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Energy Conservation in Electrical Machines from Small Scale Food Industry

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Abstract: **Present global scenario of energy crisis has forced food processing industry to become more energy conscious. With liberalisation of industrial policy, the food processing industry is facing challenges both in terms of quality and plant performance. In snack processing line, electricity was the main energy utilized for operation of machineries, such as prime movers and lighting. For any industry, a perfect energy audit being first step to identify and suggest the area of energy wastages and set realistic goals for achievable savings. For this research consider a small scale food industry in Gujarat. In this paper preliminary energy audit was done by carrying out visits to the plant and collection of the past bills available with the plant. The detailed energy audit was carried out in snack processing line in which the energy consumed by the unit processes were determined and the energy consuming devices were tested for their performance. The total energy consumed in the chips line, inclusive of all unit operations. The illuminance levels of all the sections were determined. The relationships were developed with electricity consumption and the product produced. The possible suggestions for conserving energy were made and the reduction in energy consumption would be obtained.**

Keywords: **Energy Audit, Electrical Energy, Illumination, Snack Processing Line.**

I. INTRODUCTION

Energy is one of the essential requirements for the economic growth of developing countries. Energy consumption is a measure of prosperity. The projected per capita energy consumption for India in the year 2011-12 is estimated to be 546 Million Tonnes of Oil Equivalent (MTOE) [1] which is just 4% of USA and 20% of the world average. It is major important input in economics of country. The standard of living of country is depending upon the energy consumption per capita. The conservation of energy is an essential step towards overcoming the mounting problems of the worldwide energy crisis and environmental degradation.

1.1 Indian energy scenario

Indian electricity consumption has reached a level of about 600 kilowatt hour (kWh) per head per year which is too low as compare to China (1380 kWh), USA (13,000 kWh) and world average (2430 kWh). India is targeting a growth rate of 9-10% and to sustain the double-digit growth rate for next 10-15 years, the level of energy availability need to be enhanced substantially. In the profile of energy sources in India, coal constitutes about 51% of India's primary energy resources followed by oil (36%), natural gas (9%), nuclear (2%) and hydro (2%) [2].

1.2 Need for Energy audit

In any industry, three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of cost or potential cost savings in each of the above components, energy would invariably emerge as the top ranker and thus energy management function constitutes a strategic area for cost reduction. Energy audit will help to understand more about the ways energy and fuel are used in any industry and in identifying the area where waste can occur and where scope for improvements exist. The energy audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programme which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, energy audit is translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organisational considerations within a specified time frame.

1.3 Potential for industrial energy conservation

Energy is the essential input for all industrial activities. At the same time, energy is becoming an increasingly scare and costly resource too. The rapid escalation of fuel costs and the inadequacy in supplies and predicted future limitations has focused attention on the need for a complete're-think' on fuel usage, with particular emphasis on energy conservation. The term 'Energy conservation' as used here means a reduction of energy waste, the increased efficiency of energy utilization and conservation should not be confused with curtailment.

1.4 Electrical Energy

The compressor motor is responsible for two-thirds of the total electricity use, and the water pump motor(s) account for an average of 22% of the total and other motors, such as those that operate evaporative condenser fans and water pumps, contribute the remaining 13% of the energy use in hydro coolers which have same cooling system and reported that the energy requirement for the cooling fruits by hydro cooling technique was (2.66-7.36) x 106 kJ [3].

II. RESULT AND DISCUSSION

2.1 power consumption and efficiency of motors

In detailed energy audit it was found that the theoretical power consumption of motors of de oiling belt, inspection conveyor, elevator, flavour applicator and flavour drum per hour were 0.55 kWh, 0.37 kWh, 0.75 kWh, 0.37 kWh and 0.37 kWh while actual power consumption was 0.54 kWh, 0.34 kWh, 0.64 kWh, 0.32 kWh and 0.17 kWh respectively. The power consumption per day for de oiling belt, inspection conveyor, elevator, flavour applicator and flavour drum was 9.9 kWh, 6.66 kWh, 13.5 kWh, 6.66 kWh and 6.66 kWh while the actual power consumption for the same was 6.69 kWh, 6.17 kWh, 11.60 kWh, 5.69 kWh and 3 kWh respectively. The motors of de oiling belt and inspection conveyor are found to be operated at good loading condition of 76.32% and 72.23% along with the efficiency of 98.36% and 92.85% respectively. The motors of elevator and flavour drum found to be operated at good load of 67.02% and 66.60% with the efficiency of 85.92% and 85.38% respectively. The motor of flavour applicator found to be operated at poor load condition of 35.14% with the efficiency of 45.05% and could be operated at higher load for better energy utilization.

