

# Study and Experimental Investigation of Improving the Efficiency of Boiler Power Plant of a Milk Processing Industry Based at Kerala- A Case Study

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**Abstract-Different milk and milk-oriented companies are facing complicated situation in the milk marketing field at present. New people are not willing to come in milk fields and existing milk farmers go back from this field because higher rate of production cost, lack of better Government policy and cheaper rate of return of milk. In the light of above facts, a detailed study on financial challenges and technical issues being faced by milk and milk product marketing industry is conducted. Study is conducted based on a milk marketing industry situated at Kannur in Kerala-MILK PROCESSING PLANT OF JANATHA CHARITABLE SOCIETY, VELLUR(PO), KANNUR. This society is a charitable institution which milks from farmers and produces different kinds of milk products.**

**This study emphasized to improve their financial expenses incurred with their bier plant. In addition to the various equipment like compressor, evaporator, heat exchanger, packing machine etc., the main unit is its boiler plant, which produces steam for all the processing activities in the plant. The present fuel used in the boiler plant is firewood. Instead of firewood, heavy oil fuel or CNG is used, the efficiency is increased by 10% and expense is reduced by 40%. Radiation loss is also reduced considerably by using a compact oil burner and thereby the boiler plant becomes safer.**

## 1.INTRODUCTION

Milk industry in India exists more than 75 decades and was started on a very small scale. In India 90% household farming cow, goat etc.at every house. Dairy development in India has been acknowledging the world over as one of the modern India's most successful programs. Today, India is the largest milk producing country in the world. Milk processing and milk products manufacturing is treated as one of the most promising sectors which deserves appreciation in a big way. When the world milk production registered a negative growth of 2%, India performed much better with 4% growth. The total milk production is over 72

million tones and the demand for the milk is estimated at around 80 million tones. In olden view, people are making milk and milk products not for commercial purpose, only for family purpose. In 1958-65 year, more quantity of milk has been received from their house farm and they used the milk and milk product, and the balance is wasted. In these days the demand of the milk and its product is very high, and its supply is very low due to the inadequate capacity of most of the milk processing plants. Most of the milk processing plants are equipped with old types of machines and traditional methods of firing in their boiler plants. The result is higher production cost.

Hence in the present context, the detailed study and analysis of the existing technologies being used in the plant and suggesting modifications to improve the efficiency of the milk processing sector, which is most significant matter behind this study. The study covers the major activities including the production processes. Future expansion and growth of the plant has also been studied. This paper emphasized to study the boiler plant and show how the efficiency is improved.

## 2.COMPANY PROFILE

The milk processing plant of the Janatha Charitable Society is the second largest milk processing plant and marketing society in the Malabar region. Janatha Charitable Society is registers under the society's registration act xxxi of 1860, on April 1982.Today the society markets 45000 liter milk, 4900 liters of curd and 2500 liters of ghee. Society accommodating 68 employees directly and 175 employees indirectly. Present capacity of the plant is to process 50,000litres of milk per day and considering the demand, they are planning to enhance the capacity to process 100,000 liters of milk per day. They have already received the

ISO certificates and many other rewards and recognitions.

2.1 MILK COLLECTIO AND DISTRIBUTION:  
COLLECTION

From branches directly	:3787.9 liters
From co-operative societies and individuals	:5128 liters
Other agencies	:34611 liters
TOTAL	:43526 liters

SALES

Milk	:	45,000 liter per day
Curd	:	4900 liter per day
Ghee	:	2500 liter per day

2.2 IMPORTANT MACHINES AND RAW MATERIALS

Machines are

1. Heat exchangers
2. Steam boilers
3. Automatic packing machine
4. Cream separator
5. Refrigeration plant
6. Water treatment plant
7. Filters including micro filters

Raw materials are

1. Milk
2. Milk powder
3. Water & Steam

3. BOILER PLANT

Boiler is a closed vessel in which the given fluid (water) is heated, and steam is generated by evaporating the water. Water is used in boilers to produce steam, which is used as the main energy to process the raw milk at various stages. It is used to increase the temperature of raw milk. Also, hot water is used to clean the various vessels and carrying boxes of milk packets. Steam is the main hot fluid for heat transfer applications in heat exchangers. Water is taken from the bore well using a 15 hp pump. Also, after processed water is treated in a separate plant and it is reused for various cleaning purposes like flow cleaning, vessel cleaning etc.

