International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

Efficient Milk Chiller for Small Scale Dairy Farmers

1.Abhineel Yemprediwar, 2.Diksha Wasekar, 3.Chetan Karare
Guide: Prof. A.B. Amale

Submitted: 15-05-2021 Revised: 26-05-2021 Accepted: 28-05-2021

ABSTRACT— It is well known fact that operation of many refrigeration systems is dynamic in nature and bulk milk coolers are no exception to this. It is necessary to study bulk milk cooling systems and improve them to reduce chilling time and energy consumption within desired limits. Bulk milk coolers are analyzed and diagnosed with a simple thermodynamic model. A global approach is required whereby detailed component models are linked together to develop an accurate and complete simulation model package of vapor compression bulk milk cooler. These component models include mass, momentum and energy balance equation along with thermo physical property data and the appropriate heat or work transfer relationships. Solving these equations by method of substitution yields a prediction of refrigeration system behavior. This helps in large reduction in time and cost spent in designing a system for given application, leading to the opportunity of achieving a more optimal design through evaluation of different design configurations. This dynamic model helps in adopting better control strategies to improve energy efficiency. The authors have attempted to develop such a global model for bulk milk coolers using vapor compression system with R22 as refrigerant.

I. INTRODUCTION

Bulk milk cooler uses the vapor compression system. These are used to cool the milk from its harvesting temperature of 35 to storage temperature of 4.Existing bulk milk coolers consume relatively more energy and more time to complete the operation. The operation and performance of BMC depends upon the behavior of vapor compression system consisting of reciprocating compressor, air cooled condenser, thermostatic expansion valve and jacketed plate type evaporator. Behavior of the system with respect to time.

There are two types of refrigerated farm bulk tanks: the direct cooling or direct expansion type of tank and the indirect cooling or the ice building chilled water bulk tank. The time required for cooling milk is less with the indirect cooling tank than with the direct one. Bulk-milk coolers have been calibrated to facilitate in determining the amount of milk present. Proper sanitation and maintenance of milking equipment are important adjuncts to healthy cows, efficient production of milk, providing tasty and high-quality milk for man. The production of high-quality milk requires that it must be cooled promptly after milking and stored at a temperature low enough to inhibit the growth of bacteria.

A. Problem Statement

The distance between the farm, the dairy and the consumer became greater, as did the time lapse between milking and the drinking of milk. Milk storage on the farm, and the time taken to bridge the gap between producer and consumer gave bacteria the chance to acclimatize and grow in this nutritious liquid. It became a problem to keep milk quality at the same level as just after milking.

If you lower the temperature of stored milk, chemical processes and microbiological growth will slow down, delaying the reduction in quality. This knowledge enabled farmers, transporters, and dairy organizations to provide milk to consumers after a time delay, without an unacceptable impact on quality. Cooling is a very good method to keep the quality of milk at a high level.

B. Objectives

Following are the Objectives:

1. The purpose of storage tank is to hold milk at low temperature so as to maintain continuity in milk processing operations.
2. To preserve the quality of raw milk supplies.
3. To enable transportation of milk to the dairy plant without spoilage.
4. To arrest bacterial growth, retain freshness and enhance the keeping quality of milk
5. To avoid economic losses to the producers due to spillage/storage of milk.
6. To make available quality milk for production of quality products for export as well as to meet the domestic requirements.
7. To reduce the transportation cost by regulating

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

transportation of the milk on alternative days or once in day for two collections and also through reduction in expenditure on purchase and maintenance of cans.

8. To ensure clean milk production.

II. LITERATURE REVIEW

A. Present theories and practices

For calibrating and evaluating the performance of bulk-milk cooler under every day-milk collecting conditions, the following conclusions should be taken into consideration and can be deduced as follows.

1. The applied recommendations for operating the bulk- milk cooler can be concluded in this research paper.
2. For every day-milk collecting experiments, the bulk milk cooler capacity should not exceed 80.38% (1.286m3) from milk to maintain milk temperature at the recommended level for safe storage and marketing.
3. During the second milk loading, milk temperature was increased by 3.43 and 1.44% for both ever and every other day-milk collecting experiments successively. Conversely, during the first milk loading, milk temperature was reduced by 4.72 and 5.46% for both every and every other day-milk collecting experiments respectively.

the predicted and the experimental values of performance parameters such as work input, coefficient of performance, and condenser refrigerant temperature closely match with each other. But it still required to improve these models to give more accurate results with less number of inputs. Currently the evaporator model gives more variation of evaporator temperatures about 30% as compared to other results. The modular nature of the system model allows the use of other compression and expansion devices.

Water flow rate affects the heat recovery from system; this is seen from the results. It is necessary to optimize the flow rate of water to have maximum heat recovery. With optimum water flow rates energy consumption can be reduced. Due to thermal energy losses unavailable heat cannot be recovered because of practical limitations.

All chemical processes depend on temperature. At lower temperatures, chemical processes are slowed down and chemical spoilage is delayed. Milk contains several nutrients that are necessary for the life of all living beings. It is also the perfect growing medium for micro-organisms, although at 4°C micro-organisms cannot duplicate and the microbiological spoilage of milk is avoided. After having followed the right milking and hygienic procedures, quickly cooling milk to 4 – 3°C is the best way to avoid microbiological growth and chemical changes.

