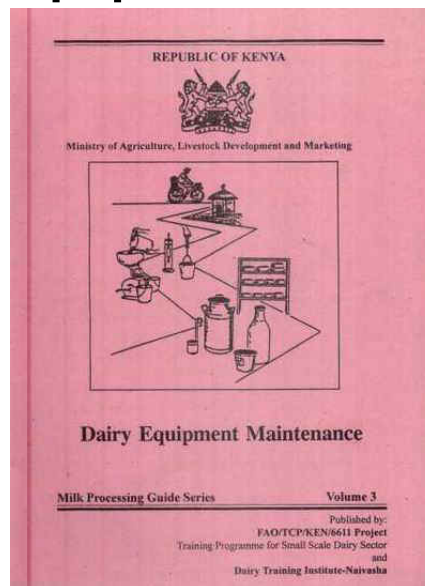


Dairy Equipment Maintenance



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Since the liberalisation of the dairy industry in Kenya in 1992, many small scale to medium scale dairy processing plants have been established in most of the major milk producing areas. The sizes

vary from as small as 200 litres per day to as high as 15,000 litres per day. The level of mechanization and automation also vary according to the size of the plants and the capital investments that have been put unto the establishments.

On account of its constant everyday use and service, the presence of water, steam, ammonia, brine and a variety of cleaning agents, the Dairy and Food plant equipment are more expensive to maintain than equipment in many other industries. In addition, the equipment is usually made demountable for sanitary reasons. This also increases the wear and tear. So whatever the size of the plant and type of equipment used, from simple milk cans to expensive machines like homogenisers, the dairy plant owner should be concerned with the length of service each particular equipment is going to give. This is important because it has a direct influence do the economic returns to investment and profits. This is more apparent with highly specialised and complicated equipment which are very costly. This together with the ever increasing labour costs requires that each piece of equipment be used continuously at peak efficiency and have a prolonged useful life.

Although the length of service one can expect from any given machinery or equipment will depend on the durability associated with its design and workmanship, the way it is used and handled will influence greatly whether or not its utility will extend as long as it was designed to last. The expected useful life of most dairy equipment is about 8 years, implying a depreciation of 12.5% per

annum. With good care and optimum maintenance, the useful life of such equipment can easily be extended by 30-35% or more.

This brief guide has been put together by DTI/FAO training team under Project TCP/KEN/6611 to complement the short course instructions on Dairy Equipment Maintenance Module which has been designed for the Training Programme for Small Scale Dairy Sector in Kenya. It is not meant to be a substitute for detailed manufacturers maintenance manuals usually provided with each dairy equipment. Rather, the main intention is to draw the attention of dairy processing plant and equipment operators to the importance of proper procedures of dairy equipment maintenance and how the neglect of this important aspect can affect dairy product quality and profitability of the dairy processing plant. For more detailed treatise of Dairy Equipment Maintenance, the reader is referred to the bibliography at the end of this guide.

2. DAIRY EQUIPMENT MAINTENANCE

2.1 WHAT IS MAINTENANCE?

Maintenance is the upkeep of plant and machinery in proper working condition at all times

2.2 TYPES OF EQUIPMENT MAINTENANCE SYSTEMS

2.2.1 Preventive maintenance

This is the persistent and systematic procedure for the care of all production, control and auxiliary machinery in a dairy factory including regular servicing, upkeep and overhaul, record keeping and stocking of essential spare parts for the purpose of preventing breakdowns and emergency shut downs for repair.

Preventive maintenance must begin with the purchase of the right type of equipment for any specific job. The machine must always do the job of its right capacity for high durability. If a machine that is of low capacity is consistently being called upon to do a job meant for a high capacity one, no amount of preventive maintenance will cure it!

