INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE & TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No. MH-659/13(N)
www.vmsindia.org

Assessment of Energy Conservation and Solar Energy ApplicationIn Milk Processing Plant

V.P. Pandagale[1], Madhuri Gajabe[2], V.P. Khambalkar[3]
Department of Farm Power & Machinery,
Dr.PanjabraoDeshmukhKrishVidyapeeth, Akola
vpandagle@gmail.comvivek_khambalkar@hotmail.com madhurigajabe@gmail.com

Abstract
Present study was carried out to understand the milk process of Akola milk scheme. The status of milk processing industry showed that there is huge amount of milk processing plant available for the energy conservation.The operation viz pasteurization, hominization were studied for the requirement of energy from the boiler system. The data regarding the furnace oil requirement, cost of furnace oil, boiler capacity, milk processing capacity and the temperature ranges for the milk processing were collected from the milk processing plant. The fuel consumption of the studied plant was observed to be 100 litre per day. The cost of fuel per litre was found to be Rs 31.10. The energy require to raise the desired temperature of 1 litre of water requires 3.45 kWh. Water requirement to process one litre of milk requires 0.657 litre. By integrating the solar water system of 2000 LPD, saving in furnace oil was found to be 28 lit/day. The total amount of energy conserved during the integration of system was found to be 97608 kWh per year. The total cost of operation for the capacity of 5258 litre per day were found to be Rs. 107420 per day and the net annual cost saved using the proposed solar system was comes to be Rs. 261300.
Keywords: Milk processing parameter, solar thermal energy, boiler

1.Introduction

India is the world's no. 1 milk producing country, with an output of 117 million tons in 2010 as reported by the National Dairy Development Board, and is second only to the European Union in production. Furthermore, milk production in India is growing at an annual rate of 4.5 %, far ahead of the global average of 1.35 %. Nearly 15 % of the milk sold in the domestic market is processed into dairy products (baby foods, ice cream, whey powder, casein, and milk albumin) and that requires heat. There are some 700 milk processing plant in the formal dairy sector, heating water accounts for more than 30% of the energy in Dairy Industry of India, while most of the hot water requirements are at the dairy processing plant, there is also a minimal need for hot water to clean containers at the collection and chilling centre. Thermal energy is used for various process, such as pasteurization and washing. At the dairy processing plant, a central boiler produces steam which is then used to heat water. The largest advantage of solar energy is captured and converted into electricity via photovoltaic (PV) cells. There are also larger solar power plants that collect the heat from the sun, which is subsequently used to produce steam for powering a generator. In industrial applications there are some cases in which the penetration of the thermal-solar system can be particularly substantial. There are industries which have relatively low energy consumption and the energy derived from the thermal-solar system substitutes an important part of conventional fuels in their energy balance.

2. Material and method

India is a tropical country, micro-organism grow very fast and deteriorates quality of milk. Milk organism requires moisture media and temperature (20 to 40^{0}c) which is suitable for their rapid growth and multiplication. It is therefore necessary to use great care in collecting and handling of milk.

2.1.1Location and site plan

Akola is situated at 77^{0}2'F longitude and 20^{0}42 latitude having altitude of 281 m above mean sea level, proper utilization of solar energy most of processing industries take advantage of it. The Government milk scheme was started in 1962. Then the expansion of dairy was made and completed in 1975. The cost of building was 63.81 lakh and errection of machinery cost 24.10 lakh. The milk was purchased from village co-operatives. The powder plant construction was completed in March 1988 and started working in December 1988.

2.1.2 Organization set-up

The efficient management of whole plant it has been divided in the following section.

a) Reception and whole milk processing
b) Butter section
c) Ghee section

d) Boiler, refrigeration and cold storage section
e) Establishment and account section
f) Repair and maintenance section
g) Skim milk power plant and efficient treatment section
h) Store house and security section

2.1.3 Product flow pattern

The full skeleton view of the various operation phases in the plant which leads to the production of the final milk products. The dairy receives nearly 25000 to 30000 litres/day in lean season and 150000 litres/day in flush season.

2.2 Milk processing plant

2.2.1 Reception section

Milk is received by tankers, which are ofdifferent capacity e.g. 7000 litresrepectively from chilling centers also milk is received by cans from societies. Each trunk carries about 50 to 60 cans of 40 litres. Various equipments use in this section is given below

i. Weight bowl (Avery Bridge)
ii. Dump tank
iii. Can drip saver
iv. Centrifugal pump
v. Cans scrubber
vi. Straight through can washer

2.2.2 Milk processing section

It includes the pasteurization of milk, separation of cream and pasteurization of cream and their storage. It also includes the pouches filling.

