ISSN 2348-8565

Volume 9 Issue 3 | September 2021 ISSN: 2320-9984 (Online)

International Journal of Modern Engineering & Management Research

Website: www.ijmemr.org

Optimization Approach to Minimize Energy Consumption in Jabalpur Dugdh Sangh (JDS)

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***Abstract**:— Dairy is a universal agricultural production, it is fact that the dairy industry actively contributes to the economies of countries. It is fact that demands of milk and milk product an increasing worldwide. Economic dairy benefits can be accessed from the point of view of production of milk and dairy products, but the question is how and on what criteria we can objectively assess the economic benefits of the dairy sector. The competition and quality aspect limited the profitability of the milk dairy plant, but high energy cost is a serious problem. In the current scenario to understand the problems related to high energy consumption of the milk processing and to suggest methods for their active reduction with the help of different approaches needed proper management of the all processes used in the plant. For the Indian Dairy Industry, efforts need to be directed to accelerating the pace of application and adoption of modern technologies to improving productivity, and to reducing costs of operations and ensure greater availability of milk and milk products. To attain this, national development programs need to be dived tailed with state Governments programmes on animal husbandry and dairying, poverty alleviation programmes, R&D strategies, Agricultural Universities and other developmental agencies.*

***Keywords**:— Problems, Challenges, Pasteurization Process, Heat exchanger, Energy Optimization, Energy audit.*

1. INTRODUCTION

Jabalpur Dugdh Sangh (JDS), a Diary plant under Co-operative union of M.P. State Co-operative Diary Federation Ltd. (MPCDF), Bhopal; located at Imliya Jabalpur is engaged in production of various milk products such as liquid Milk, Shree-khand, Ghee and Lassi in brand name of 'SANCHI' with presents capacity of 22,000 liters per day. The plant -installed capacity is 1 Lakh litres per day. Electricity and Coal are the major input sources to the plant. Electricity is mainly used for operating various electrical machines such as Air Compressors, Vapour Compressor, Pumps, Fans, etc and Coal is used for Energy input in 2 Nos. of Horizontal Boilers. Refrigeration section consumed major share of electrical Energy and connected load of plant is about 230 HP i.e. 50% of the total load. Energy audit of Jabalpur Dugdh Sangh (JDS) with an objective to estimate the energy consumption level for different equipment and to suggest suitable cost effective measures to reduce electricity as well as coal bill.

2. ABOUT JABALPUR DUGDH SANGH

- Located at village Imliya, Jabalpur. Engaged in production of Milk, Ghee, Shreekhand & Lassi of "SANCHI" brand.
- Major processes involved in production are Chilling, Pasteurization, Homogenizing, Ghee making and storage.
- The plant operates in single and two shift basis depending on the demand.
- Presently average milk processed per day is about 22,000 litre.
- The present contracted Maximum demand with MPSEB is 200 KVA, whereas the actual maximum demand is about 183 KVA.
- The connected Electrical load of plant is 760 HP.
- Average Power factor is maintained between 0.92 to 0.95.
- The average electricity bill is Rs.40 Lakhs per annum whereas fuel bill is 15 Lakhs amounting to total bill of Rs.55 Lakhs per annum.
- Thrust areas of Energy & Coal consumption are refrigeration system, Boilers, Air compressor.

OBJECTIVES

- The major objectives of conducting Energy Audit at Jabalpur Dugdh Sangh (JDS) are
- Reduce electricity bill of the company up to 5 to 8%.
- Reduce Coal bill up to 10%.
- Reduce Specific Energy consumption.
- Adopt modern practices/technologies for improving energy efficiency.
- Increase the profitability of the company.

3. METHODOLOGY

Methodology There is no tailor made proposed methodology, as the energy audit role changes with the organization type [10]. The aim of .representing the methodology for milk dairy plant is to control the wastage and losses of the complete manufacturing cycle. The first step of methodology is the identification of main work center or functions of the dairy plant. The different types of energy used and equipment are listed for detail energy audit. The energy audit is conducted on selected function's selected equipment only [10]. The data of energy consumption and energy related data are collected [3]. An audit team consisting of qualified and experienced electrical and mechanical engineers. However, it may be mentioned that each team was accompanied by an expert. The energy audit identifies the dairy plant areas where wastage of any type of energy found. To developed improved model of manufacturing system the audit approach determined the critical areas and energy wastage and the advanced manufacturing techniques improved them [3].