3.1. ESSENTIALS OF A GOOD STEAM BOILER

1. It should produce maximum quantity of steam with minimum fuel consumption.

2. It should be economical to install and require little attention during operation.
3. It should rapidly meet the fluctuation of the load.
4. It should be capable of quick starting
5. It should be light in weight.
6. It should occupy small space.
7. The joints should be few and accessible for inspection.
8. The mud and other deposits should not collect on the heating plates.
9. The refractory material should b reduced to a minimum. But it should be sufficient to secure easy ignition, and smokeless combustion of the fuel on educed fuel.
10. It should comply with the safety regulations as laid down in the Boilers Act

4. SPECIFICATIO OF THE PRESENT BOILER IN THE PLANT

1. Pressure of steam	:	10 bar
2. Steam condensed	:	500kg/hr
3. Fuel used	:	125kg/hr (Wood)
4. Moisture in fuel	:	2% by mass
5. Mass of dry flue gas	:	9kg/kg of fuel
6. LCV of fuel	:	18500 KJ/kg
7. Temperature of flue gas	:	300°C
8. Temperature o boiler house:	:	30°C
9. Feed water temperature	:	50°C
10. Mean specific heat of flue gas:	:	1Kj/kg.K
11. Dryness fraction of steam:	:	1

5. BILER EFFICIENCY

It may be defined as the ratio of the heat used in producing the steam to the heat liberated in the furnace. It is also known as thermal efficiency of the boil

Heat actually used in producing steam

$$\eta = \frac{\text{Heat liberated in the furnace}}{m_e (h - h_{f1}) / C}$$

where  $m_e$  = mass of water evaporated in kg/kg of fuel

$m_e = m_s / m_f$

where  $m_s$  = Total mass of water evaporated in to steam in

Kg/hr

$m_f$  = Mass of fuel used in Kg/hr

C= Calorific value of fuel in kJ/kg.