2.2.3 Milk pasteurization

In the Govt. milk scheme, Akola there are two milk pasteurizer. The existing pasteurizer is of H.T.S.T. type by using the circulation of hot water. It consists of regeneration section i) regeneration section, ii) heating section, holding and chilling section respectively.

2.2.4 Cream pasteurization and separation

The milk Scheme is provided with one H.T.S.T. cream pasteurizer and three cream separator of centrifugal type. The separated cream is utilized for butter and ghee making.

2.3 Study of Ancillary plant

2.3.1 Water supply

Water is required in the milk scheme for following main purpose.

i) Cleaning of vats, cans etc.
ii) Cleaning of floors
iii) Cleaning of various machinery
iv) Refrigeration purpose

2.3.2 Steam generation section

The steam generation is carried out by boiler. Govt. milk scheme provided with two horizontally mounted, oil fired boilers. These two boilers are semi-automatic. The various accessories used in boiler include.

i) Water level indicator
ii) Pressure gauge
iii) Safety valve
iv) Blow-off cock
v) Fusible plug
vi) Man-hole
vii) Electronic control circuit

2.3.3 Refrigeration section

Govt. milk scheme provided with three single stage compressor of kirloskar K-60 type and two compressors of two stage kirloskar (Booster) Kc-31 type. Refrigeration section has

i) Compressor
ii) Condenser
iii) Evaporator
iv) Expansion

2.3.4 Solar energy demand and saving in energy

The solar energy utilization for the proposed study were determined by considering the use of energy in the homonization and pasteurization process of milk processing. Generally these process were utilized the energy received from the boiler of heated water. Furnace oil is used as feed fuel for boiler to heat for various application of the milk processing. The determination of various parameters as below.

$$\text{Water requirement for processing of milk} = \frac{\text{Milk processing capacity of plant (LPD)(per liter)}}{\text{Boiler capacity (Water, LPD)}}$$

The energy required to warm the water from the normal temperature to the 35^0c was determined by considering the following facts.

1 gm of water for raising the 1^0c temperature requires 1 calorie

3. Result and discussion

3.1 Study of different operation and processes

3.1.1 Can washing

In milk scheme a straight through can washer is used for can washing which is semi-automatic unit, which is also designed for sterilization and complete drying of milk cans. The existing can washing system required water supply of 1400 lit/hr. The steam is supplied at pressure of 6 kg/cm^2 for this system.

3.1.2 Milk Pasteurization

Milk scheme is provided with three H.T.S.T. pasteurizers. One is cream pasteurizer having capacity of 5000 lit/hr and two milk pasteurizers with capacity of 15000 lit/hr each. The milk is heated up to 790c and hold at this temperature for 15 sec.

3.1.3 Cream Separation

The milk scheme is provided with three cream separators, which is of centrifugal type having the capacity of 15000 lit/hr each.

3.1.4 Cream Pasteurization

The cream separated after first regeneration of the milk pasteurizer. It is then pumped to first stage of plate pasteurizer for heating up to 92^0 c by hot water. It is cooled by chilled water up to 7^0c and pumped to cream storage tank.

3.2 Status of milk industry in Maharashtra

The actual processing of milk (LPD) in Maharashtra state was collected from online portal of dairy department of government of Maharashtra. It is found that a total of 1500-2000 ton of milk capacity is processes in the state(Anon,2010).

3.3 Data of Milk processing industry of Akola district

To determine the energy conservation practices and saving in the cost of fuel following data was utilized of the milk processing plant of Akola district

Table2. Data of milk processing industry of Akola district

Sr. No.	Parameters	Quantity
1	Furnace oil consumption, lit/hr	100
2	Boiler capacity, tone/day	8
3	Furnace cost, Rs/lit	31.10
4	Temperature range of operation considered	35^0c
5	Cost of solar water, Rs. Per 200 litre	35000

Table2 depicts the information of parameters collected from the milk processing plant of Akola district. The cost of fuel was 31.10 Rs/l. The furnace oil consumption per was observed to be 2400 litre. The actual cost of furnace oil for one day operation was found to be Rs. 74640. The details of calculation are given below;

For Akola milk Scheme

1	Total milk processing capacity	=	5258 lit/day
2	Capacity of boiler	=	8000 lit/day
3	Calorific value of Furnace oil	=	10,000 Kcal
4	Furnace oil required for 1 hr	=	100 lit/hr
5	Then, Furnace oil required for 24 hr	=	2400 lit.
6	Net Energy for boiler	=	27912 kWh
7	1 lit of water boiler capacity requires energy	=	27912/8000 = 3.45 kWh/lit
8	Water required for 1 lit of milk process	=	5258/8000 = 0.657 lit.

