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Ministry of Labor and Skills

Fruit and Vegetable Processing

Level I





Based on September, 2021, Version 3 Occupational Standards (OS)

Module Title: Operating Pumping Equipment

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Introduction to the Module

This module covers to provide the trainees with the skills and knowledge required to prepare pumps for operation, operate pumping equipment and shutdown and maintain pumping equipment.

LG #16	LO #1 Prepare pumps for operation

Instruction sheet

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

- Preparing pumps for operation
- Operating Pumping Equipment
- Shutting down and Maintain Pumping Equipment

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

- Prepare pumps for operation
- Operate Pumping Equipment
- Shutdown and Maintain Pumping Equipment

Learning Instructions:

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

Information Sheet 1

1.1. Carrying Out Pre-Start Checks on Pumps.

Check whether any maintenance work is carrying out on the pump. If it is completed be clear that job as been done clearly and tested the pump working.

The points to be checked before starting the pump are:

- ✓ Make sure that discharge valve is slightly open condition, this is important step because as these pumps are lack high suction rate.
- ✓ Turn the pump shaft by hand; make sure that pump turns smoothly.
- ✓ Check the coupling for the drive and driven shaft to rotate smooth, without any unsteady rotation.
- ✓ Now open the suction valve and start the pump, check the current, pressure, any visible leakages, and unusual sound.
- ✓ If all looks ok, open discharge valve fully and continue the running of pump.

It's crucial for maintenance teams to employ proper checks before starting their systems to ensure centrifugal pumps don't fail during start-up. We've made it easy for you or your team to conduct these important maintenance checks before startup and outlined the process to follow to make sure your pump runs beautifully when you do go back online.

Centrifugal pump maintenance checklist:

- ✓ Have you checked the impeller, pump shaft and internal casing for any signs of wear including erosion or pitting? If required, repair this with a two-part alloy epoxy putty or replace component parts as required.
- ✓ Is there any sign of wear and tear on the shaft bearings or thrust bearings? Replace if necessary.
- ✓ Have you checked wear ring clearance with feeler gauges and replaced any rings if required?
- ✓ Is there any sign of leakage or flush water on the mechanical seal?
- ✓ Is there any damage on the impeller key?
- ✓ Are threads in good condition? Unscrew the impeller shaft securing nut to find out. If required, retighten.

- ✓ Have you removed all dirt and residue and lubricated the pump and driver? Check your manual for specific lubrication requirements for your pump.
- ✓ Are there any signs of axial or longitudinal movement on your drive motor shaft/coupling? Rotate the shaft and listen for bearing noise – replace if required.
- ✓ Any dampness or wear on the drive motor windings? A full motor strip may be required to check rotor and stator conditions. Otherwise, grease any unsealed bearings.
- ✓ Record the date of maintenance checks and any parts that you replaced.

Table 1.1: Pre start-up/post start-up check list of centrifugal pump

CENTRIFUGAL PUMPS

START-UP DATE:		ORDER No.:		SERIAL No.:
PUMP SIZE	MIN. SUCT.PRESS.	FLOW	HEAD	VOLT_____ PHASE ____ Hz____

CHECK THE FOLLOWING AT PRESTART-UP	OK	REMARKS / CORRECTIVE ACTIONS
1. STORAGE Verify equipment for improper storage or mishandling.	☐	
2. INSTALLATION Compare electrical supply to one indicated on motor nameplate. Compare current rating of overload relays and fuses in controller against full load current value on motor nameplate.	☐ ☐	
3. ALIGNMENT Verify the alignment of driver to pump. (Horizontal Pumps Only) Verify suction and discharge for pipe strain. Do the flanges meet squarely?	☐ ☐ ☐	Indicate alignment reading _____
4. ROTATION Manually turn coupling to assure free rotation of pump and motor.	☐	
5. SYSTEM Insure system is free of foreign matter which could damage the pump. Responsible parties present when equipment is energized.	☐ ☐	
6. DIESEL DRIVEN FIRE PUMP ONLY Engine coolant filled to the proper level? Engine oil filled to proper level? Fuel line from the tank connected to engine (supply and return)? Fuel tank filled with proper diesel fuel? Silencer properly connected to engine and outside? Engine controller wiring connected to engine junction box? Is engine jacket water heater connected to AC power? **Batteries charged (*MIN.24 HRS PRIOR TO START-UP*) and connected to engine?**	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
CHECK THE FOLLOWING AT POST START-UP	**OK**	**REMARKS / CORRECTIVE ACTIONS**
6. VIBRATION Upon the occurrence of excessive vibration or noise, was equipment immediately shut down?	☐	
7. FLOW Has flow been established? Take gauge and amperage readings (if motor driven) ? Packing been adjusted to a slight leakage? If pumps are equipped with mechanical seals, has the establishment of a clear source of water to lubricate the seals been made? Is the lubricating seal water pressure a constant 10 to 15 PSI above the discharge of the pump?	☐ ☐ ☐ ☐ ☐	
8. READINGS Flow, pressure and amperage readings taken immediately after correction of all problems and restart.	☐	