Preventive maintenance is useful and necessary because it will prevent loss of money and profits due to:

- ***Unnecessary machinery shut downs***
- ***Shortened machine life***
- ***Machine inefficiency and***
- ***Reduced productivity***

The main objective of preventive maintenance is to:

- ***Increase the efficiency and improve the performance of all processing and service equipment***
- ***Increase the overall productivity of the entire plant by achieving coordinated and continuous operation of all plant equipment***

- ***Increase the certainty of meeting daily production schedules***
- ***Reduce unscheduled down time***
- ***Extend the useful life of all plant equipment***
- ***Minimize property and personnel hazards.***

2.2.2 Elements of preventive maintenance programme

A good preventive maintenance programme must include the following elements:

- ***Routine external inspection of all equipment***
- ***Periodic internal inspection***
- ***Systematic lubrication***
- ***Prompt adjustment, repair or replacement of defective part(s)***
- ***Record keeping system***
- ***Periodic analysis of system(s) operating parameters***
- ***Spare parts inventory and inventory control***
- ***Scheduled major overhaul of machinery***
- ***Economic basis for scrapping off of equipment***
- ***Maintenance cost analysis and reporting to management***

- Capable maintenance supervision

All the above elements are essential for an effective PM programme. None should be overlooked or ignored.

From the above, a more comprehensive definition of PM should be:

"Preventive Maintenance is a procedure utilising programmed and coordinated lubrication, internal and external inspections, timely adjustments, repairs and replacements performed by skilled and trained personnel under qualified supervision., for the purpose of preventing unscheduled down time, preserving equipment, maximizing overall plant performance, minimizing maintenance costs, and thereby contributing to an improved profit position" (Newcomer, 1981).

2.2.3 Scheduled repairs

Replacement of parts at preset time or service intervals may be prescribed for certain parts. They must be replaced when due for replacement. It may apply for gaskets, O-rings; oil and air filters.

2.2.4 Economical Maintenance

The secret of economical upkeep is to train operators to handle the equipment as if it were their own, and to keep a continuous inspection for the small things that go wrong. This should be supplemented by a periodic general inspection. In small plants, it is

advisable for each operator to take care of the equipment he/she runs, when minor repairs are needed since there is seldom an engineer around. In large plants, a trained engineer should usually be available for all required repairs.

2.3 IMPORTANCE OF FOLLOWING MANUFACTURER'S INSTRUCTION

The things which go wrong with equipment can often be easily solved by reference to the manufacturer's instruction manual. It is very unfortunate if equipment is unsatisfactory when a simple adjustment as explained in the instructions manual would solve the problem. Most manufacturers of dairy equipment furnish complete instructions that show exactly how the equipment is to be operated, especially on major items of the equipment e.g. pasteurizer, refrigeration machine, Ice Cream Freezer, homogenizer etc.

Most breakages of machinery and loss of efficiency, together with unsatisfactory operation can be traced from failure to follow the manufacturer's instructions. It is impossible for busy superintendent to carry around all detailed instructions for all his machineries. It is therefore important at all times that the instructions be available to the man who operates the machine. The superintendent/supervisor should occasionally check them over with the operator to make certain that the operator has absorbed the information in the instruction book.

Operators should be responsible for their machines.

2.4 COMMON MAINTENANCE PROBLEMS

The commonest maintenance problems include:

- Lack of proper lubrication***
- Breakage due to operators not handling the machine properly and according to instructions or using wrong tools to open or service a machine***
- Leaks due to rough handling of equipment or improper assembling or mounting***
- Corrosion due to improper washing and cleaning methods (use of wrong detergents or too high concentrations and/or temperatures).***

Care directed to the above items will pay dividends in the long run.

2.5 COMMON MAINTENANCE PROCEDURES

2.5.1. Lubrication

Lack of lubrication is one of the principal causes of equipment breakdown. The best solution is to have a regular lubrication schedule, and perhaps a lubrication chart for each machine, setting the frequency of lubrication, type of lubrication needed, and places

to be lubricated.

Modern equipment calls for certain types of lubricants for certain types of bearings e.g. light, high speed bearing will require a light oil, whereas a heavy duty, low speed bearing will require heavier oil.

