International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 02 | Feb-2016 www.irjet.net p-ISSN: 2395-0072

ENERGY SAVING USING DMAIC APPROACH IN MILK PLANT -A CASE STUDY

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Abstract - In the current work investigation was done to reduce the chilling cost of milk which was depend on the following critical factors such as normal water added to Ice bank tank, improper production planning, poor maintenance of machine, lack of coordination between production and Refrigeration section, scaling over ammonia pipe etc. The critical factors which was responsible for higher Chilling cost was analyzed and minimized by the application of DMAIC methodology. Finally the Chilling cost was reduced from Rs.0.57 per liter to Rs. 0.39 per liter.

Key Words: Energy efficiency, chilling cost, quality of milk, IBT, Refrigeration process, DMAIC.

1. INTRODUCTION

Energy saving is the most important measure that everyone should implement in daily life. The water if not saved we will be definitely in a big problem in a near future.

Energy is required for the various operations in milk processing plant. The steam is used for cleaning as well as for process heating. Electrical energy is required to power electric motors and to provide lighting. It may also be used for heating purposes.

The milk plant consumed major part of electricity due to continuous running of compressor in Refrigeration section for chilling of milk. If the cost increased it will go beyond the reach of common person. Therefore we should minimize the wastage of milk and water to reduce the cost of milk. Refrigeration is the backbone of milk industry. For processing of milk chilling is an essential activity to chill the milk. Chilling cost involves electricity cost, Overhead cost, and maintenance cost including depreciation cost.

It was observed that due to improper production planning, temperature of cold storage and reprocessing of milk was not properly handled. As a result consumption of electricity was more due to continuous running of compressor.

2. METHODOLOGY

The DMAIC process follows a systematic methodology to clarify process performance and make improvement.

The five DMAIC phases and tools used in each phase are mentioned as below:

Define : Brainstorming, Check sheet

Measure : Check sheet, Cause and effect diagram

Analyze : Validation of causes, check sheet

Improve : Modified action

Control : Full proofing

3. PROBLEM FORMULATION

In Milk Plant, several problems were observed in different important subsection. The priority was given to reduce two top problems which is contributing 88% of total cost. The plant consumed an average 6800 units of electricity per day for chilling of 83000 liters fluid milk per day amounting to 57 paisa per liters. It has also observed that milk processed per unit of electricity consumed is 10 liters. The cost of electrical energy has been increased dramatically. The aim is to reduce electricity consumption and save water.

Define phase: Layout of water from I.B.T to different equipments

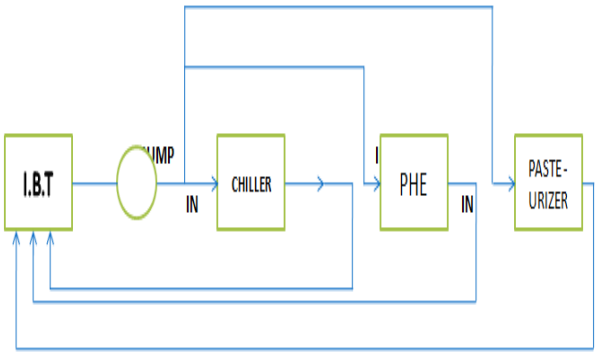

Fig.No.1- Flow of water to different equipments

Measure phase:

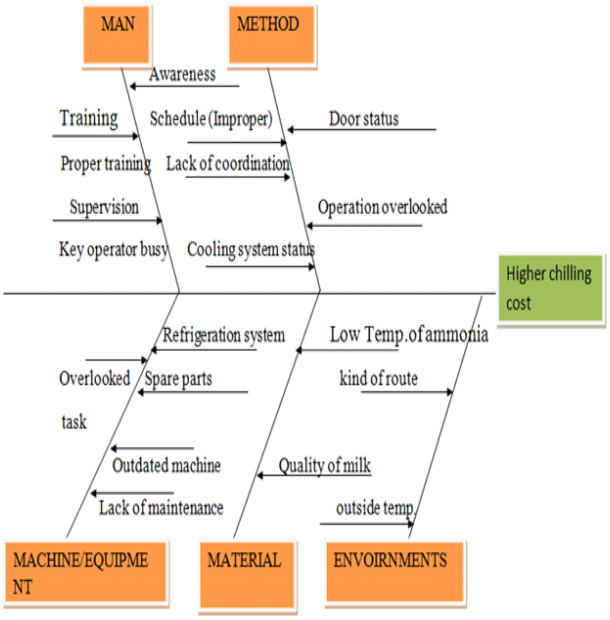

Fig. No. 2- Cause and effect diagram related to chilling cost

The problem related to Man, Material, Method, Machine and Environments as shown in Fig. No. 2. Critical factors that mentioned in Cause and effect diagram were responsible for higher chilling cost of milk.