CUSTOMER'S REPRESENTATIVE(S) WITNESSING TESTS:

WITNESS _____

DATE: _____

ARMSTRONG PUMP DIV., REPRESENTATIVE CONDUCTING TESTS:

WITNESS _____

DATE: _____

1.2 Identifying and Reporting Condition of Pumps

Pumps are among the most commonly used machines in the food process industries (FPI). Condition monitoring tests and predictive maintenance can help pump operators determine when to overhaul pumps in a way that minimizes costs. Despite pumps' ubiquity and large energy demands, however, relatively little information is available on how to apply predictive maintenance approaches and condition monitoring to process pumps. Pump overhauls may occur on a fixed time schedule or as a result of a specific breakdown, but neither case necessarily represents the most cost-effective policy. In cases where deterioration in the performance of a centrifugal pump causes a drop in plant production, pump overhaul is readily justified, because the cost of performing the overhaul is usually small compared to the losses from reduced production. However, when pump performance deteriorates due to wear and the only effect is increased power consumption (with no discernable effect on production), the question of when to perform an overhaul becomes important.

Pump monitoring methods (where justified) should be chosen that can detect each of the pump degradation modes that are either experienced or expected. Common pump-monitoring methods include the following:

- Vibration monitoring and analysis: probably the most widely applied method of condition monitoring for rotating machines in general, and suited to detect such faults as unbalance, misalignment, looseness
- Sampling and analysis of lubricants for deterioration and wear debris: relevant for bearings and lubrication system faults
- Electrical plant tests: relevant for motor condition
- Visual inspection and non-destructive testing: particularly relevant for pump casing wear
- Performance monitoring and analysis: relevant for pump internal conditions



Figure 1.1: Pump wear, such as that shown on this pump impeller, can lead to reduced pump performance



Figure 1.2: The degree of pump wear is expressed as the percent reduction in total head

For critical machinery, the use of more than one method of condition monitoring in combination may be justified. This article demonstrates the use of performance analysis and includes some examples of condition monitoring in practice.

An understanding of basic pump performance characteristics is assumed, as is how to measure test data in a repeatable manner. For condition monitoring, repeatability is more important than absolute accuracy. The most useful condition-monitoring method is head-flow measurement, because in addition to pump deterioration, it also detects any changes in system resistance. This method can be used for all pumps where flow (or some repeatable indicator of flow) can be measured.

The shut-off head method can be used for predictive maintenance of pumps. While measuring the head at zero flow is a relatively simple test, it is only possible where it can be tolerated by the pump. This is not the case for high-energy pumps and for pumps of high specific speed where the power at shutoff is greater than that at the duty point. Pumps have exploded from a build-up of pressure when left running at zero flow.

Another method of pump monitoring is to measure the temperature rise of the liquid through the pump. This measurement is a reflection of the inefficiency of the pump. Because the differential temperature is small, great care is required to measure it. For example, effects of recirculation at the pump inlet and outlet must be eliminated and thermodynamic tests are not possible at low or zero flow. Pump efficiency can be calculated from the measured data of inlet temperature, the differential temperature and the head. If the efficiency changes over time, comparisons can be made on plots of efficiency versus head. For high-head pumps, an allowance must be made for the isentropic temperature rise, which occurs as a result of pressure increase.

Self-Check – 1	Written test

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

Part I: Write True If the Statement Is Correct and False If the Statement Is Incorrect

1. Pumps are among the most commonly used machines in the food process industries
2. The shut-off head method can be used for predictive maintenance of pumps.
3. It's crucial for maintenance teams to employ proper checks before starting their systems to ensure centrifugal pumps don't fail during start-up.

Part II: Short Answer Questions

1. Write the major points to be checked before starting the pump?
2. Write the common pump-monitoring methods?

LG #17	LO#2- Operate Pumping Equipment

Instruction Sheet

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

- Starting up Pumps.
- Monitoring and maintaining pump performance.
- Rectifying and reporting Equipment performance based on operating manuals

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:

- Startup Pumps.
- Monitor and maintaining pump performance.
- Rectify and reporting Equipment performance based on operating manuals

Learning Instructions:

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

Information Sheet 2

2.1 Starting Up Pumps

Pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work moving the fluid.

2.1.1 Startup the Operations Role

It's all about boosting team productivity to ensure a product idea becomes a reality as quickly as possible. Basically, an operations manager makes sure everyone is doing what they should be doing, and holds the startup.

