding, improperly stacked or misplaced items;
- being hit by objects falling from a high shelf or the top of a cupboard; and
- being cut or punctured by a protruding nail or sharp object

Good Housekeeping Basics

There are three key factors to good housekeeping. They are:

A) Overall cleanliness and orderliness

B) Adequate space and proper layout

C) Correct storage and materials handling

Responsibility for Housekeeping

Good housekeeping is everyone's responsibility. Keeping a workplace safe, clean and clutter free is an ongoing activity in which all employees have to do their part;

- **Prevent slips, trips and falls.**
  - ✓ Do not stack items along walkways or passageways;
  - ✓ Put away electrical cords and water or air hoses; and
  - ✓ Put away tools and keep drawers closed.
- **Limit spills.**
  - ✓ Clean up spills immediately;
  - ✓ Repair leaks as soon as possible; and
  - ✓ Sweep up debris.
- **Ensure machine safety**.
  - ✓ Inspect machines and ensure that all guards are in place before use;
  - ✓ Keep area around machines clear;
  - ✓ Put away tools; and
  - ✓ Clean machines regularly.
- **Prevent fires.**
  - ✓ Store flammable or combustible liquids in labeled and closed containers;
  - ✓ Keep flammable or combustible materials away from sources of ignition;
  - ✓ Keep electrical equipment clean; and
  - ✓ Inspect electrical cords before use.
- . **Ensure exits and access routes to fire equipment are clear.**
  - Do not block emergency exits;
  - Keep evacuation routes clear;
  - Check that fire extinguishers are accessible; and
  - Ensure that electrical panels can be opened

8.2 What are the elements of an effective housekeeping program?

Maintenance; The maintenance of buildings and equipment may be the most important element of good housekeeping. Maintenance involves keeping buildings, equipment and machinery in safe, efficient working order and in good repair. It includes maintaining sanitary facilities and regularly painting and cleaning walls

- Dust and dirt removal
- Employee facilities Surfaces
- Maintain light fixtures
- Aisles and stairways
- Spill
- Tools and equipment
- Waste disposal
- Storage

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. What are key factors to good housekeeping?

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

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

Score = ___________

Rating: ____________

Information Sheet 9- Maintaining Workplace records.

9.1 Maintaining Workplace records

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 margarine production process and by using different types quality raw materials should be recorded for future use as reference. Maintaining workplace records in operating margarine production processing include;

- Quality of raw material/ingredient
- Parameters for processing
- Employee training records
- Method of processing margarine production
- 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 – 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. What are workplace records?

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

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

Score = ___________

Rating: ____________

Operation Sheet 1– Procedures for monitoring margarine production process

Objectives; To know how to process margarine product.

Purpose : To understand margarine production flow.

Procedure for processing margarine

1 Use personal protective equipment
2 Treat the oil (safflower, corn, or soybean, among other types) with a caustic soda solution to remove unnecessary components known as free fatty acids.
3 Wash the oil by mixing it with hot water, separating it, and leaving it to dry under a vacuum.
4 Bleach the oil with a mixture of bleaching earth and charcoal in another vacuum chamber.
5 Filter the bleaching earth and charcoal absorb any unwanted colorants from the oil.
6 Use whatever liquid in the manufacturing process (milk, water, or a soy-based substance) it too must undergo preparatory measures. It also undergoes pasteurization to remove impurities, and if dry milk powder is used, it must be checked for bacteria and other contaminants
7 Then hydrogenate the oil to ensure the correct consistency for margarine production, a state referred to as "plastic" or semi-solid. In this process, hydrogen gas is added to the oil under pressurized conditions. The hydrogen particles stay with the oil, helping to increase the temperature point at which it will melt and to make the oil less susceptible to contamination through oxidation.
8 Mix together the liquid, salt, and lecithin into one tank opposite another vat holding the oils and oil-soluble ingredients.

9 Keep while the blending process is taking place, the equipment's sensors and regulating devices and the mixture's temperature near 100°F (38°C).

10 Cool the margarine emulsion in what is referred to as Chamber A. Chamber A is divided into a trio of tubes that successively decrease its temperature. Within two minutes the mixture has reached 45-50°F (7-10°C).

11 Then pumped into a second vat called Chamber B. There it is occasionally agitated but generally left to sit still and form its semi-solid 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 **10** hour. The project is expected from each student to do it.