The BMC tank should meet the standard requirements for milk collection cycle of two times in a day with not more than 3.0 hours cooling time from 35 to 4 Deg. C for all milking and not more than 1.5 hours for second milking i.e. from 10 to 4 Deg. C For design of condensing unit ambient temperature condition shall be applicable. The tank shall be of an established & proven Direct Expansion type design, in regular production & use and not a prototype.

From this research paper, it has been perceived that by supplanting the normal bulk milk chiller by this system will vanguards to rescue cost on heating water. Thus saving energy which would have been utilized by electric heater, LPG gas, boilers etc. This not only saves the cost but also it bulwarks the environment by truncating global warming engendered because of heat dissipation to the atmosphere. Also, the hot water produced can be utilized for washing milk containers and other basic purpose. Thus it is advised to use waste heat recovery system wherever possible to increase the energy efficiency of bulk milk chillers.

III. DESIGN OF MECHANISM

The design procedure followed in the industries includes customer probing for temperature Difference (temperature required) to be maintained in the evaporator or for water and flow rate of water. Refrigerant to be used is generally decided by the company but in rare cases it is considered according to the customer. Then capacity of chilling plant is calculated then capacity of compressor, capacity of condenser and capacity of evaporator is calculated. After deciding capacities of all equipment"s, all the equipment"s are either designed at home industries or import from other industries. In medium scale and small industries 5 ton based chilling plant equipment"s are import from other vendors and assembled.

A. Vapor Compression refrigeration cycle

The main components of VCR System:

return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads- the template will do that for you. Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

1. Compressor
2. Condenser
3. Expansion device

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

4. Evaporator

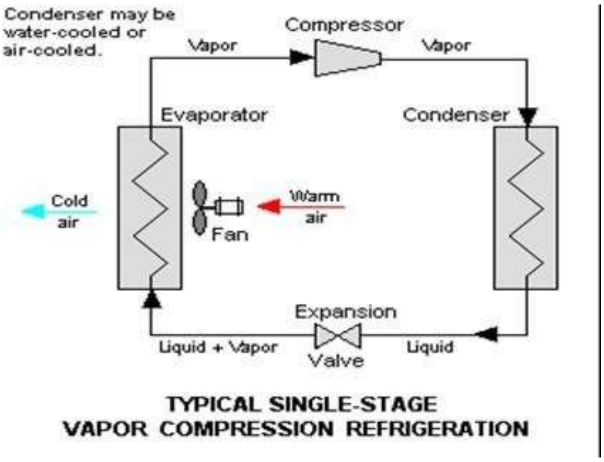


Fig.3.1 VCR System

1) Compressor:

An exact analytical model of reciprocating compressor is extremely complex. Complicated refrigerant flow through valves, flow through compressor inlet and outlet, a complicated heat transfer mechanism, the presence of lubricant within compressor shell, refrigerant charge and refrigerant oil mixture concentration and properties are all phenomena that are almost analytically indescribable. Two parameters that are commonly used to quantify reciprocating compressor operation are volumetric efficiency and compressor power. Volumetric efficiency is directly proportional to refrigerant mass flow rate. So mass flow as directly measurable value is utilized in the model.

2) Condenser:

Condenser is an important device used in the high side of a system. Its function is to remove heat of the hot vapour refrigerant discharge from compressor. A condenser is a device or unit used to condense a gaseous substance into a liquid state through cooling. In so doing, the latent heat is released by the substance and transferred to the surrounding environment.

3) Expansion device:

Expansion valve is used to regulate the refrigerant flow rate such that a constant amount of superheat is maintained at the evaporator exit. During the expansion process the refrigerant liquid passes through the valve and a portion of it flashes in the reduced pressure of the evaporator. This expansion is universally modeled as an isenthalpic process on all refrigeration systems regardless of the geometry of the expansion valve.

4) Evaporator:

The evaporator is a device used in low side of a system. The liquid refrigerant from the expansion valve enters into the evaporator where it boils and changes into vapor. The function of an evaporator is to absorb heat from the surrounding location or medium which is to be cooled, by means of a refrigerant.

Design Calculation and Selection of Components
Components of BMC:

- BMC Tank:
1. Tank
2. Evaporator
- Refrigeration Unit:
1. Compressor
2. Condenser
3. Evaporator
- Control Panel
1. Sensors
- Condensing unit
- Installation

Design of Bulk Milk Cooler: The Used Technique:

1. Tank

cooler, kJ/h V- Milk volume inside bulk- milk cooler, m3
P -Milk density (1032), kg/m3
Cp - milk specific heat (3.940), kJ/kgK
T1 - milk temperature at any loading time, K T2- milk temperature at the time which gives the temperature of safe Storage, k
t -Cooling hours or the time through which temperature of milk reaches T2, h.