Before the pump is start know flow and pressure to expect on the instrumentation. Use all of your senses when starting pumps or any equipment bearing temperatures (or the oil temperature) should be closely monitored on startup. For start a water pump engine rotate the fuel valve lever to on position (to the right). Push the air choke lever to the close position out to close the choke (to the left). Hold the frame by the left hand. Grasp the recoil starter handle and fast pull it until the engine starts.



Figure 2.1: Starting up positive displacement pumps

2.1.2 Centrifugal Pump Start Up Procedure

- ✓ Open the suction valve.
- ✓ Open any recirculation or cooling lines.
- ✓ Fully close or partially open the discharge valve, depending on system conditions.
- ✓ Start the driver.
- ✓ Slowly open the discharge valve until the pump reaches the desired flow.

Before you start the pump

- ✓ Make sure the power is turned off.
- ✓ Gain access to the pump system.
- ✓ Check for damage.
- ✓ Test a hose.
- ✓ Open the relief valves.
- ✓ Attach the hose.
- ✓ Turn on the water and wait for it to enter the tank.
- ✓ Turn the power on.

a. **DOL (Direct on Line)**

DOL is turning the pump directly on and off, e.g. with a simple contactor. This is only recommended on smaller pumps as this method produces the highest inrush current spikes (often up to 3 times the running current and potentially higher).

This is the simplest and cheapest method. These current spikes have to be taken into consideration when sizing power supplies e.g. generators, as well as contactors and breakers.

b. Star-Delta

Star-Delta is an older method of starting motors (no longer frequently used in the UK) which allows for connection of the pump motor with reduced voltage (across the motor windings). This also reduces the torque by a factor of three.

After a short period of time the delta configuration is then employed which makes the motor run normally.

This starting method has considerably reduced inrush current spikes and therefore the power supply and starting equipment does not have to be quite so oversized.

c. Soft Start

This is a frequently used method of starting larger three phase motors which limits large inrush currents by ramping up the initial voltage as the motor starts similarly to star delta, but much more gradual instead of one step. Therefore the power supply and starting equipment does not have to be quite so oversized.

Soft start is of medium cost, is most widely used above 11kW and is the most-widely used starting method.

d. **Inverter Drives**

Inverter drives (also known as Variable Frequency Drive or Variable Speed Drives) control pump motors by varying the frequency of the electrical power. For instance in the UK standard line power is at 50Hz so a VFD may start a pump at 30Hz and increase it to 50Hz. This means that as frequency is directly proportional to running speed (and therefore consumed power in centrifugal pumps), the inrush current spike is almost removed, meaning that the power supply e.g. generator, and breakers etc. only have to be slightly larger than the running requirements of the pump.

In addition inverters can be used to produce variable pressure/flow with centrifugal pumps including submersible pumps. Inverters are the most costly method of pump starting and therefore used less often. Check if there is any leakage in the pump or not. If there is any leakage then maintenance personals needs to be called for fixing it. Switch off the motor. If everything is okay then the pump can be started by opening the discharge valve and then starting the motor or signaling the control room to start the motor.

I. Pump Start-Up Procedure

1. Unlock and remove chains from inlet/outlet valve wheels and make sure valves are open and there is liquid at the pump. Outlet valves should be 10-15 percent open. Now that you've opened the suction valves, check that the pump is primed and vented.

2. Check for any leaks by expelling air from the line and pump.
3. Remove the coupling guard and turn the shaft coupling to make sure the shaft rotates.If there is resistance, check the pump for any built-up solids or mechanical issues. Now the coupling guard is off, check the condition of the coupling for signs of wear. Re-align the pump if necessary.
4. Check the base to make sure all bolts are tight, with base plates level and no soft feet on the pump or motor.
5. Reconnect the motor.
6. Remove any warning notices on the pump and restore breakers.
7. Start the motor and the record current drawn when starting and when running. Check and record the discharge pressure.
8. Last but not least, make sure the pump is running smoothly with no unusual vibrations or noise.

2.2 Monitoring and Maintaining Pump Performance

2.2.1 Monitoring Pump Performance

Monitoring pump performance is to measure the temperature rise of the liquid through the pump. Pump performance characteristics is assumed, as how to measure test data in a repeatable manner. For condition monitoring, repeatability is more important than absolute accuracy. Pump monitoring methods should be chosen that can detect each of the pump degradation modes that are either experienced or expected. Common monitoring pump performance methods include the following:

- Electrical plant tests: relevant for motor condition
- Visual inspection and non-destructive testing: particularly relevant for pump casing wear
- Performance monitoring and analysis: relevant for pump internal conditions
- Sampling and analysis of lubricants for deterioration and wear debris: relevant for bearings and lubrication system faults
- Vibration monitoring and analysis: probably the most widely applied method of condition monitoring for rotating machines in general, and suited to detect such faults as unbalance, misalignment, looseness

Centrifugal pumps must be monitored regularly, correctly and accurately according to a specific plan which is made by specially trained personnel.