Task 1: Procedures for monitoring margarine production process

LG #55	LO #3- Shut down the margarine process

Instruction sheet

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

- Identifying appropriate shutdown procedure..
- Identifying workplace procedures for shut down the process.
- Identifying and reporting Maintenance requirements in workplace reporting requirements

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

- Identify appropriate shutdown procedure..
- Identify workplace procedures for shut down the process.
- Identify and report Maintenance requirements in workplace reporting 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" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work.
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,

Information Sheet 1- Identifying the appropriate shutdown procedure

1.1 Identifying shutting down procedure

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

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

1.2 Seven steps/procedures for a successful shutdown

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

I. A comprehensive list

A checklist with every piece of equipment involved in the outage should be available for review. Every stakeholder should examine this list to ensure nothing is missing. Examples of assets for most plant checklists include: Agitators, Airlocks, Conveyors, Doors, Dust baggers, Gearboxes Man ways Mixers and blenders, Motors, Piping, Pumps, and Valves.

II. Have it in inventory

Ensure that all replacement parts, accessories and rebuilt equipment are in stock before the shutdown. The last thing any team needs is to have staff on hand to conduct maintenance, replacements and new installations only to be held up waiting for rebuilt equipment to return from a shop.

III. Safety first

Safety should be the top priority during any outage. Before beginning work, all lock out/tag out (LOTO) procedures should be followed and personnel must wear all required personal protective equipment (PPE).Because equipment is shut down, personnel may have a false sense of security

IV. Within current specifications

Double check that all equipment (new and rebuilt) is within current operating parameter specifications. When assets were specified, they met the requirements of the process at that time. Condition changes, such as fluid temperature, flow requirement or process fluid pH must be considered. Different parts or different equipment may need to be used.

V. Inspect before installation

Personnel should inspect all equipment before anything is installed; look for wear or damage. Installing new components into a worn piece of equipment is almost always counterproductive. Demise of the new components begins immediately.

VI. Precise installation

While this step seems obvious, improper installation happens all the time. Reliability begins with the asset selection and correct installation. If installed imprecisely, failure begins at startup

VII. Inspection before restart

The plant team should give everything one more look before restarting the plant or process. Even when every step is taken and every job plan is followed, stuff happens. A motor is bumped during work on another piece of equipment, causing misalignment.

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. Discus the seven procedures for effective shutdown process?

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

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

Score = ___________

Rating: ____________

Information Sheet 2- Identifying workplace procedures for shut down the process.

2.1 shutting down process of margarine production

Procedure for down process of margarine production such as:

- Shutting Transfers the oil phase and emulsifier from the storage tank to the weighing system and onward to the plate heat exchanger for mix emulsifier.
- Shutting Transfers water-ingredient solution for Mix water with solid/liquid ingredients
- Shutting Transfers oil, emulsifier and water to the emulsion tank for creates the emulsion by mixing the oil phase and water ingredient
- Shutting the line Transfers of emulsion from the emulsion buffer tank to the pasteurization area for Heats the emulsion to kill pathogenic bacteria for food safety
- Shutting Contherm Cooling machine of the emulsion under high-pressure conditions, turning the liquid into a solid and plasticizing it.
- Shutting the Transfers the emulsion in the high-pressure section to the crystallization area
- Shutting the worker units.

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date…….

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

Test I short answer

1. What is Procedure for down process of margarine production?

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

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

Score = ___________

Rating: ____________

Information Sheet 3- Identifying and reporting Maintenance requirements in workplace reporting requirements

1 Identifying maintenance requirements

Maintenance is a general upkeep and repair of equipment, buildings and grounds, heating and air-conditioning; removing toxic wastes; parking; and perhaps security Food premises and equipment that are not kept in good repair and condition are a potential source of microbiological and physical contamination of food. Poorly maintained premises and equipment cannot be cleaned effectively. Poor maintenance may allow the entry of other sources of physical, microbiological and chemical contaminants such as water, pests and dust. Poor maintenance can have health and safety implications for workers.

3.1 Identifying and reporting maintenance requirements

To minimize the hazards that might be happen during equipment operation, you have to check that the equipment was in a god operating condition or not. If there is a defects on it, report and undertake maintenance before starting operate equipment.

The maintenance that needed may be adjusting thermocouple, pressure sensors, some components of a machine or equipment and etc.

3.2 Maintenance activities

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

- Operational maintenance (e.g. connection-disconnection of hoses, greasing, lubrication and lubricant systems, adjusting sealing glands, cleaning and changing filters, 'nipping up' flanges)

- General cleaning
- Removal and replacement (e.g. gland packing, changing blades or cutters, replacing gaskets, replacing /maintaining seals, changing filter elements, servicing strainers).

3.3 Routine maintenance

Routine maintenance tasks refer to on-going, scheduled tasks that are performed in order to keep hand tools and basic equipment functioning properly. It could include tasks such as unblocking pipes and nozzles, sharpening blunt tools, cleaning nozzles on sprayers, checking water and oil levels in machinery, cables and plugs.