3.4 Integration of solar water system

The energy supplied by solar thermal device viz. solar water heating system was considered as feed water for the boiler scheme. The feed water of normal temperature have to raise the temperature in solar water heating system and then circulate to the boiler for the additional heating. Based on the concept that energy require to raise the temperature of water for the 8 tone capacity of boiler up to 35^0c temperature.

For solar energy

8000 gm of water for 350c requires =280000 Kcal
Saving of furnace oil in boiler = 280000/CV of furnace oil = 28 LPD

It was found that nearly 28 litre of furnace oil was saved once the boiler system is coupled with the solar water heating system.

3.5 Scenario of Energy conservation

The project was mainly emphasised on the saving of traditional fuel by using the solar water system to the boiler. The use of furnace of oil for the boiler has been reduced up to the 28 lit/day operation of milk processing. The annual saving of the furnace oil has been calculated by considering the total operational duration of milk processing plant. The annual working were considered as 300 days. The total volume of furnace oil conserve in the proposed integration of the solar water is found to be 8400 litres. The net amount to be saved from the solar water heating system is comes to be Rs. 2,61,300 per annum. The total amount of energy conserved during the integration of system was found to be 97608 kWh per year.

3.6 Energy conservation economical feasibility

The relation to the economical feasible of solar water heating system which interested to the boiler has been worked out. The milk processing cost per litre was determined and it comes to be Rs.20.43 per litre. The total cost of operation for the capacity of 5258 litre per day were found to be Rs. 107420 per day. The net savin g cost of conserved fuel from the boiler by the solar system comes to the Rs. 871 per day. The net annual cost saved using the proposed solar system was comes to be Rs. 261300.

4. Conclusion

Present study was carried out to understand the milk process of the Akola milk scheme. Based on the analysis and the result following conclusion could be drawn.

1. The status of milk processing industry showed that there is huge amount of milk processing plant available for the energy conservation.
2. The fuel consumption of the studied plant was observed to be 100 litre per day.
3. The cost of fuel per litre was found to be Rs. 31.10.
4. The energy require to raise the desired temperature of 1 litre of water requires 3.45 kWh. Water requirement to process one litre of milk requires 0.657 litre.
5. By integrating the solar water system of 2000 LPD, saving in furnace oil was found to be 28 lit/day.
6. The total amount of energy conserved during the integration of system was found to be 97608 kWh per year.
7. The total cost of operation for the capacity of 5258 litre per day were found to be Rs. 107420 per day. The net annual cost saved using the proposed solar system was comes to be Rs. 261300.

References

1. Anon 2003.Solar overview, Gujarat Energy Development Agency.www.organic downurder.com / solardryer.htm
2. Anon 2010. Dairy development department, Government of Maharashtra, accessed at 12-5-2010. http://dairy.maharashtra.gov.in/index.php?lang=mr.
3. Anantkrishnan, C.P. and Sinha 1961.Dairy Engineering and Technology Engineering of Dairy Plant Operation Si Version, New Delhi Laxmi Publication.
4. Cromarty, W.A. 1981. Australian Journal of Dairy Technology, Australian Society of Dairy Technology, Victoria, Australia
5. Eckles, C.H. and Comb, W.B. 1957. Milk and milk products, Tata McGraw-Hill Publishing Company Ltd. Bombay, New Delhi.
6. Farrall, A.W. 1966. Food engineering system, west port, the Avi.Pub.I Co. Inc.

a. Johnson, E.F. 1967. Automatic process control, McGraw-Hill book company New Yark.

7. Madansure, V.N. 1980. Steady state modelling and simulation of H.T.S.T milk pasteurization process. Unpublished Thesis submitted to partial fulfilment of M.tech. Degree, Agril.Engg.Deptt.I.I.T.Kharagpur.
8. Natarajanm, E., Perumal, E.A. 2000. Potential and prospects for commercial exploitation, proceeding of national conference on renewable energy, held on 27, 28 April 2000 at Udaipur 181-184
9. Rai, G.D. 1993. A text book of solar energy utilization.
10. Rai, G.D. 1994. Solar energy utilization khana publication, New Delhi. 1-3
11. Sukhamte, S.P. 1984. Solar energy-Principles of thermal collection and storage. Tata McGraw-Hill publishing company ltd. 14-50.

????