The following six parameters should be regularly monitored to understand how a pump is performing:

- ✓ Suction pressure (Ps)
- ✓ Discharge pressure (Pd)
- ✓ Flow (Q)
- ✓ Pump speed (N)
- ✓ Pump efficiency (η)
- ✓ Power.

To improve pump performance: avoid oversizing the pump, Impeller trimming, Variable frequency drives, parallel pumping systems, limit pipework pressure loss, eliminate unnecessary use, carry out maintenance.

2.2.1 Pump Maintenance Schedule

- ✓ Clean bearing bracket from any oil if found.
- ✓ Check oil drain plug.
- ✓ Lubricate the bearings.
- ✓ Inspect suction and discharge flanges for any leak.
- ✓ Inspect pump casing for any unusual damage signs.
- ✓ Inspect the seal.
- ✓ If the pump is offline check the coupling and its shims for any damage.

Table 2.2: Maintenance check list of fruit and vegetable pumping equipment's and tools

	pumping equipment and tools of Fruit and vegetable	Yes	No	Remark
1	Are tools in safe condition?			
2	Are instruction manuals available?			
3	Are power tools properly grounded?			
4	Are guards and shields in place?			
5	Is Personal Protective Equipment available?			
6	Are pumping equipments and tools properly stored?			

2.3 Rectifying and Reporting Equipment Performance Based on Operating Manuals

2.3.1 Identifying and Rectifying Pumping Equipment Performance

The performance of a pump equipment can be measured using three main analytical models; flow rate (Q), head (h), and efficiency (n). These three models allow users to gain an overall sense of how the pump is performing during operation. Pump efficiency is determined by principally two parameters, head and flow rate, in addition to other factors such as properties of the fluid, impeller design and motor speed selected.

2.3.2 Pumping Equipment Performance Characteristics

The output of a pump running at a given speed is the flow rate delivered by it and the head developed. Thus, a plot of head and flow rate at a given speed forms the fundamental performance characteristic of a pump.

2.3.3 Reporting Pump Equipment Performance

The main purpose of regular maintenance is to ensure that all equipment required for production is operating at 100% efficiency at all times. To solve the problems of flow rate (Q), head (h), and efficiency (n) of pumping equipment sharing the experience, discussing the problem and solution with other members of the operations and quality control staffs through one-on-one discussions, group discussions, written communications, or formal training sessions so that each team member gains the experience of defect recognition, solution determination, implementation for as many situations as possible. Untrained pump operators can result in abused machinery and costly breakdowns. To improve the problems of pump performance avoid oversizing the pump Impeller, Variable frequency drives, Parallel pumping systems, Limit pipework pressure loss, Eliminate unnecessary use, Carry out maintenance

Self-Check – 2	Written test

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

Part I: Write true if the statement is correct and false if the statement is incorrect

1. Pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy
2. The main purpose of regular maintenance is to ensure that all equipment required for production is operating at 50 % efficiency at all times.
3. Monitoring pump performance is to measure the pressure rise of the liquid through the pump.

Part II: Short Answer Questions

1. Write the six parameters should be regularly monitored to understand how a pump is performing?

LG #18	LO#3 Shut-down and Maintain Pumping Equipment

Instruction sheet

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

- Shutting-down Pumping equipment
- Dismantling pumps for Cleaning
- Replacing Parts in motors and pumps as preventive maintenance schedule
- Taking Corrective action the pump fails
- Recording Workplace information

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

- Shut-down Pumping equipment
- Dismantle pumps for Cleaning
- Replace Parts in motors and pumps as preventive maintenance schedule
- Take Corrective action the pump fails
- Record Workplace information

Learning Instructions:

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

3.1 Shutting-Down Pumping Equipment

It is a process of factory pumping equipment; a termination/suspension of pumping equipment operation, services is turn off or stop. Shutdown includes steps to render the systems safe, such as removal of hazardous process materials and inert (asphyxiating) gases. The systems might be cleaned as part of the shutdown; Plant shutdown, or turn around, is a temporary closure of a building to perform maintenance.

When a pump is shut down for an extended period, or for overhaul inspection and maintenance, the following procedures apply:

a) Shut off all valves on suction discharge, water seal and priming lines. Drain the pump completely by removing the vent and drain plugs until the water has run off. This operation protects against corrosion, sedimentation and freezing.

b) Disconnect the switch to the motor and remove the fuses.

c) Drain the bearing housing. If the shutdown is to be followed by an inactive period, purge all the old grease. Otherwise, refill with fresh grease. If an overhaul is scheduled, do not refill the oil or grease receptacles until the pump is reassembled.