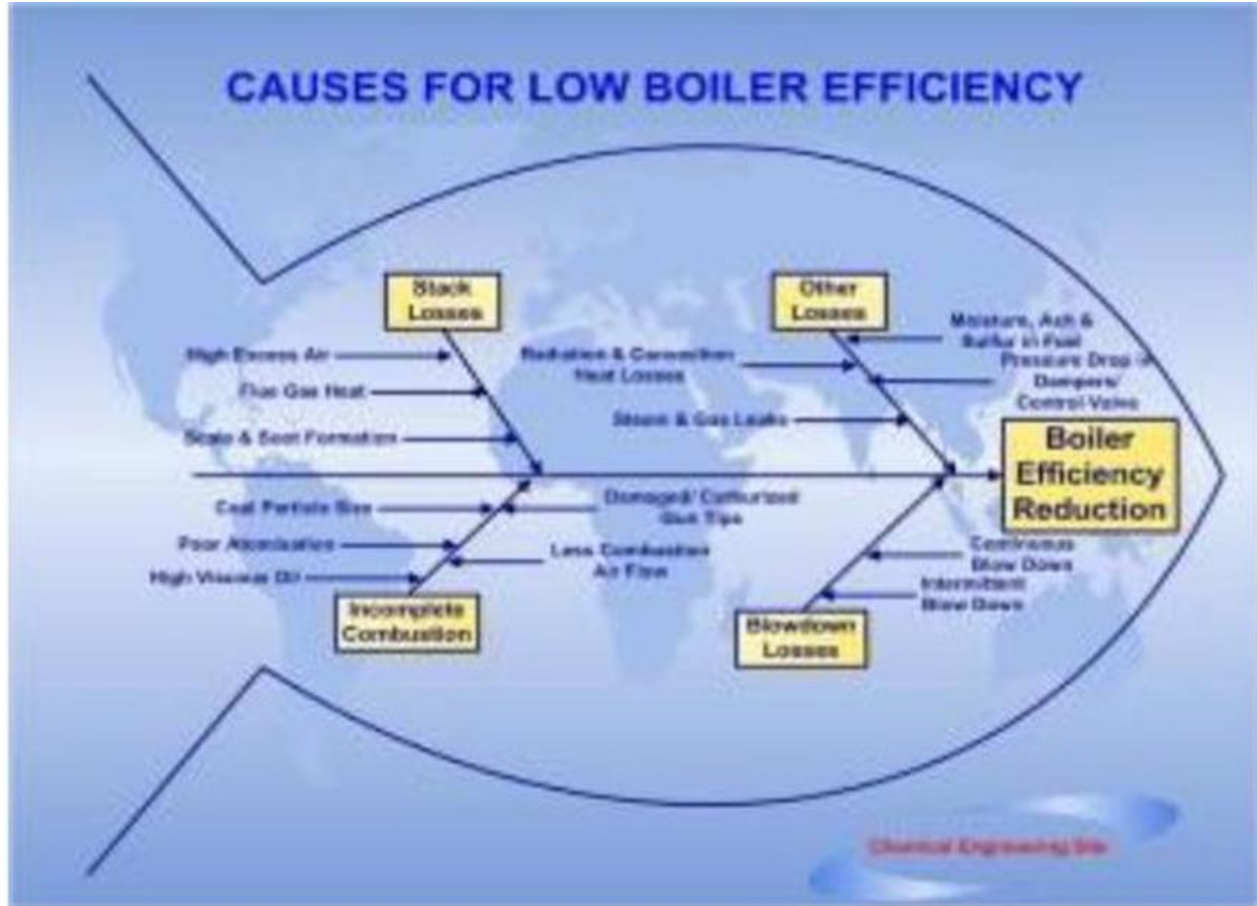
2776.2KJ/Kg

$h = h_g$  (for dry saturated steam,  $x = 1$ )

$h_{f1}$ = enthalpy corresponding to a feed water

Corresponding to a steam pressure of 10bar,  $h =$

temperature of 50°C = 209.3KJ/Kg.



6.EFFICIENCY AND COST ANALYSIS STUDY

Efficiency Analysis

1.Fuel used: Wood (Present condition)

LCV = 18500KJ/Kg,

$m_f = 125\text{kg/hr}$

$m_s = 500\text{kg/hr}$

$m_e = m_s/m_f = 500/125 = 4\text{kg/kg of fuel}$

$h_{f1} = 209\text{KJ/Kg}$

$h = 2776\text{KJ/Kg}$

$$\text{Therefore efficiency } \eta = \frac{4(2776-209)}{18500} = 55\%$$

2.Fuel used: Heavy Fuel oil

LCV = 43000KJ/Kg,  $m_f = 53\text{kg/hr}$

$m_s = 500\text{kg/hr}$

$m_e = m_s/m_f = 500/53 = 10\text{kg/kg of fuel}$

$h_{f1} = 209\text{KJ/Kg}$

$h = 2776\text{KJ/Kg}$

$$\text{Therefore efficiency } \eta = \frac{10(2776-209)}{43000} = 60\%$$

3.Fuel used: CNG

LCV = 50000KJ/Kg,  $m_f = 46\text{kg/hr}$

$m_s = 500\text{kg/hr}$

$m_e = m_s/m_f = 500/46 = 11\text{kg/kg of fuel}$

$h_{f1} = 209\text{KJ/Kg}$

$h = 2776\text{KJ/Kg}$

$$\text{Therefore efficiency } \eta = \frac{11(2776-209)}{50000} = 56\%$$

6.2COST ANALYSIS

**1.Present Condition (Fuel: Wood)**

Market value of wood per kilogram = Rs.15 (including labour charge)  
 Cost per day for 8hrs =  $125 \times 8 \times 15 =$   
 Rs.20,000/day

**2.Heavy Fuel Oil**

Market value of heavy fuel oil per kilogram = Rs.40  
 Cost per day for 8hrs =  $53 \times 8 \times 40 =$  Rs.16,960/day



Fig(1)-Present Boiler plant in the company

**1. CNG**

Market value of CNG per kilogram= Rs.61  
 Cost per day for 8hrs =  $46 \times 8 \times 61=$  Rs.22,448/day

**8. Summary**

Fuel used	Efficiency (%)	Cost of fuel per day (Rs)	Remarks
Fire wood	55	20,000	Excluding the cost of social impact
CNG	56	22,448	
Heavy fuel oil	60	16,960	

Hence from the above data, it is suggested to use heavy fuel oil as the fuel in the boiler so that the efficiency is increased by 27% and the expenditure incurred on fuel can be reduced by 15.2%

**9.CONCLUSION**

- Using heavy fuel oil as the fuel in the boiler plant, the efficiency is increased by 27% , and expenditure incurred for fuel is reduced by 15.2% per day.
- Using a compact oil burner, the radiation losses are reduced.
- Using an oil burner, the boiler plant becomes more safer.
- A full time operator during the operation is

eliminated.

**REFERENCE**

- [1] Kern: Process Heat Transfer.
- [2] P.K.Nag: Power Plant Engineering.