Bearings that are operated at high temperatures must have a lubricant specially adapted for this use, just as those bearings that operate at extremely low temperatures will require zero oil.

Many dairy plants have rather high humidity and for that reason the moisture problem should be considered. Certain lubricants are available that resist rusting and corrosion due to moisture. There are also oils that resist emulsification with water and are advantageous for flooded systems of lubrication where gears and chains run in oil.

The most tightly enclosed oiling system will with time allow moisture to accumulate. It is essential to occasionally check the oil in an enclosed drive to make certain it is not contaminated with water. Usually the water will collect at the bottom and may be drawn off easily.

2.5.1.1. Handling of Lubricants

In many cases, bearing failures may be traced directly to improper lubrication responsibility and to the handling of lubricants. Some of

the factors concerned are:

- ***Centralised Lubrication Responsibility. Lubrication responsibility should be given to a trained specialist who is fully familiar with the most exact lubricating requirements of the equipment.***
- ***Planned Lubrication Schedules. Schedules outlining the type of lubricant to be used and lubrication frequency should be established and followed to the letter.***
- ***Lubricant identification. Frequently the product loses its identity after being received by the used and becomes just another barrel of grease. Good housekeeping will assure clean and well marked containers.***
- ***Lubricating Devices. Adequate lubricating devices should be supplied for proper lubrication. Proper lubricating devices make it easier for personnel to maintain an adequate lubricating schedule. The use of Teflon for bearing has increased greatly. It is a self lubricating plastic material.***
- ***Accessibility of L Lubricating Devices. Lubrication devices should be placed in accessible locations to ensure safety of the operators and to encourage attention to lubrication.***

2.5.1.2 Indications of Faulty Operations of Anti-friction Bearings

Faulty anti-friction bearing operation can sometimes be distinguished by abnormal noises. Accurate diagnosis, however, is possible only if the bearing is dismantled and inspected. Some of

the defects that cause noisy bearing operations are:

- **A scraping noise indicates the presence of foreign bodies e.g. metal chips,**
- **dirt of sand.**
- **A regular grinding noise indicated cracked or jammed belts or rollers; and irregular grinding noise may indicate that the bearing cage is rubbing against the inner or outer race.**
- **A clear, metallic ringing, almost a whistle, indicates lack of lubricant**
- **A jotting noisy indicates surface crumbling or races and rolling elements out of line. Another cause is hardened deposits on the roiling elements resulting from lubricants of poor quality or improper type.**
- **Alternatively strong and weak rattling indicates a loose ball or roller or too much play in the bearing cage.**
- **A regular humming sound indicates that the bearing is in normal operation.**

2.5.1.3 Over or under-lubrication.

Over lubrication causes overheating and waste of lubricant.

Under lubrication results in excessive wear, overheating due to friction and as a result reduced bearing life.

If a high speed, antifriction bearing equipped with a grease fitting is

pumped full of grease, the grease increases in volume, and excessive pressures and temperatures result because of the churning of the lubricant and the resulting rise in temperature.

It is recommended that a bearing be padded or filled not more than 1/3 or 1/2 full. This will allow the grease, under operating conditions, to expand without building up excessive internal pressure.

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2.5.1.4 Contamination and Corrosion

The presence of abrasive contaminants such as dirt, dust, metal particles, hardened grease deposits and other foreign materials is probably the principal source of antifriction bearing damage and failure. The other important cause for bearing trouble is corrosion resulting from moisture introduced by handling or by exposure to excessively wet conditions and inadequate sealing.

Grease containers should be kept covered, grease dispensing equipment should be cleaned, grease fittings should be wiped clean before refilling.

2.5.2 Lubrication of Equipment.

The direction on how to lubricate equipment given by the manufactures should always be followed. Below is given some

general facts of how to lubricate and what type of lubricants to use when lubricating the most common types of dairy equipment.