Figure 3.1: Shutting-down pumping equipment

Types of shut-down

1. **Emergency (Unscheduled) Shutdowns**

   An emergency condition is the presence of immediate risk of injury to persons and/or serious damage to the physical plant. In an emergency situation, there is no time available for obtaining clearances and approvals. All employees are expected to take whatever action they can to eliminate the emergency as quickly as possible.

Drivers

Drivers for emergency shutdowns include but are not limited to:

1. Failure of essential part of system (Pipe, belt, bearing, shaft, etc.)
2. Fire
3. Flood

2. Formal (Scheduled) Utility Shut-Downs)

A formal scheduled utility shutdown is required anytime any utility needs to be shut down for any reason with two exceptions:

1. Unscheduled emergency shutdowns are a separate procedure.
2. When a contractor is working in an unoccupied area, he may shutdown a contractor-provided and contractor-installed valve, damper or switch located within his jobsite that does not affect any occupied space.

- ❖ **Drivers**

Drivers for formal scheduled utility shutdowns include but are not limited to:

- ✓ Tie in new building or addition to existing building.
- ✓ Decommissioning an existing lab space.
- ✓ Decontamination of an existing lab space.
- ✓ Demolition of an existing space.
- ✓ Deactivation of an existing space to temporarily abandon.
- ✓ Disconnect an existing piece of equipment prior to removal.
- ✓ Modification of an existing utility system such as rerouting utility lines to improve space efficiency.
- ✓ Shutdown of air system for asbestos removal or other containment.
- ✓ Shutdown of smoke detectors to avoid nuisance alarms due to welding or soldering.

- ✓ Preventive maintenance (changing belts and filters, lubricating, etc.).
- ✓ Tap existing lines to add new equipment.
- ✓ Drain water lines to avoid freezing.
- ✓ Repair of leaks or other repair.
- ✓ Testing and commissioning.
- ✓ Switch-over between different equipment or sources.
- ✓ Switch-over to bypass a work area or piece of equipment.

3.2 Dismantling Pumps for Cleaning

3.2.1 Dismantling/Disassembling Pump

Disassembling requires expertise and knowledge of the procedures; therefore the work must be carried out by qualified personnel. These instructions must be carefully read and understood in conjunction with the section drawings and tables contained in the manual, prior to attempt any work on the pumps. For safety, installation and maintenance instructions consult the "operating manual for centrifugal pumps" attached to the pump at time of shipment. Consult also any other attached instructions for accessories and/or components included with the pumps such as mechanical seals, heat exchangers, flushing systems, instrumentation, etc. Before operating or working on the pump it is recommended to adopt safety precautions wearing safety attire (hat, glasses, gloves, shoes, etc.) and have ready the necessary tools required for the work to be done. Do not subject the pump or its components to sudden mechanical impacts and /or distortions. Do not damage or scratch the sealing faces. Pay particular attention not to damage flat gaskets and O-Rings. Be careful not to leave foreign matters such as bolts, screws, washers, rags, etc. in the pump.

When requesting spare parts or technical information for the pump, always quote the pump model number and serial number which is printed on the pump nameplate: therefore it is recommended not to remove the pump nameplate or, in case this action will be necessary, write the serial number on the pump (for example on the flange).

Procedures for Dismantling/Dissembling

- ✓Disconnect pump from power supply
- ✓Remove screw from bottom of filter/inlet cover

✓Loosen the 4 screws from end of pump under the handle

✓Remove the water chamber from the main housing

✓Remove the rotor assembly/impeller from the main housing

✓Clean the shaft hole by using a long Q-tip

✓Clean all parts using fresh water and soft sponge. CLR may be used for mineral/iron build up



Figure 3.2. Dismantle centrifugal pump trainer - YouTube **(Access date 01/19/2023)**

3.2.2 Cleaning Pump

The transfer of hygienic, high quality products requires a clean pump. Therefore at the end of a production process the pumps must be cleaned immediately. The plant needs to be clean and free from germs before starting a new production cycle.

Cleaning is the operation to remove all traces of product from the plant. A properly cleaned surface is free from visible, perceptible or chemically detectable dirt deposits (residue).

The standard cleaning process for plants is the CIP - (Cleaning in Place). This implies cleaning without dismantling of the plant by means of CIP fluids.

In the food industry a CIP process requires the following steps:

- ✓ Preliminary rinsing with water
- ✓ Flushing with alkaline solution
- ✓ Intermediate rinsing with water
- ✓ Flushing with acid

- ✓ Rinsing with clean water

To clean the unit efficiently a turbulent flow of the CIP fluid is required. A minimum flow velocity in pipes is usually 2 m/s. Viscous fluids are often transferred by positive displacement pumps at low flow velocities. In order to obtain the flow rate required for CIP it may be necessary to fit an additional cleaning pump such as a centrifugal pump. After CIP cleaning an additional sterilization in place process (SIP) may be required when highly sensitive products are handled, inactivating any micro-organisms which might be still present in the pump. The sterilization can be carried out by means of chemicals, hot water or steam. In the dairy industry the sterilization temperature is approximately 145° C.