The experimental investigation comprised two essential systems; namely every other day-collecting of milk for the bulk cooler. The used technique for cooling milk was done as follows:

1. Air temperature of milk room space was measured and the mean value was of 304.42±275K.
2. Before loading milk to bulk cooler, air temperature of cooling tank space was recorded for every other day- milk collecting experiments.
3. At the first milk loading to bulk cooler, the following successive steps were done:

a) After bringing the first quantity of milk to bulk cooler, refrigeration is turned on automatically and agitator is started and kept going until milking is completed and milk is cooled to at least 277.4K.

b) Quantities of milk are withdrawn from electronic milking system to bulk cooler having the form of successive once every 0.1h. For only one once, milk volume was of 0.044m3 and of 0.022m3 for every other day-milk collecting experiments respectively.

c) Milk temperature was measured every 0.1h throughout loading and storage time of milk inside cooling tank, i.e., from the beginning of loading milk to bulk cooler until milk inside cooling tank has been reached the temperature for safe storage (277.4K).

4. At the second milk loading to bulk cooler, the steps which have been followed during the operation of bulk-milk cooler at first milk loading, were repeated. But at the end of milk loading, bulk cooler was filled by approximately 100 and 50% from its capacity for every other day-milk collecting experiments successively.

Measurements:

1. A volumetric meter was used to measure milk volume inside the bulk-milk cooler. The meter gives volume in liters and then those can be easily converted to cubic meters. Milk temperature was measured by using a digital thermometer which reads temperature in centigrade degrees and after that it can be converted to an absolute Kelvin.
2. For accounting the suitable and safe milk volume inside bulk-milk cooler, at the second loading (100%) for every day- milk collecting, the Arithmetic Interpolation Method was used to fulfill this task.
3. Cooling capacity of bulk-milk cooler was determined by the following formula:

$$CC = \frac{v * \rho * Cp(T_1 - T_2)}{t}$$

Where;
CC - cooling capacity of bulk-milk
Area of Tank=1*1*1=1m^3=1000mm^3 Capacity: 1000 lit. Material of BMC: SS304
Manufacturing Process of Tank:
TIG Welding Process:

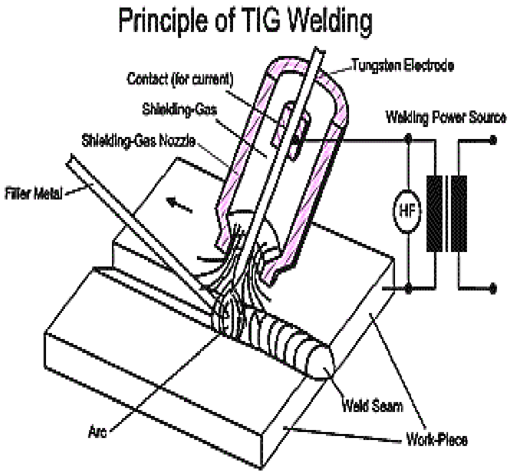


Fig.3.2.4 TIG Welding

The TIG process uses the heat generated by an electric arc between the metals to be joined and an infusible tungsten- based electrode, located in the welding torch. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool and the tungsten electrode. The filler metal as a rod is applied manually by the welder into the weld pool. TIG welding is especially suited to sheet materials with thicknesses up to about 8 or 10 mm.

2. Evaporator:

The evaporator is a device used in low side of a system. The liquid refrigerant from the expansion valve enters into the evaporator where it boils and changes into vapour. The function of an evaporator is to absorb heat from the surrounding location or medium which is to be cooled, by means of a refrigerant.

Types of evaporator:

1. Shell and tube type
2. Shell and coil type
3. Tube in tube type
4. Bare tube type
5. Dimple pressed plate jacket type

We use dimple pressed plate jacket type evaporator in BMC system.

1. Power consumption is less than indirect type evaporator.
2. Life of dimple pressed plate jacket type

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

evaporator is 20 years.
3. Heat transfer rate is high.
4. Ease of cleaning.

Material Advantage Disadvantage

Material	Advantages	Disadvantages
Stainless steel	free from rust easy to clean easy to build scratch proof shock proof acid proof	
Synthetic	Light weight ΔT easy to build shock proof acid proof	easy to scratch more expensive difficult to adapt difficult to clean
Enamelled steel	free from rust easy to clean scratch proof	most expensive difficult to repair not shock proof

General

Materials in contact with cleaning water and chemicals must be resistant to cleaning and disinfecting agents, in normal conditions of dosage and temperature. This is to avoid tainting the milk.

Stainless steel

The chief alloying element in stainless steels is chromium (CR), which in concentrations above 12 – 13 % forms a passive layer on the metal. Increasing chromium content leads to a stronger passivity and thus a higher corrosion resistance. Although chromium makes the steel stainless, it cannot resist certain more aggressive environments. Other elements are therefore added to modify the structure, mechanical properties and corrosion resistance. These elements are Nickel (NI), Molybdenum (Mo), Nitrogen (N) and Copper (Cu). Stainless steel is available in many different quantities.

Refrigeration Unit:

1. Design of compressor:

The refrigeration compressor (s) shall be scroll type suitable for Indian climatic conditions. The motor of the compressor should have a thermistor temperature sensor embedded in windings for protection from excessive heating due to overloading or short-circuiting. Similarly, a protection against off cycle migration of refrigerant to the compressor be necessary in the refrigeration unit, preferably a self- regulating PTC crank case heater.