- **Motors. How to lubricate motors will depend on what type of bearings is used. Sleeve type bearing are usually lubricated with oil fed by a ring oiler, or if a it is small motors by felt wick. The type of oil used for these barings are oil with viscosity of 300-500 seconds at 100↔F. For anti-friction bearings a multipurpose grease of medium consistency is recommendable**
- **Speed Reducers. Reducing gears and their bearings are almost invariably enclosed in oil tight housing, which has filling level testing and drain plugs. Well-refined oils containing an oxidation inhibitor provide the best results. Depending upon gear types and other design and operating factors, the oil used can have a viscosity of 300-2000 seconds at 100↔F; it should as well be rust-inhibited and foam inhibited.**
- **Conveyors. All bearings should, if the design permits, be lubricated with a water repellent grease, as forcing grease into bearings forces dirt out and provides a seal against the entrance of all kind of foreign materials. If the bearings have to be lubricated by oil, oil of a rust-inhibiting type with a viscosity of 300 seconds at 100↔F should be used. The chains are often lubricated by soap-water solution.**
- **Air compressors and vacuum pumps. The viscosity of the oil used for both vacuum pumps and air compressors affect the operating efficiency very much. If oil with too low viscosity is**

used it will pass the rings, and the result will be increased oil consumption and inefficient pump operation. It should be kept in mind that compressor oils should match the pressure and temperature conditions. The type of oil used should be rust and oxidation inhibited, non-foaming and have a viscosity of 300 seconds at 100 F.

2.6 CORROSION OF DAIRY EQUIPMENT.

- **Corrosion of dairy equipment is one of the major dairy equipment problems, as it accounts for great annual loss to the industry.**
- **Corrosion is caused by an electrochemical action which takes place in the presence of moisture and causes the surface to pit or rust. The best protection for the exterior surfaces of the dairy equipment is to keep them well painted with a good quality moisture proof and heat resistant paint. Some parts, however, can better be protected by some of the metallic coatings e.g. galvanising, tinning or chrome plating.**
- **Corrosion and pitting of the interior surfaces of vats and machinery are best prevented by attention to proper cleaning methods and by keeping the equipment as dry as possible when not being used. Aluminium plate is hung in the vat to prevent electrolytic corrosion of tinned copper vats in some plants.**
- **Proper ventilation of the dairy plants will reduce casting and maintenance since moisture will not collect on the surface of the equipment and remain there for long. Ammonia is corrosive**

hence all ammonia leaks should be prevented.

2.7 TOOLS

The key to caring for tools is to have a rack for each tool stacked and painted in distinct colour. If a tool is to be frequently used on a special machine, the tool rack should be near that machine.

The general purpose tools should be kept in a locked cabinet with the outline painted on the back of the wall cabinet for each tool. Small tools can be kept in a portable metal box.

2.8 CARE OF TINNED SURFACES

To get best service from a tinned surface, two principal considerations are important:

- 1. First, tin is soft metal and is easily scratched and eroded by abrasion, hence abrasives such as steel wool and washing powders etc should not be applied on tinned surfaces.**
- 2. Secondly, tin is acted upon by electrolytes, when in contact with other metals and under certain conditions extensive impairment of the tin surface results. The tin may disappear completely or localised spotting and removal may occur.**

- RETINNING OF SURFACES.

Tinned surfaces require occasionally retinning. This should be done

by RETINNING experts with necessary equipment.

2.9 MAINTENANCE OF BASIC EQUIPMENT

2.9.1 Milk cans

Great care should be observed in the handling of milk cans i.e. that they are not dented or damaged more than necessary. During cleaning of cans, the cleaning solution should be kept at the proper strength as alkali or acid cleaner of high concentration remove the tin and allow rusting. Thorough drying of cans will increase their life span and also improve on milk quality handled.