3.3 Replacing Motors and Pumps as Preventive Maintenance

3.3.1 Parts and Components in Motors and Pumps

Pump: is a mechanical device that converts mechanical torque into hydraulic energy. It simply facilitates movement of fluids from one place to another using suction or pressure or both.

Motors, on the other hand, are electro-mechanical devices that are used to convert electrical energy into mechanical energy. When a pump breaks down, sometimes buying replacement parts or components is an alternative to buying a new pump. Most centrifugal pumps consist of a few basic components:

Housing/casing – The outer shell of the pump which protects most of the components from the outside elements. The casing of the pump should be of materials suitable to withstand the environmental conditions of the application (e.g. submersible pumps should be water and rust corrosion resistant

Impeller – A rotating disk with a set of vanes coupled to a shaft. When the impeller rotates, it imparts energy to the fluid to induce flow. Flow characteristics of the pump vary widely based on the impeller design.

Shaft – The shaft connects the impeller to the motor/engine that provides power for the pump.

Volute – The inner casing that contains the impeller and collects, discharges, and (sometimes) recirculates the fluid being pumped. The materials used to construct the lining of the pump volute must be compatible with the handled media.

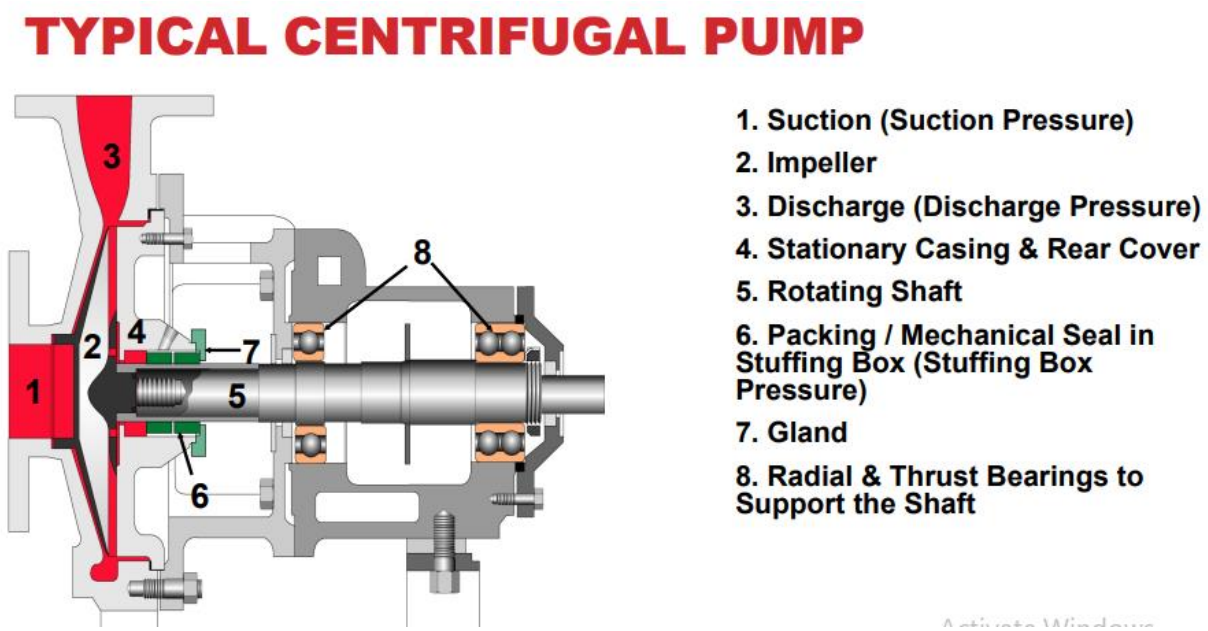


Figure 3.3: Centrifugal pump

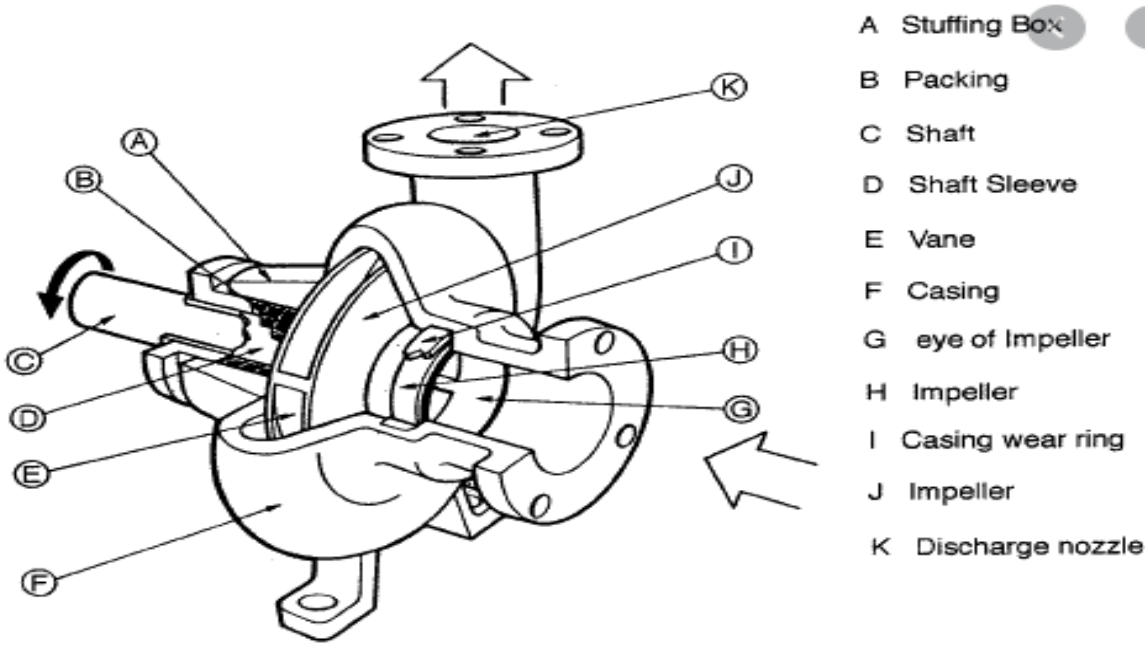


Figure 3.4: Parts and components of centrifugal pumps of fruit processing

3.3.2 Preventive Maintenance

Maintenance is an activity to keep the assets as long as possible in their original condition because any machine/equipment is subject to tear and wear. A preventive maintenance system is a time-based process whereby we prevent the failures and problems in the machines and equipment before those occur. The preventive maintenance makes the machine and equipment more reliable and efficient performance by doing the maintenance periodically.

Preventative maintenance is about regular maintenance checks and repairs in order to reduce the risk of equipment's breaking down. Preventive maintenance keeps the machine running longer time without breakdown by optimizing machine operating condition which leads to prevent unplanned breakdown in the production line.