3.1 VALIDATION OF CRITICAL FACTORS

S.No	Critical Factors	Validation	Data collected	Remark
1	Normal water added at IBT	Valid	20 min.	Due to leakage in water lines
2	Improper production planning	Valid	40 min.	Processing hours increased
3	Poor maintenance of machine	Valid	27 min.	Improper maintenance of old m/c
4	Lack of coordination	Valid	40 min.	Chilled water motor always in running condition
5	Improper working of Refrigeration section	Valid	30 min.	Suction/discharge pressure not proper
6	Scaling over ammonia pipe in cooling tower	Valid	35 min.	Ammonia not converted into liquid
7	Unskilled worker	Valid	35 min.	Ammonia and cold store not maintained
8	Ice formation on Ammonia Pipe	Valid	30 min.	Normal water takes more times to reach temp. at °C
9	Voltage Fluctuation	Valid	20 min.	Running hours of compressor increased
10	Acceptance of poor quality of milk	Valid	60 min.	Due to improper schedule quality of milk not maintained

Table -1: Validation of Critical Factors related to chilling cost of milk

4. DATA ANALYSIS

4.1 DATA COLLECTION RELATED TO CHILLING COST OF MILK

Analysis Phase: Analyzed the root cause sub cause and data collected in support to corresponding critical factors for enhancing the chilling cost of milk.

Regarding normal water added to chilled water at IBT has been explained as below:

Ice bank Tank is a storage system which is used to minimize the temperature of water that was discharged from Chiller after cooling the milk. Cooling milk from 75°C to 4°C accounts for biggest proportion of total energy cost. When temperature of water is low in Ice Bank Tank, Chiller operates efficiently. The Chiller is connected to Ice Bank Tank through vales and other accessories. If there was any leakage in Valves or glands that used in Chiller it may affect the efficiency of the Chiller as well as temperature of water in Ice Bank Tank. It was observed that during the cooling of milk, water was leakage through valves as a result less water returned to Ice Bank Tank.

Due to leakage level of water in IBT reduced, on an average 11276 lt. of water added in Ice bank Tank at a temperature of 20°C.

To bring down the temperature of water at 0°C., running of compressor was increased, as the Chiller capacity is 5000 lt/hr. The motor was running extra 2.20 hour in 8 hour shift so that working of compressor also increased by 20 minutes.

Reprocessing of milk: Reason for Re-processing of milk explained below:

Due to continuous reprocessing of milk in the milk plant affected the running of compressor and increased the chilling cost as well as electrical cost. Due to poor maintenance of machine and old model of compressor the production was held up. The temperature of cold storage increased and to reduced the temperature of cold storage the running hour of compressor increased by 30 minutes.

Reason for unskilled workers has been explained as there were four Ice Bank Tank at milk plant. The function of Ice BANK Tank to reduce the temperature of water that comes out after chilling of milk in Chiller. Unskilled worker did not know when and what time changes the water connection when temperature of water was increased. As a result temperature of water was not maintained in Ice Bank Tank and running hour of compressor increased .

RESULT AND DISCUSSIONS

Improve Phase**:** The purpose of this step is to identify and implement a solution to the problem. Check sheets and Brainstorming were used as a tool in Improve phase

Month	Total compressor running hours	Submeter reading	Elect unit consumption in lacs	Qty. of milk process in lacs	Total cost of Refrigeration in lacs	Cost/litre (Rs.)
April 2012	2214	6200	1.86	24.00	12.93	0.54
May 2012	2480	6800	2.10	26.35	14.60	0.56
June 2012	2264	6340	1.90	22.80	13.20	0.58

July 2012	2400	6700	2.07	24.80	14.44	0.58
Aug. 2012	2680	7338	2.20	25.50	15.30	0.60
Sept. 2012	2571	7200	2.23	27.90	15.51	0.56
Oct. 2012	2490	6971	2.16	26.50	15.20	0.57

TABLE: 2 Data collected Month wise related to chilling cost

To evaluate the Chilling cost/litre , the running hours of compressor, sub meter reading of Refrigeration section was noted down from log book. The data of quantity of milk processed month wise also taken from Production dept. The electrical unit consumption and total cost of refrigeration were obtained by multiplying the month reading of electricity by Rs. 6.95. Chilling cost was calculated.