2.9.2 Milk cooling equipment.

Various types of refrigeration equipment ranging from surface coolers, immersion coolers, ice-bank and direct expansion refrigeration systems are in use throughout the dairy industry. Whereas it is beyond the scope of this guide to go into detailed description of maintenance systems of each type of cooling system, it suffices to mention here that manufacturer instructions on service ice and scheduled repairs should be followed very strictly. Special attention should be paid to lubrication of compressors and detection and timely repair of refrigerant gas leakages.

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Where brine is used as a coolant, its corrosiveness to dairy

equipment should also receive particular precautions during its circulation and handling. In view of the importance of milk cooling vats in dairy industry from the producer cooperatives to the processing factories here we produced a summary of fault finding procure for direct expansion refrigeration vat:

ITEM	PROBLEM	CHECKLIST
Vat milk temperature	Above 4-5C	<p>Check if condensing units are running.</p> <p>Check time since milk was put in vat, and (if recorded), the temperature of the milk in the vat just as it had been put in.</p> <p>Check quantity of milk in vat.</p> <p>The vat system should cool 10,000 litres of milk at rate of 1.8C per hour or 5,000 litres of milk at 3.6C per hour.</p> <p>If time taken is</p>

		<p>excessive, call maintenance firm/engineer.</p> <p>If condensing units are not running, check control switches on panel. If these are on, check power supply, including low voltage control. If power is OK, check vat control unit. If no action, check fuses, if still no action, call maintenance firm/engineer.</p>
Vat milk	Below 4C	Check/adjust settings on vat control unit.
Agitator	Not running when it should	<p>Check power supply. Check settings of vat controller and control switch on panel. Check fuses. If still no action-call maintenance</p>

		firm/engineer.
Milk pump	<ol style="list-style-type: none"> 1. Not running when it should 2. Excess noise/heat 3. Milk leakage 	<ol style="list-style-type: none"> 1. Check power supply. Check starter re-set button on panel. Check fuses. If still no action-call maintenance firm/engineer 2. Call maintenance firm/engineer 3. Check cover "O" ring; tighten nuts or replace "O" ring. If leaking from adaptor housing, call maintenance firm/engineer to replace carbon seal unit.
Power	Plant not running	Check phase indicator lights (or vol meters if fitted) on panel. Check indicator light for low

		voltage control. If power is on and low voltage trip-out light is showing, wait for voltage to rise (call PLN or get generator checked if necessary). If power is on and low voltage tri-out is not showing, wait 5 minutes. If no plant will run after 5 minutes, call maintenance firm/engineer.
All plant	Frequent resetting required	Call maintenance firm.

2.9.3 Milk separator maintenance

- **The gears must be well lubricated; Follow manufacturers instructions.**
- **The level of the lubricant must be kept constant; observe the oil level through the sight glass.**
- **The bowl must be carefully balanced.**

- **The bowl should be cleaned thoroughly immediately after use to ensure proper functioning of the separator and for hygiene.**

2.9.4 Butter churn maintenance

- **The churn and butter making equipment should be washed as soon as possible, preferably while the wood is still damp in the case of wooden churns.**
- **Wash the inside of the churn thoroughly with hot water. Invert the churn with the lid on in order to clean the ventilator; this should be pressed a few times with the back of a scrubbing brush to allow water to pass through (NB The ventilator should be dismantled occasionally for complete cleansing).**
- **Remove the rubber seal from the lid and scrub the groove. Scald the inside of the churn with boiling water or steam. Invert and leave to dry. Dry the outside and treat metal parts with food grade grease or Vaseline to prevent rusting. The rubber seal should be placed in boiling water or dipping in warm water with disinfectant is enough.**

2.9.5 Milk pumps

Generally follow manufacturer's instructions and lubrication procedures outlined above (see section 2.2-2.5.2).

Table 2 below gives common pump problems and possible causes.