A. Preliminary Energy Survey

(i) Searching for energy savings possibilities by visual inspection.

(ii) Identifying leakage in compressed air line and Visual inspection of the insulation provided.

(iii) Understanding the process of different sections of the plant.

(iv) Inspecting illumination level of working areas.

(v) Identify status of energy meters installed at the individual sections and main substation.

B. Data Collection

(i) Month wise energy consumption & Maximum Demand data was collected from MPSEB energy bill for last 3 years (2012-13), (2013-14), and (2014-15) up to March 2015 to review the energy consumption level of JDS.

(ii) Data was also collected from individual sections /substation to understand the present process & energy scenario at the workshop.

(iii) Designed data are also collected for individual equipment & process.

C. Measurement of Operating Parameters

Measurements were taken for individual motors of pumps, homogenizers, Compressors with the instruments available with me & available instruments at JDS to measure various electrical parameters such as V, I, KW, KVA, power factor. Temperature measurements were done at boiler, Pasteurizer, condenser, ice bank tank to check the actual operating parameter in the present working conditions. Following instruments were used for measurements during field's studies of energy Audit:-

Opt fuel – fuel gas analyzer

Temperature and CO%, O_2 of Flue Gas of Boilers.

Digital temperature indicator

For measuring the temperature of the boilers, pasteurizer, chillers, condenser, air, & vapour Compressor

Digital anemometer

For measuring speed of air flow in fan.

ph & TDS meter

For analysis of feed water and blow down water for coal fired boilers

Hygrometer

For measuring relative humidity and temperature during study of refrigeration system.

Load manager – KRYKARD ALM-3

For complete electrical Energy management (V, I, kW, kVA, kVAR, P.F., etc.) during the study of transformer , electrical motors, distribution system.

Clamp on multimetre

For measurement of V, I, kW, KVA, P.F. etc.

LUX meter

For measuring the illumination level.

Digital tachometer

For measuring speed of shafts, motors.

D. Data Analysis

(i) Data analysis done after the field visit includes:

(ii) Findings the energy saving options.

(iii) Analysis & review of past energy consumption data recorded from MPEB bills.

(iv) Analysis of the measured data taken on line from individual equipment like pumps, boilers, Vapor compressor, Air compressor etc.

(v) Quantification of energy efficiency & associated losses in the equipment.

(vi) Techno-Economic benefits calculations for the cost effective recommendations.

(vii) Analysis of the Coal samples.

(viii) Proximate & Ultimate analysis and determination of GCV.

(ix) Analysis of Coal sizing and firing

methods for effective combustion.

(x) Analysis to provide recommendation to reduce coal wastages at various stages i.e. Coal storage, handling & firing.

Past energy consumption pattern

Electrical energy which is the major Energy input in dairy unit is purchased from MPSEB at an average tariff rate of Rs. 7.40 / Unit including demand charge. The past Energy bills from 2011-12 to 2013-14 were studied and analyzed critically. The month wise energy consumption pattern (kWh), Power factor, Maximum demand, Demand charge etc are presented below. The graphical presentation of month wise Energy consumption as well as MD & PF variation is also given on Figure No.

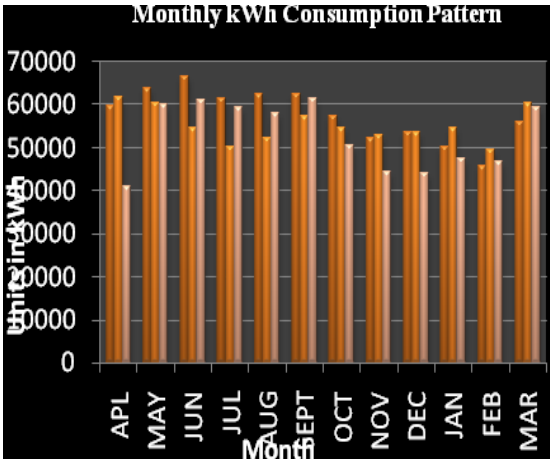

Figure 1: Monthly KWh Consumption at J.D.S.