Client shall approve Emerson Climate Technologies Make(s) of the compressor & condensing unit. The compressors selected should be energy efficient and consume least power to meet the cooling load requirements.

For three phase compressor motors, star /delta starters will be preferable to reduce the starting current.

Capacity of compressor determined by following formula;

Q = m*Cp*

$= \frac{1000}{120}$*3.93*(35-4)

=8.33*3.93*31

=10.14kw

=3 TR

Where,

m = capacity of milk cooler Cp=Specific heat of milk

ΔT=Temperature change of fluid

Fig.3.2.7 Compressor

2. Design of condenser

The part where the refrigerant condenses. The heat in the gas is released into the air and the gas turns into liquid.

Fig. Fin type condenser

3. Design of Expansion device

Thermostatic expansion valve or TEV is one of the most commonly used throttling devices in the refrigerator and air conditioning systems. The thermostatic expansion valve is the automatic valve that maintains proper flow of the refrigerant in the evaporator as per the load inside the evaporator. If the load inside the evaporator is higher it allows the increase in flow of the refrigerant and when the load reduces it allows the reduction in the flow of the refrigerant. This leads to highly efficient working of the compressor and the whole refrigeration and the air conditioning plant.

The thermostatic expansion valve also prevents the flooding of the refrigerant to the compressor ensuring that the plant would run safely without any risk of breakage of the compressor due to compression of the liquid. The thermostatic expansion valve does not controls the temperature inside the evaporator and it does not vary the temperature inside the evaporator as its name may suggest.

Fig. Expansion valve

Functions of the Thermostatic Expansion Valve
The thermostatic expansion valve performs following functions

1. Reduce the pressure of the refrigerant
2. Keep the evaporator active
3. Allow the flow of the refrigerant as per the requirements

Selection:
To correctly select a thermo expansion valve on a refrigerating system, the following design conditions must be available:

- Type of refrigerant
- Evaporator capacity, Qe
- Evaporating temperature/pressure, Te/ pe
- Lowest possible condensing temperature/pressure, pc
- Liquid refrigerant temperature, Tl
- Pressure drop in the liquid line, distributor and evaporator, Δp

The following procedure helps to select the correct valve for the system.

4. Refrigerant:

A refrigerant is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycleIn most cycles it undergoes phase transitions from a liquid to a gas and back again. Many working fluids have been used for such purposes.

Types of refrigerant used in refrigerator: Cooling medium (refrigerants)

For milk cooling, mainly halogenic cooling agents are used. These are indicated by the letter „R" (standing for refrigerant), followed by a code. This code gives the ollowing proportions in R of

- Carbon [C]
- Fluorine [F]
- Chlorine [Cl]

Halogenic cooling agents are described by the following items

- In the vapor phase they are odorless and non-irritating
- They are not poisonous (except by open fire)
- They cause no corrosion
- They are neither inflammable nor explosive.

R for Refrigerants

1. R12: The first widely used artificial refrigerant. Yet because of effects on the ozone layer, and the negative influence of greenhouse gases, it is no longer allowed. Production has therefore been stopped. Boiling point = [1 x 105 Pa] (°C) – 30.

%

2. R22: Presently the most widely used artificial refrigerant. Disadvantage is that it still has some effect on the ozone layer (5 % of R12). Boiling point

= [1 x 105 Pa] (°C) – 40 %

3. R134a: Replacement for R12, with no ozone and only a slight greenhouse effect. Disadvantages are that it requires special oil and that it is rather difficult to change an existing R12 installation to R134a. Boiling point = [1 x 105 Pa] (°C) –

26.5 %

4. R404a: Replacement for R22, with no ozone and only a slight greenhouse effect. Disadvantages are that it requires special oil and that it is rather difficult to change an existing

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

R22 installation to R404a. Boiling point = [1 x 105 Pa] (°C) –
46.4 %

5. R407c: Replacement for R22, with no ozone and only a slight greenhouse effect. Disadvantages are that it requires special oil and that it is rather difficult to change an existing R22 installation to R407c. Boiling point = [1 x 105 Pa] (°C) –
44. %
6. R507: Replacement for R22, with no ozone and only a slight greenhouse effect. Disadvantages are that it requires special oil and that it is rather difficult to change an existing R22 installation to R507. Boiling point = [1 x 105 Pa] (°C) –
46.5 %

We use R22 refrigerant in BMC system:

- It is nontoxic.
- It is nonflammable.
- It is non-irritating.
- Odorless.

5. Agitator

No hazardous part of the agitator shall come into contact with the operator. Non - protected parts shall be present on the agitator shaft, with the exception of the agitator blades and accessories for the cleaning system.

Operation of the agitator shall not cause milk to overflow when the tank contains any volume of milk up to 100 % of its rated volume. The agitator shall be capable of producing a uniform distribution of fat throughout the milk in an operating time of not more than 2 minutes and, after that, when the milk is allowed to stand non-agitated for 1 hour.