3.4.1 Some tips on routine maintenance, we have to follows

- Use the correct tool for the job
- Keep tools in good condition
- Handles should be tight and free from defect
- Cutting tools should be kept sharp
- Use and maintain power tools according to their operator instructions
- Make sure power tools are properly grounded or are double insulated
- Switch off and unplug power tools before changing blades or servicing and repairing
- Wear appropriate personal protective equipment (PPE), such as glasses, goggles, dust masks, face shields, hearing protection, etc.
- Keep all guards and shields in place
- Unplug and store tools after use

3.4.2 Scheduling routine maintenance

Some tools may require daily checks and maintenance after use. Other tools, such as power tools, usually must be checked once in 6 months or so. More complicated power tools would need to be serviced on a regular interval

A maintenance schedule assigns a specific date to specific maintenance tasks.

It states what has to be checked and will require that the assigned person signs off the document assuring that the checks were done.

If faults are found, the tool must be sent for maintenance and the assigned person that fixes the tool has to report on exactly what was done and when it was completed.

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. Discus the maintenance requirement?

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

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

Score = ___________

Rating: ____________

Operation Sheet 1– Procedures for shut down the process

Objectives; to know successful shut down procedure of margarine production.

Purpose: to understand margarine production shutdown procedure.

Procedure for down process of margarine production such as

1. Shutting Transfers the oil phase and emulsifier from the storage tank to the weighing system and onward to the plate heat exchanger for mix emulsifier.
2. Shutting Transfers water-ingredient solution for Mix water with solid/liquid ingredients
3. Shutting Transfers oil, emulsifier and water to the emulsion tank for creates the emulsion by mixing the oil phase and water ingredient
4. Shutting the line Transfers of emulsion from the emulsion buffer tank to the pasteurization area for Heats the emulsion to kill pathogenic bacteria for food safety
5. Shutting Contherm Cooling machine of the emulsion under high-pressure conditions, turning the liquid into a solid and plasticizing it.
6. Shutting the Transfers the emulsion in the high-pressure section to the crystallization area
7. Shutting the worker units.

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

Task 1: Procedures for shut down the process

Reference Materials

Book:

- Article discussing degumming and acid washes. Acta Chimica Slavaca Vol. 1, No. 1, 2008, 321-328
- Bleaching clays - Oil-dry corporation
- D.H. Morris, M. Vaisey-Genser, in Encyclopedia of Food Sciences and Nutrition (Second Edition), 2003
- (Gunstone and Herslof, 2000; Gurr, et al., 2002; Pollock, 2004; ISEO, 2006).
- Introduction to Fats and Oils Technology: Second Edition. AOCS Press, 2000.
- Vegetable oil processing equipment - Tinytech
- Northeast Oilseed Information, University of Vermont
- M. Vaisey-Genser, in Encyclopedia of Food Sciences and Nutrition (Second Edition), 2003

WEB ADDRESSES

- http://dx.doi.org/10.1016/B978-1-63067-050-4.00007-6
- http://www.madehow.com/Volume-2/Butter-and-Margarine.html#ixzz6p7q4mkBj
- Riepma, S. F. *The Story of Margarine.* Public Affairs Press, 1970.
- http://www.madehow.com/Volume-2/Butter-and-Margarine.html#ixzz6p87a1WYP

AKNOWLEDGEMENT

We would like to express our appreciation to the TVET instructors and experts of regional TVET bureau, TVET College, and Federal Technical and Vocational Education and Training Agency (FTVETA) who made the development of this learning module with required standards and quality possible.

We wish thanks and appreciation to the representatives of BEAR II UNESCO PROJECT who covers the financial expenses, scarifying their time and commitments to develop this learning module.

The trainers who developed this learning guide

No	Name	Qualification	Educational background	Institution	Region	Phone Number	E-mail
1	Wondimagegn Tamiru	B	Chemical engineering (Food eng.)	Yirgalem Industrial college	Sidama	0916164466	Wondet2011@gmail.com
2	Sefinew Abere	A	Agronomy	Bahirbar Polytechnic	Amhara	0913336337	sefinew14@gmail.com
3	Misganaw Molla	A	Agronomy	Bure Polytechnic	Amhara	0924520299	mmisganaw2011@gmail.com
4	Bereket Balcha	B	Chemical engineering(Food process)	Sodo Polytechnic	Debub	0910918094	bereketbate@gmail.com
5	Cheru Petros	B	Food technology and process engineering	Arbaminch Polytechnic	Debub	0994505626	cherupeter143@gmail.com
6	Debre Shewarega	B	Food technology and process engineering	Kolfe Industrial college	Addis Abeba	0922944810	henatu3@gmail.com
7	Tesfaye Tekola	A	Agronomy	Asossa ATVET	Benshangul	0910550651	tttekola@gmail.com

8	Workineh			Federal TVET Agency			