Preventive maintenance system can be costly and spending time but the benefit of it is more than the lose because it will reduce the number of big repairs and decrease the downtime of the machine and solve the small issue in the machine before they become bigger and eliminate the unnecessary maintenance task for example, we could replace an equipment which shouldn't be replaced.



Figure 3.5: Basic pump mentainance

https://www.youtube.com/watch?v=v5lPyNSYGK8 **(Access date 01/19/2023)**

3.4 Taking Corrective Action

Corrective actions are the actions taken by the licensee to prevent the pump equipment's from CCF/ Common-cause-failure event from re-occurring. The defense mechanism selection is based

on an assessment of the root cause and/or coupling factor between the impairments. Corrective actions are the action take after events.

An effective corrective action programme relies on certain essential characteristics that provide support and enhance programme effectiveness. These characteristics are highlighted in the following paragraphs.

Important elements to consider when developing effective corrective actions are:

- ✓ Addressing the root causes
- ✓ Selecting corrective actions
- ✓ Conservative decision making
- ✓ Corrective action implementation
- ✓ Tracking of corrective action effectiveness
- ✓ Prevent repetition
- ✓ Rally commitments
- ✓ indicators
- ✓ Self-assessment
- ✓ Peer review and
- ✓ Benchmarking

Types of corrective actions

Operating experience and root cause analysis can result in three types of corrective actions:

1. Immediate corrective actions
2. Interim corrective actions
3. Corrective actions to prevent recurrence

1. **Immediate corrective actions** are actions taken to promptly restore normal conditions or eliminate problems. For example, valves and pumps are repaired, procedures are written and a communication link is established between two affected groups, etc. Interim corrective actions are short-term actions to reduce the risk of recurrence while awaiting long-term corrective actions.
2. **Interim corrective actions** could be accompanied by compensatory actions. For example, operating procedures to prevent a motor operator valve torque to be deficient while awaiting a design change to increase the size of the motor operator.

3. **Corrective actions to prevent recurrence** are the most significant of the three types. These corrective actions prevent the problem from ever happening again. Identification and selection of corrective actions that directly address the root cause(s) of the event is of utmost importance for the safety, reliability and performance, and for helping to prevent further events. They have a proven track record and do not cause unwanted problems in other areas.