6. Milk Filter

Each system shall be provided with two AISI-304 filters with SS fine wire mesh suitable to filter extraneous matter such as dust particles, hay, flies, cow dung pieces / particles etc. One filter shall be on balance tank and the other at the inlet of the bulk milk cooler. The filter shall be designed and installed in such a way that it can frequently and easily be cleaned.

7. Electrical Control Panel

- **Control Panel**

Current modern demands regarding milk cooling and tank cleaning for closed cooling tanks are embraced in the range of cleaning and control units. The unit is microprocessor controlled and provides: several cleaning programs, adjustable to the conditions on the farm; and control and alarm functions, including memory to store data regarding the development of the milk quality during the time the milk is stored at the farm. A higher level of comfort can be reached with automatic dosing. The cleaning and control unit range has been developed with unique cost and environmental saving features built in, such as low water and electricity consumption.

Three control panels shall be provided, one for the main power supply tapping, second for the refrigeration unit and the third for the milk tank. Each panel shall be provided with ELCB+ MCB's of suitable ratings for switching and protection as per the system requirement. The incoming and outgoing power supply terminals shall be covered and „secured with a lead seal to prevent tampering. The door of the panels should be provided with lockable handles. The MOC of all control panels shall be SS 304.

- **Main Control Panel**

This panel should be suitable to tap the incoming State Electricity Board supply and feed the refrigeration unit, agitator motor and milk unloading pump (from balance tank) and dispatch pump. The DG set should be hooked up with this panel through a 'change-over-switch' in order to operate the DG set in place of State Electricity Board supply as & when required. It should be provided with necessary phase indication lamps (LED type), contactors, MCBs, ammeter, voltmeter, energy-meter, frequency-meter, push buttons, DG set running hour meter etc. A battery charger to

Trickle charge the battery when the DG set is in operation (charge indications shall be displayed on the panel) should be provided. Voltage stabilizer (servo type) and single-phase preventer, wherever applicable, of suitable ratings should be supplied. The supplier should find out the voltage variation in the State Electricity supply in the region before supplying the equipment. The voltage variation from the State Electricity supply may be assumed between 150 & 310 volts in case of single phase and between 350 & 500 volts in case of three phase mains supply.

The limit switch shall put off the agitator as soon as the top cover opens up.

- **Cables & Electrical Switch gears**

All electrical switchgears and controls required for the complete system shall be of reputed make and of suitable rating & use for copper wire.

8. Condensing units

This range is specifically designed for milk cooling on the farm using environmentally friendly freon

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

gas. The condensing units are equipped with a piston or scroll compressor. It is available in an extensive range of capacities.

Fig.3.2.9 Control unit
Figure. 3.2.10 Condensing unit

9. Installation

- **Refrigeration Control Panel**

The refrigeration unit shall be provided with a control panel made out of Stainless Steel suitable for wall mounting near the unit. The panel shall be provided with motor starters, ON/OFF push buttons & necessary MCBs, control wiring, line voltage controller to guard the compressor against the supply voltage fluctuations. In case more than one compressor is provided in the refrigeration system, the control panel shall be provided with a sequence controller & timer to start one compressor at a time to avoid surge on power supply. The panel shall also have facility to operate refrigeration unit on auto/ manual mode. In the auto mode, as soon as the milk temperature reaches to pre- set value, the compressor should be switched off to avoid freezing of milk.

- **Milk Tank Control Panel**

The milk tank shall be provided with a wall mounted control panel with timer to control the intermittent operation of the agitator & a digital temperature indicator (with a battery back- up) to indicate the milk temperature to one decimal place with least count of 0.1 0 C on continuous basis. In case of power failure alternate arrangement should be available to know the temperature (stem thermometer). It shall include MCBs etc. as required for switching & protection. The agitator(s) shall have interlocking arrangement with top cover opening limit switch.

- **Stainless Steel Process Pipe and Fittings**

Stainless Steel AISI 304 process pipe shall be used for milk transfer from balance tank to Bulk Milk Tank either gravity flow or through SS sanitary milk pump and CIP line. The pipe shall be welded type having minimum 2.0 mm thickness. Inside of the tube shall be acid pickled and outer surface mirror polished. All bends and Tees required to complete milk and CIP lines shall also be manufactured from the prime quality process tube as described above. All the valve and fittings required shall be AISI 304 SMS standard made out of entire investment casting or forging.

The milk contact surface shall be ground smooth or lapped, having minimum surface roughness 150 grit. The outer surface shall be mirror polished. Material of gasket for milk application shall be neoprene / nitrile rubber. The required number of two way / three way valves should be provided. There should be adequate pipe up to the Tanker loading of the milk collection center for easy unloading into tankers. At every three meter pipe a union shall be provided so as to facilitate manual cleaning. 1 feet S.S. plate should be supply for BMCU leg foundation and the plate thickness should be 6mm in each leg. S.S. pipe should be fitting with hinge type clamps.