Table 2. Common pump problems and possible causes

PROBLEM	POSSIBLE CAUSES
No. Liquid delivered	<ul style="list-style-type: none"> • Delivery head too high. • Suction lift too high • Pump not primed - not filled with liquid.
Not enough liquid delivered	<ul style="list-style-type: none"> • Suction line leaks air. • Shaft seal leaks air. • Delivery head too high • Suction lift too high • Wrong direction of rot. • Suction line smaller than pump inlet • Air in liquid. • Impeller channels too small.
Pump works for a while and then the flow rate is reduced	<ul style="list-style-type: none"> • Suction line leaks air. • Air in liquid. • Suction lift too high. • Impeller channels clogged.
Motor overloaded and becomes too warm	<ul style="list-style-type: none"> • Head too low, pump flow rate becomes too high, throttle outlet or reduce impeller diameter. • Density of liquid too high.

	<ul style="list-style-type: none"> • Viscosity of liquid too high. • Mechanical defects. Impeller may be rubbing against pump casing.
Pump vibrates	<ul style="list-style-type: none"> • Cavitation • Head much too low. • Impeller or shaft unbalanced (shaft bent) Motor pump not properly aligned. • Impeller channel clogged.

Source. Alfa Laval Pump Guide.

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2.9.6 Plate Heat Exchanger

Generally follow manufacturers instructions and preventive maintenance

programme (see section 2.2).

Pay particular attention to possibilities of under-pasteurisation, recontamination of pasteurised milk due to air leakages into the system, and milk leakages. Have in place manual product temperature indicating thermometers in addition to automatic

monitors. Pay particular attention to the well functioning of the flow diversion valve.

2.9.7 Hot Water/Steam boilers

There are basically two types of boilers; the Fire tube boilers and the water tube type. Which ever type of boiler is used, the proper functioning of the following controls and accessories are essential for efficiency and safety.

- **Boiler waver feed pump**
- **Oil fuel filter**
- **Safety valves**
- **Blow down valves**
- **Water level gauges**
- **Low water alarms and cut-outs**
- **Steam pressure gauges**

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These have to be regularly checked and maintained for proper economical running of the equipment.

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Smaller dairies now utilise hot water generators using electric coils. Whey dealing with steam boilers or hot water generators, generally follow manufacturers' instructions and preventive maintenance

programme for dairy equipment (see section 2.2).

2.9.8 Air Compressors

Air compressors are needed in the dairy plant for operation of pneumatic valves and presses. They consist of a compressor pump, motor, air receiver and electrical controls.

Generally follow manufacturer's instructions and preventive maintenance programme (see section 2.2). Pay particular attention to the well functioning of the compressor and motor which are the heart of the machine.

2.10 Cleaning and Sanitation.

Maintenance of dairy equipment cannot be complete without due attention to its cleaning and sanitation. This is necessary not only from the hygienic point of view but also in the prevention of mechanical damage (e.g. corrosion) to plant and equipment. Selection of the right type of detergent and its proper use (temperature and concentration) is important. Generally, the cleaning procedure should consider two types of equipment, those which can be cleaned in place and those that require manual clearing.

Even for those which use CIP methods, occasionally opening up connecting ends and seals for mechanical brushing cannot be avoided. For more guidelines on proper cleaning of dairy

equipment, see Processing Guide No. 1 in his series.

2.11 Setting up of Machinery

In setting machinery, the equipment should be located, if possible in a lighted dry place with plenty of room to work around it for cleaning and repairs. The arrangement should be that the minimum amount of sanitary piping is used, consistent with efficient operation. Related equipment may be grouped together to facilitate supervision. Straight-line flow of product is usually desirable. If possible allow space for unit machine to be added later when the business grows.

Machines especially the heavy ones, are set directly on the floor or on concrete base and grated in thoroughly with a rich cement mixture (1 part cement and 2 1/2 parts sand) and sufficient water.

For improved sanitation, use is made of the ball foot mounting with equipment such as tanks, freezers, fillers etc, on a pipe legs 6-12 inches long having a round foot. Where machinery is bolted down, it is customary to see bolts in the concrete

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