Fig No.3 represented the refrigeration cost/litre from April 2012 to Oct.2012. In problem statement it has been mentioned that chilling cost is 57 paisa/liter on average which is clear from below graph and cost is on higher side.

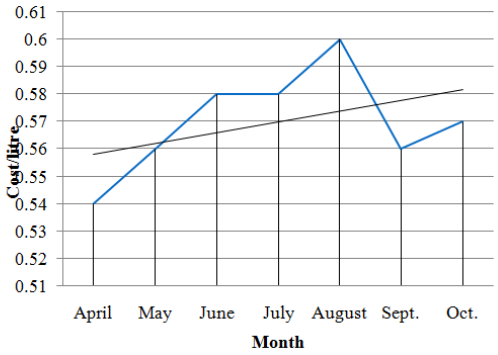

Fig No. 3 Month and chilling cost of milk

S.No	Critical factors	Data collected in minutes	Action taken	Modified action taken	Gain
1	Normal water added at IBT	20	water quantity daily monitored	replace damage glands and seals	controlled
2	Improper production planning	40	Checked variation of temp.in Pasteurization	heating and cooling of milk as per schedule	Minimized reprocessing of milk.Save compressor running hour by 1 hour
3	Poor maintenance of m/c	27	Preventive maintenance followed	Improve maintenance process	Result awaited
4	Lack of coordination	40	Running of motor daily monitored	Follow the production schedule	Controlled the extra running of chiller

5	Improper working of refrigeration section	**30**	Checked the pressure of Ammonia	Increased the volume of Ammonia	Minimized compressor running hour by 30 minutes
6	Scaling over Ammonia pipe in cooling tower	**35**	Checked the ammonia pipe	Recirculated the water to avoid scaling	Minimized compressor running hour by 35 minutes
7	Unskilled worker	**35**	Planning as per schedule	Recommended for skill worker	Improvement possible
8	Ice formation on ammonia pipe in IBT	Electrical consumption extra(2%)	Qty. of Ammonia checked	Checked discharge pressure of Ammonia form compressor	-----
9	Voltage fluctuation	20	Load checked		-----
10	Acceptance of poor quality of milk	60	Improper filling of milk	Improved production schedule	Reduce compressor running hour

Table No.3- Improved scope regarding chilling

After modified action the running hours of compressor, sub meter reading of Refrigeration was again noted from the log book. The quantity of milk processed month wise was also taken from production department. The chilling cost /liter again calculated from the above mentioned data as shown in Table No.4.

Month	Total comp. running hours	Sub meter reading of Refg.section	Elect unit consumption in lacs	Qty.of milk process in lacs	Total cost of Refg.in lacs	Cost/liter (Rs.)
Nov.2012	1807	4915	1.47	25.50	10.21	0.40
Dec.2012	1770	4800	1.49	26.50	10.36	0.39
Jan.2013	1766	4765	1.48	26.70	10.28	0.40
Feb.2013	1833	4950	1.39	24.36	9.64	0.39
March2013 -	1920	5012	1.51	27.00	10.80	0.40

Table No. 4- Data month wise Cost/lt. of chilling of milk after improvement

As mentioned in Problem statement chilling cost was on higher side but after improvement process the Chilling cost reduced to 0.39 paisa. After controlling the leakage of cooling water and also controlled the temp. of Refrigeration line/milk, the data was collected as given below:

S.No.	Month	Cost/lt. (Rs.)
1	April to Oct. 2012	0.57
2	Nov.2012	0.40
3	Dec.2012	0.39
4	Jan.2013	0.40
5	Feb.2013	0.39
6	March 2013	0.40

Table No 5- Chilling cost/liter after improvement

It has been observed the chilling cost of milk is Rs. 0.57/liter but after improvement in Refrigeration section the chilling cost of milk reduced to Rs. 0.39 /liter.

5. CONCLUSIONS

DMAIC methodology has been used to highlight the problems which were responsible for higher chilling cost of milk. Refrigeration and chilling cost of milk was reduced from Rs. 0.57 per liter to Rs. 0.39 per liter, thereby saving of Rs. 14 lakhs.

6. FUTURE SCOPE

The work can be extended by considering more parameters such as Electrical maintenance, boiler section mechanical section, air compressor etc.

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