- **Insulation**

The insulation of the tank shall be done by injection, in situ, of high density (minimum 40 kg/m3, CFC free and environmental friendly) polyurethane foam without having any

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

imperfection and hygroscopicity. The efficiency of insulation should be such that at max 50 degree C. ambient temperature, the rate of rise of the mean temperature of the milk, initially at about 4 Deg. C shall not exceed by one Deg. C in four hours when the rated volume is allowed to stand undisturbed as per the requirement of ISO 5708 2A II (latest version) when the refrigeration unit is not working.

- **Welding & Finishing**

Inner, outer, intermediate dimpled jacket and nozzle connections shall be welded with TIG process only. The inner shell and all other product contact surface shall be polished up to minimum 150 grit finish. The outer surface to be polished with 150 grit dull finish or a circle finish.

- **Cleaning**

Cleaning cannot be passed over. The careful cleaning of a milk cooling system provides the chance to avoid infections, while cooling delays micro bacterial growth and chemical processes. Avoiding bacterial growth by quick cooling, and good cleaning clearly pays good return on any extra cost that might be incurred.

Because of the nature of the product, milk, it is necessary to clean the milking equipment after every milk turn is complete. This means that the total installation must be free from any remainders of milk, one reason being that the most important life condition for bacteria, the presence of food, is taken away. By using high temperatures and thoroughly disinfecting the installation, most bacteria will be killed. A holistic look at why and how to clean can be found in

External hygiene

- Clean the tank with soapy water of a special cleansing agent
- Pay attention to the lid and rubber seals.
- Clean valve with sweeper and check the condition of the rubber seals.

Condensing unit hygiene

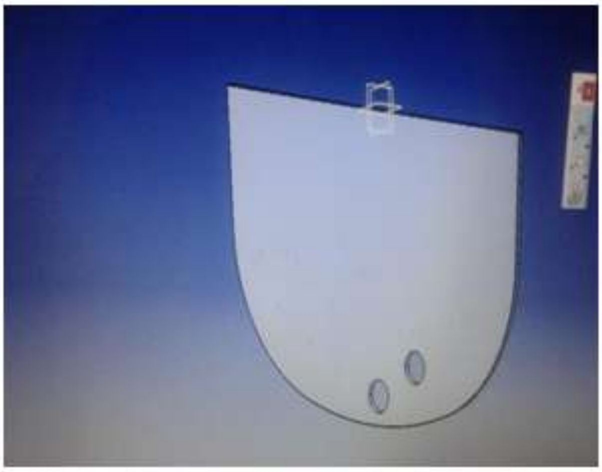
- Ensure sufficient fresh air supply
- Remove dust, hay, cobwebs, etc.

Areas that need to be checked when cleaning the cooling equipment

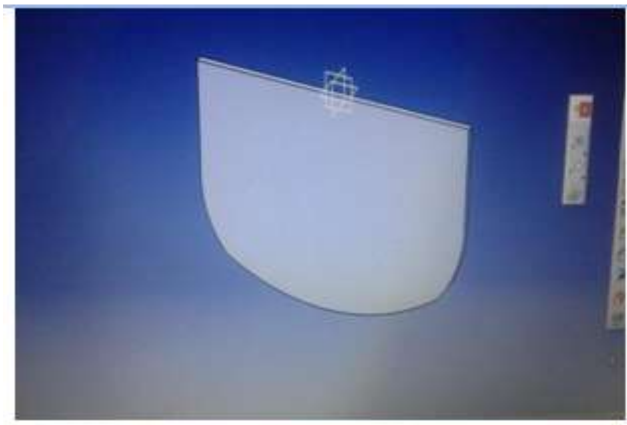
- Inner surfaces must be smooth and clean
- Dark places, and where water has been mixed with fat and stays in drops.
- The agitator wing.
- The tank interior. If necessary, climb in the tank and clean with a brush.

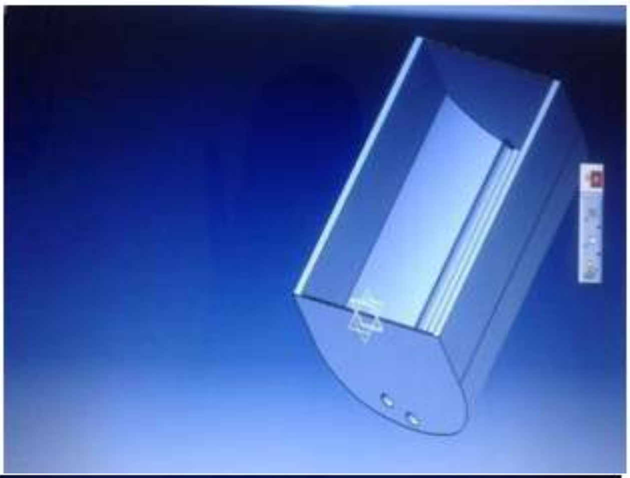
Experimental set up

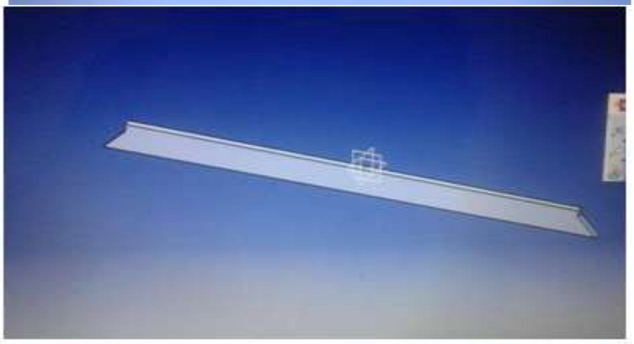
- CATIA design of system:

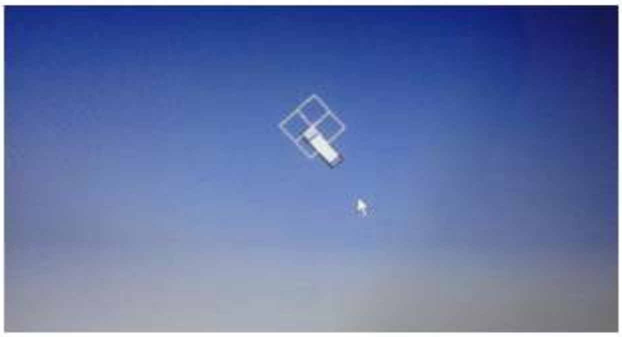


International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252









IV. ASSEMBLY/FABRICATION, WORKING AND TESTING

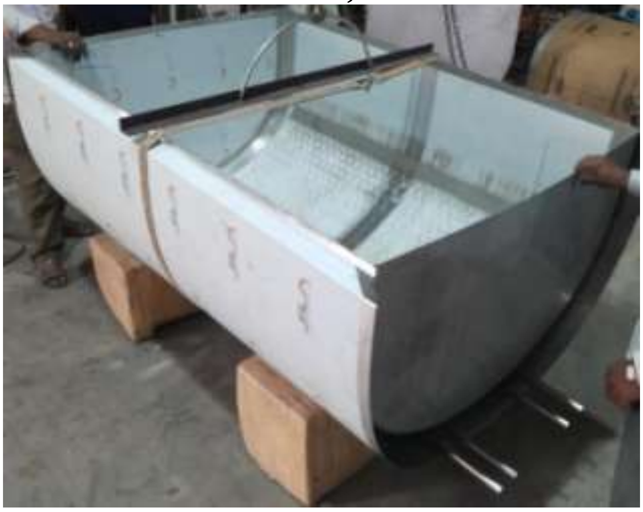
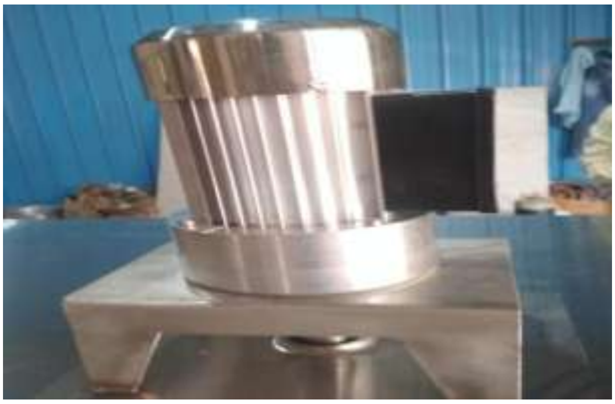


Fig. 4.1.Fabrication of Tank



International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 1466-1479 www.ijaem.net ISSN: 2395-5252

V. RESULTS AND DISCUSSION

The project aim towards to Milk needs to be chilled to 4 °C within two hours or less otherwise bacterial growth increases thus bringing down the milk quality. Best suited refrigeration system is mechanical refrigeration system for Indian conditions. Data collected from village co-operative societies was taken for design. Concept was designed keeping ergonomics in mind and also reducing the effort and time for loading and unloading the milk in chiller.

The major advantage of this project is that the milk chilled in the chiller can be used for secondary processing if packaging unit is located even at 4 -5 hr journey time.

Advantages

1. Elimination of souring/curdling of milk due to cooling at the collection center itself.
2. Adulteration of milk and spillage from cans can be eliminated during transport.
3. Transportation cost of milk can be brought down by regulating transportation to the main dairy either on alternative days or once in a day.
4. Saving of initial investment on purchase of cans and subsequent maintenance cost (Repairs, cleaning etc.).
5. Improved quality of milk can be supplied to the main dairy to manufacture quality products

for domestic as well as export markets.
6. Flexibility in milk collection time results in increase in volume of milk collected at the centers.
7. Farmers will get better returns for the quality of milk.
8. Chilling at the Main dairy can be avoided.

Disadvantages
1. Requires constant attention of flow rate.
2. Greater chances for air-borne contamination
3. Cleaning and sanitation is not very efficient.
4. There is slight evaporation loss.

Applications
1. Food processing, preservation and distribution
2. Pharmaceutical Industries
3. Dairy Products
4. Milk, butter milk, condensed milk
5. Pasteurize the milk to required temp.
6. Ice cream mix ageing

SUMMARY

1. Milk cooling requires an adequate supply of electricity and water. These are not always available on the farm and sometimes can only be arranged at relatively high costs.
2. Even though electricity and water may be available, the volume of daily milk production may be too small to justify a cooling system, and it would be too expensive to cool a small amount of milk on the farm and too expensive to collect it. Due to regulations, smaller amounts of milk are sometimes cooled on the farm, but this milk is then expensive to transport. In such cases, it is possible to transport the cooled milk in an insulated vessel to a collecting point, where a tanker collects milk from several suppliers.
3. Bulk collection of milk on farms not only requires a supply of water, electricity and a certain daily production of milk, but also good road access for milk transport trucks.
4. If a dairy intends to introduce bulk collection of cooled milk in areas with many low producing farms (and where the milk is not cooled), substantial resources are required.