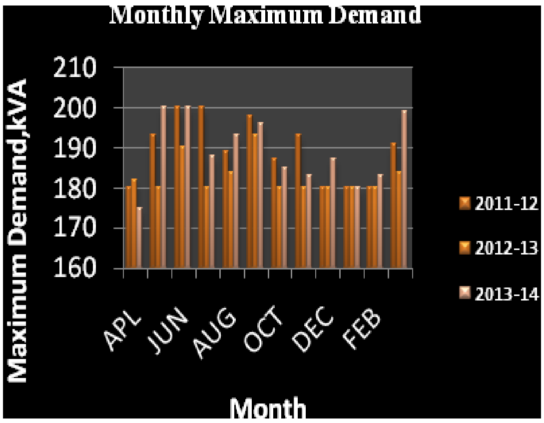

Figure 2: Monthly Maximum Demand for Plant

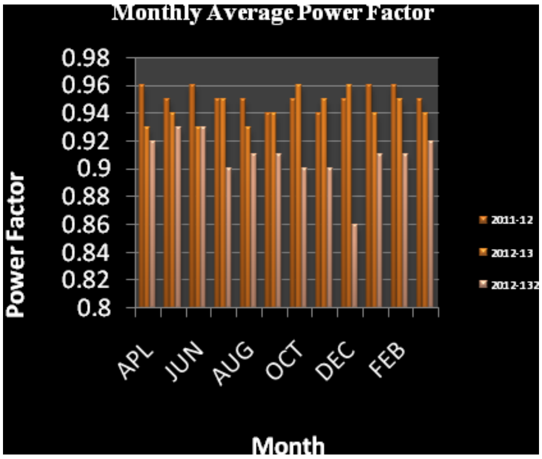

Figure 3: Monthly Average Power Factor

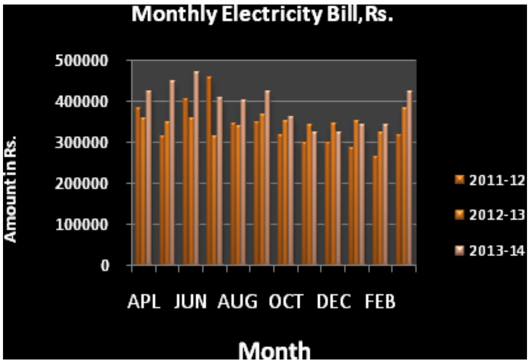

Figure 4: Monthly Electricity bill

4. SPECIFICENERGYCONSUMPTION

Specific energy consumption is defined as Energy consumed for handling one kilolitre of milk. The average energy consumption and milk handled are presented below for last three years to estimate specific energy consumption. Both month wise and yearly specific energy consumption is estimated as below:

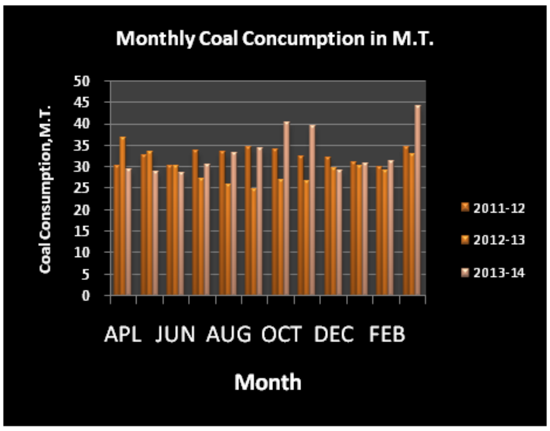

Figure 5: Monthly Coal Consumption in Plant

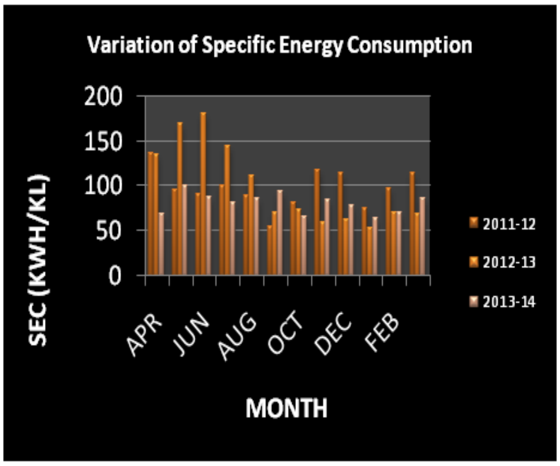

Figure 6: Variation of S.E.C. in Plant

Coal Consumption Pattern

Coal is the major input source of thermal energy in the plant and is used as input energy source in horizontal boilers. The month-wise coal consumption pattern is reviewed for the last three years and is presented in Figure (A), (B), (C).