3.5 Recording Workplace Information

A record is information created, receives, and maintained as evidence and information by an organization or person, in pursuance of legal obligations ISO 15489- The International Records Manegemant Standards. Workplace records management concerns more of the day-to-day activities involving physical or digital files, like capturing, storing, modifying, or sharing them**.**

Workplace information include:-

- Standard operating procedures (SOPs)

Standard operating procedure (**SOP**) is a set of step-by-step instructions compiled by an organization to help workers carry out routine operations. SOPs aim to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply with industry regulations.

The purpose of a SOP is to provide detailed instructions on how to carry out a task so that any team member can carry out the task correctly every time. The purpose or objective of a SOP should restate and expand a well-written title.



Figure 3.6: Recording workplace information

Records management has several goals:

- Organizing existing and future documents
- Improving workflow
- Allowing quick search and retrieval of documents
- Maintaining organization of files to reduce the number of lost and misfiled documents
- standard forms and reports

Analysis of these records can identify:-

- ✓ Common problems by model
- ✓ Spare parts most frequently used by model
- ✓ Maintenance activities performed in a month by administrative area
- ✓ Service histories of individual devices
- ✓ Equipment operator training needs and
- ✓ Cost–effectiveness of equipment maintenance and repair services.

Methods of work place record use notecards or a notebook to record the information.

- ✓ Print out the information you find and then
- ✓ Take notes on notecards or in a notebook.
- ✓ Find it easier to remember information if you have written it down yourself.
- ✓ Document each source as you work
- ✓ Specifications.

Many industries require thorough documentation performed in a specific way. If organizations fail to maintain organized records, some of the consequences may include:

- ✓ Ongoing audits
- ✓ Improper billing
- ✓ Inefficiencies for employee growth
- ✓ Lost revenue
- ✓ Compromised safety
- ✓ production schedules and instructions
- ✓ manufacturers' advice

Self-Check – 3	Written test

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

Part I: Write true if the statement is correct and false if the statement is incorrect

1. Shutdown includes steps to render the systems safe, such as removal of hazardous process materials and inert (asphyxiating) gases.
2. Disassembling requires expertise and knowledge of the procedures; therefore the work must be carried out by qualified personnel.
3. The transfer of hygienic, high quality products requires a clean pump.
4. Maintenance is an activity to keep the assets as long as possible in their original condition because any machine/equipment is subject to tear and wear.
5. Workplace records management concerns more of the day-to-day activities involving physical or digital files, like capturing, storing, modifying, or sharing them**.**

Part II: Choose the best answer. (2point each)

1. Drivers for emergency shutdowns include:

A. Failure of essential part of system (Pipe, belt, bearing, shaft, etc.)

B. Fire

C. Flood

D. All

2. Drivers for formal scheduled utility shutdowns include:

A. Tie in new building or addition to existing building.

B. Decommissioning an existing lab space.

C. Decontamination of an existing lab space.

D. Demolition of an existing space.

E. All

3. Important elements to consider when developing effective corrective actions:

A. addressing the root causes
C. conservative decision making
B. selecting corrective actions
D. corrective action implementation
F. All

Part III: Short answer

1. List down steps for CIP In the food industry (3points)

2. Briefly explain preventive maintenance (1point)

3. List down and explain types of corrective actions (3points)

Operation Sheet- 3

3.2 Techniques/Procedures of Dismantling Pumps

A. Tools and equipment

- Hat
- Glasses
- Gloves
- Shoes
- Mask
- Goggles

B. Procedures/Steps/Techniques

1. Disconnect pump from power supply
2. Remove screw from bottom of filter/inlet cover
3. Loosen the 4 screws from end of pump under the handle
4. Remove the water chamber from the main housing
5. Remove the rotor assembly/impeller from the main housing
6. Clean the shaft hole by using a long Q-tip
7. Clean all parts using fresh water and soft sponge

LAP TEST - 3	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00 ours. The project is expected from each student to do it.

Task-3 Perform Pump Dismantling

Reference Materials

Books

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Web addresses

- ✓ https://www.youtube.com/watch?v=v5lPyNSYGK8

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THE TRAINERS WHO DEVELOPED THIS LEARNING GUIDE:

No	Name	Qualification	Educational Level	Region (College)	Phone number	E-mail
1	Gadisa Berhanu	Food Science& Technology	B	Negele Arsi TVET College ,Oromia	0923450658	gadisabe08@gmail.com
2	Mulugeta Alemu	Horticulture	A	Nefas silk polytechnic College , Addis Ababa	09 25322650	mulugetaalex44@gmail.com
3	**Solomon Lambaso**	**Food Science & Technology**	**A**	**Hawassa Tegbared TVET College, Sidama regional state**	**0913729746**	**sole9746@gmail.com**
4	Bogale Tesfaye	Food Science	A	Yeka Industrial College , A.A	09 20 30 85 94	bogalt19@gmail.com
5	**Kiros Mesgbu**	**Food Science**	**A**	**FTVI**	**0921310111**	**kirosmez@gmail.com**