3.2 Illumination of Chips line

The illumination level was studied for this section, the floor area 252.44 square meters and the calculated room index of the section was 1.05 as given in the Table 1. The total lamp wattages connected in the room was 860 watt and the calculated watt per square meter was 3.214 W/m2. The average maintained illuminance is 335.46 and 109.79 Lux for day hour time and night hour time respectively with the installed load efficacy ratio of 1.890 and 0.618 for the same. The result shows that the ILER of this section during night hour time was critically low according to Bureau of Energy Efficiency and needs to be improved by installing more lamps which gives more illumes per watt.

Table 1: Illumination of Chips line

Steps	Observations	Results	
		Night	Day
1	Measured Floor Area of Interior (m2)	252.44	252.44
2	Room Index	1.05	1.05
3	Total lamp wattages (watt)	860	860
4	Watts per Square meter (3/1) (W/m2)	3.214	3.214
5	Average maintained illuminance (Eav) (lux)	109.79	335.46
6	Calculated Lux/W/m2 (5/4)	32.16	98.26
7	Target Lux/W/m2	52	52
8	ILER	0.618	1.890

Total energy saving in illumination in different sections like Krackers, Storage, Packaging, Chips Line, raw material storage etc. is sown in Table 2.

Table 2: Energy saving in illumination

Section	ILER	Total Circuit Watts	AEW (kWh/year)
Krackers	0.703	504	44.88
Storage (Krackers)	0.516	214	220.55
Packaging (Chips)	0.380	438	580.10
Chips Line	0.616	896	712.12
Packaging(6gmNamkeen)	0.457	112	127.71
Storage (Namkeen)	0.467	504	554.51
Raw material storage	0.541	112	107.95

Process Name				
			4.5	
Circulation Pump				1075
		1.00		
		0		
	9.25			650

3.3 Relationship between the energy consumed and the snacks produced

The relationship between the different energy consumed and the snack produced were derived from the electrical energy utilization. Figure 2 shows the relationship between electricity used with respect to snack produced. As the snack production increases the electricity consumption also increases [5].

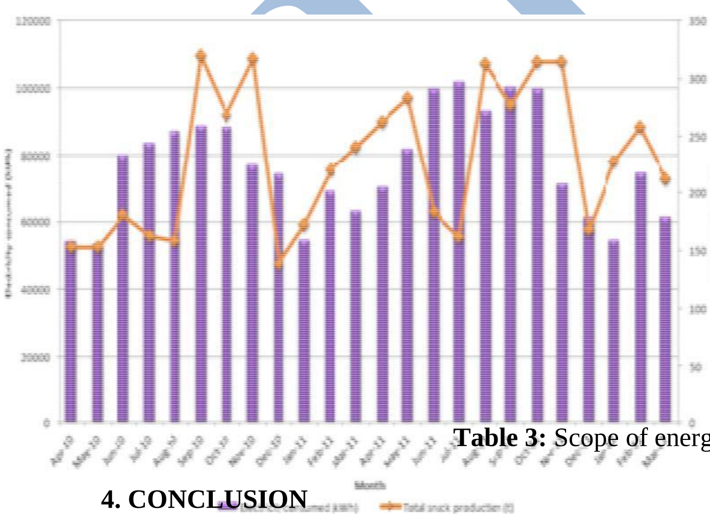

Fig.2: Relationship between electricity and snack produced

3.4 Measures of energy saving

Table 3: shows the scope of energy saving in terms of electrical energy used by the electric motors in the snack processing plant. If the installed motors are replaced by the suggested motors approximately 65680 kWh can be saved per annum. Diesel consumption can be reduced by 24% after improving the percent energy gain of frying oil for Krackers line up to 14%.

Table 3: Scope of energy saving in electric motors

4. CONCLUSION

It would be concluded that as the production of the snacks increased the electricity and diesel consumption also increases and result into the decreases in specific energy consumption. To reduce the energy consumption, non-conventional energy source can be used for heating the frying oil for both the krackers and chips line.

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