CONCLUSION

It is important is to know that cooling is a compliment and not a replacement for hygienic working practices, and that prevention is better than cure. Avoiding infections is the first priority. Cooling is the weapon against growth, and with efficient cooling and good care the battle against micro- organisms can be won. Milk quality rises, as does the quality of all milk products.

A. Comparison of simulated and experimental results

1. Milk cooling requires an adequate supply of electricity and water. These are not always available on the farm and sometimes can only be arranged at relatively high costs.
2. Even though electricity and water may be available, the volume of daily milk production may be too small to justify a cooling system, and it would be too expensive to cool a small amount of milk on the farm and too expensive to collect it. Due to regulations, smaller amounts of milk are sometimes cooled on the farm, but this milk is then expensive to transport. In such cases, it is possible to transport the cooled milk in an insulated vessel to a collecting point, where a tanker collects milk from several suppliers.
3. Bulk collection of milk on farms not only requires a supply of water, electricity and a certain daily production of milk, but also good road access for milk transport trucks.
4. If a dairy intends to introduce bulk collection of cooled milk in areas with many low producing farms (and where the milk is not cooled), substantial resources are required.

B. Future scope

One of the most labor intensive and time-consuming jobs in dairy milk production is the milking itself, which takes place at least twice a day. Demands have therefore been growing for automatic milking systems to solve this. They offers the total automatic system, VMS, the Voluntary Milking System.

Due to a continuous low quantity milk flow, 24 hours per day, the VMS system requires an efficient, specially-designed cooling concept, and therefore developed a professional cooling system.

ACKNOWLEDGEMENT

We would like to express our deep and sincere gratitude to our Guide Mr. A. R. Mane, Department of Mechanical Engineering, for guiding us to accomplish this Project work. It was our privilege and pleasure to work under his able guidance. We are indeed grateful to him for providing helpful suggestion, from time to time. Due to his constant encouragement and inspiration we are able to present this project.

We also thankful to Mr. D.Pawar from “Shiv Engineers and Services, Taswade MIDC, Karad” for offering the sponsorship to our project work.

REFERENCES

[1] Mohamed A. Basiouny, S. E. Abdallah. “Evaluating the Performance of a Bulk-

Milk Cooler on a Dairy Farm".Misr J.Ag. Eng., 24(4): 956- 977 October (2007).
[2] D. V. Ghewade, Dr. S. N. Sapali, Dr. S.R.Kajale. "Dynamic Modeling of Bulk Milk Cooler". 5th International Conference on HEFAT 2007 Fluid Mechanics and Thermodynamics Heat Transfer, (2007).
[3] Browne M.W., Bansal P.K., "Challenges In Modeling Vapor Compression Chillers". (1998).
[4] S.N.Sapali , S.M.Pise , A.T.Pise , D.V.Gewade . "Investigation of Waste Heat Recovery from Bulk Milk Cooler". Case studies in thermal engineering (2014).
[5] Mr S. Y. Jansen, Mr A. P. M. Rombouts, Mr P. Schriemer, Mr G. Wever. "Efficient Cooling". DeLaval International AB Business Unit Cooling, October, (2000).
[6] NDDBANAND. "Direct Expansion Type Bulk Milk Cooling System". (2009)
[7] R.R.Yenare, Prajakta Mohalkar, Komal Bhangale, Jidnyasa Jalgaonkar, Ninad Mahamulkar. "Investigation of Energy Saving Potential of Bulk Milk Chiller by Waste Heat Recovery".JETIR, Volume 6, Issue 4, April (2019).
[8] Bendapaudi, Braun J.E., Groll E.A., Dynamic modeling ofcentrifugal chiller system, Model development, Numericalstudy and validation, ASHRAE Transactions Research, 2005.
[9] RaneMilind, V.Tandale,Madhukar S. "Benefit of Super Heat Recovery on Chillers Case Study for a Hotel Installation, In International Refrigeration, (2003).
[10] VinayHegde, Arup Bhattachrya, S. Srikari. "Design of Mobile Raw Milk hilling Unit for Rural Areas". SAS Tech Journal 31 Volume 13, Issue 1, April (2014).
[11] Prof.Taware Omkar H. "Review paper on evaporative cooling system". Volume4, April 2017.
[12] S. M. Pise, Dr. S. N. Sapali and Dr. A. T. Pise. "Investigation of waste heat recover from refrigeration system". 05 July 2017.
[13] National skill development corporation "Qualification pack-occupational standards for agriculture and Allied industry". 28 September 2015

Reference Books

[1] A, M. Domkundwar, Arora "Refrigiration and Air- Conditioning", Edition-1, 2009