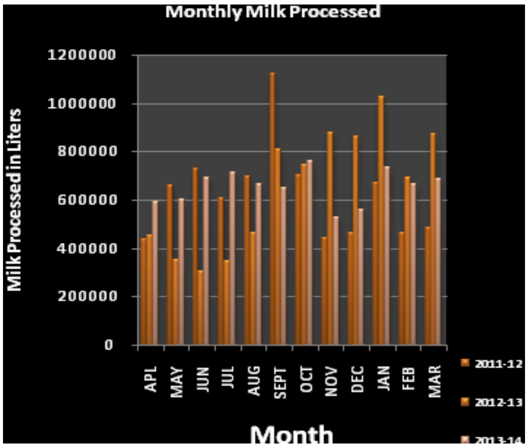

Figure 7: Monthly Milk Processed in Plant

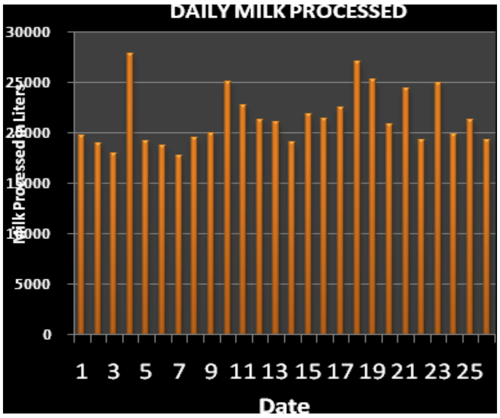

Figure 8: Daily Milk Processed in Plant

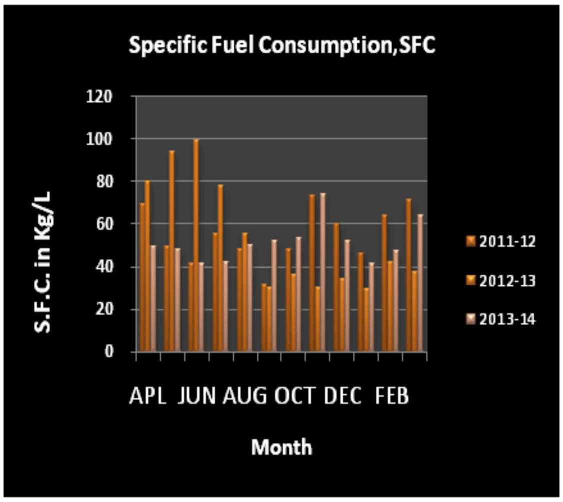

Figure 9: Specific Fuel Consumption of Plant

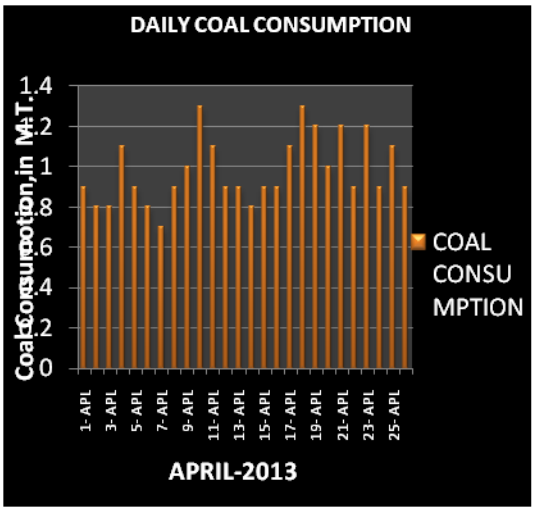

Figure 10: Daily coal consumption in plant

Analysis and Recommendation

Improve Present Power Factor from 0.95 to 0.99

Analysis

Power Factor of Jabalpur Milk Scheme is recorded 0.95 and can be improved to 0.99 by connecting additional capacitor to reduce demand charge and to get Power Factor rebate.

The saving estimated in Demand Charge does not contribute financial benefit to JDS, as maintain billing demand is 190 KVA . Even though the C.D. is increased to 250 kVA, the saving in demand charge will not reflected in bill.

Saving In Power Factor Rebate

The P.F. rebate of 1% on energy & demand charge is given by MPEB for every 1% improvement of P.F. above at flat rate.

Increase Contract Demand from 200kVA to 250 kVA

Analysis

Install 15HP & 10HP Compressor Near Milk & Ghee Pouching Machine By Replacing Existing 40HP/30 KW Air Compressor.

Alternative Options of energy savings on existing compressor

Energy savings By Improving Performance (FAD) from 50% to 80%

Energy Savings By Arresting Leakage from 36.4 to 10%

5. Operate the under -loaded Electrical motors at permanent star mode.

Analysis

Table 1: Motors operating at under condition (<50% loading) with the power consumption & Efficiency

Motor Location	Rated kW	Actual load (KW)	% Loading	Efficiency (Delta)	Efficiency (Star)	Power consump. (Star)	Saving /hr (kW/hr)	Operating hr	Saving Day (kWh)
Chilled water pump-4	5.5	1.66	30.18	0.65	0.76	1.41	0.25	9	2.25
Ghee boiler agitator	2.2	0.49	22.27	0.63	0.76	0.40	0.09	6	0.54

6. Reduce Excess Air level of 3T boiler presently operating from 96% to 60%

7. Install HSD/LDO fired high temperature Hot water Generator for pasteurizer, cleaning & Ghee boiler (With & Without Solar water heating system)

Analysis

Without Solar water heating system

Investment Required

Total investment required for high temp. hot water generator = Rs.6 lakh

Payback period = 16 months

Install 1 Lakh kCal HWG with Solar water heating system(1 Lakh litre capacity)

Installing a solar water heating system as a backup system, for reducing fuel cost in Hot water generator is also a possible solution.

Analysis:

Fuel saving: Cost of fuel saving by boiler replacement + Cost of fuel saved using solar water heating system as back up.

Modifications/ Repair of existing solar collectors.

If, existing collectors are repaired and operated and 120 no. of collectors are recovered for installation, then cost of repair & installation = Rs.10.0 lak (say)

Total investment including HWG= Rs.16 lakh

Then, Payback period = 1 year & 2 months

8. Reduce condenser temperature by operating Vapor compressor during Night period for Ice formation in Ice Bank tank

9. Operate 100HP 3 cylinder Vapor compressor by replacing with 2 cylinder for reducing capacity to match the actual load requirement.

OR

Convert 15HP booster compressor to main compressor by replacing existing 15HP motor with 30 HP motor to match actual load requirement

Operation of Compressor by replacing with 2 Cylinder

Convert the booster compressor to Main compressor by replacing 15 HP motor with 30HP motorPayback period = 1 year

10. Install 'Variable Frequency Drive (VFD)' system for controlling speed of motor for chilled water pumps

Analysis

2 No. of Chilled water pumps are operating in parallel with total load of 10kW approximately. Whereas the chilled water requirement varies with process requirement. However, it is observed that 2 no. of pumps are operating continuously with throttle control increasing the losses . It is therefore recommended to install one VFD System with 2 motor operating to conserve energy.

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