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Electrical energy conservation in dairy industry

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ABSTRACT : Energy is a critical input for the production and consumption activities in the development of economy of any country. Electrical energy is the most widely used form of convectional energy. Processing of milk and milk products require considerable amount of energy in the terms of the heat and electricity. A major amount of electricity is used for running motors, fan, blowers, and lighting the plant building. The total cost of dairy product contributes to 80% for raw milk costs and remaining 20% comprises of the other variable and fixed costs. The energy cost reflects to ~ 4% of the expenditure. Hence, any attempt to efficiently manage the energy costs will influence the processing costs. Soft starter for motor control, energy efficient motor, variable frequency drive and fluorescent tubes for lighting purpose etc. in dairy industry would used to save immense electricity.

KEY WORDS : Energy, Electrical energy, Soft starter, EMM, VFD, Power factor

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Energy is a critical input for the production and consumption activities in the development of economy of any country. In addition to land, labour and capital, energy are the four factors for the production of dairy product. Energy conservation (EC) is not the suppression of demand for energy use in dairy industry, but efficient use of more and more energy and steep rejection of its wastage (Rao and Radhakrishna, 1988). Electrical energy is the most widely used form of convectional energy. The total electrical energy production in the India was 1, 67,480MW in march2008. Of this, 144,130MW were accounted by utilities and 23350MW capacity by captive power plants. Amongst utilities, 64% capacity was accounted by thermal power plant, 25% capacity by hydro; 3% capacity by nuclear and 8% capacity by renewable energy sources based power plants. It is observed that 80% of the world's population of the developing countries consumes only 40% of the world total energy consumption and rest is consumed by developed nations. Specific electric energy requirement in milk processing section like In bottle- pasteurized milk, sterilized milk, skim milk powder and butter, full cream milk powder, Ripened cheese-without whey processing,-with whey separation is 55, 70, 90, 80, 75, 100, 60 kW per tonne, respectively.

Processing of milk and milk products require considerable amount of energy in the terms of the heat and electricity. A major amount of electricity is used for running motors, fan, blowers, and lighting the plant building. Typically, in dairy plant, 80% cost is of milk and remaining 20 % comprises of the other variable and fixed costs. The energy cost reflects to ~ 4% of the expenditure. Hence, any attempt to efficiently manage the energy costs will influence the processing costs (Desai and Zala, 2010).The use of energy efficient motor, soft starter for motor control and variable frequency drive etc. in dairy industry would save immense electricity. Installing high efficiency motors can reduce energy use as pumps and aeration systems can contribute 50-90% of the total energy and capacitor can be connected across large motors to maintain healthy P.F.(between 0.9 to 0.98) correction. The removal of incandescent lamps and the use of higher power factor tube light would also save electricity.

Electrical gazettes:

There are following electrical gazettes used in dairy industry to conserve the electrical energy.

Soft starter:

Soft Starter is the common application for electric motor control driven for dairy industry. Soft starter now more advance technologies and can replaced conventional motor starter such as star delta starter, auto transformer or direct online starter. The soft starter makes use of the fact that when the motor voltage is low during start, the starting current and

starting torque is also low. This type of motor starting is common used for air-conditioning and chiller system in dairy industry because it can reduce starting current in rushes and can made a compressor more life span.

Variable frequency drive (VFD) :

A viable-frequency drive (VFD) is an electronic controller that adjusts the speed of an electric motor by modulating the power being delivered. Variable-frequency drives are an excellent choice for adjustable-speed drive users in the dairy industry because they allow operators to fine-tune processes while reducing costs for energy and equipment maintenance. Variable-frequency drives are reliable, easy to operate, increase the degree of flow control, and reduce pump noise. By using these drives, the motor will only draw energy which is required according to the present load. If the load is less, then the energy consumption will be lower and *vice versa*. Ten horsepower of excess motor capacity results in $400 to $600 per month of excess electricity costs.

Energy efficiency motor (EEM):

In dairy industry, motors are generally used for driving pumps, compressors, boilers, fans, agitator etc. as they consume bulk of electrical energy. The oversize motors or running of idle motors should be avoided. The size of motor used in boiler, refrigeration, effluent treatment plant ranges between 2 to 12 Hp, 5 to 100 Hp and 1 to 15 Hp, respectively. As pumps and aeration systems can contribute 50-90% of the total energy in waste water treatment for dairy industry (Rajasekhar *et al.*, 2000).Efficiency of electric motor is defined as the ratio of mechanical energy output to the electrical energy input. Efficiency of the electrical motor depends on the electrical load and its power factor. It is observed from Table 1 that motors operated at full load and at higher power factor, run at higher efficiency. The Efficiency of motor is low when it runs at a speed other than the optimized one. An energy efficient motors (EEM) produces the same shaft output power, but uses less input power than a standard efficiency motor due to (a) Higher quality and thinner steel laminations in the stator, (b) More copper in the windings, (c) Optimized air gap between the rotor and the stator, (d) Reduced fan losses, (e) Closer machining tolerances, (f) A greater length, (g) High quality aluminium used in rotor frame (Corino *et al.*, 2010).Low operating cost, higher speed ,robustness and reliability are the four major merits of the EEM than the standard motor. (McCoy and Douglass, 1995).

Efficiency = [Output/Input] = [1-(Losses/Input)] = [Output/(Output+ Losses)]

Power factor correction:

Electrical energy is mostly utilized in the form of alternating current (AC).By switching on the heating load like an electric heater or a lamp, most of the energy is converted to heat or light. But we encounter problems with induction motors, which are mostly used in dairy industry. The ratio of active and apparent power components is called the power factor (PF).If the power factor is unity one can say that there is no reactive component and full power is put to work. Capacitor can be connected across large motors to maintain healthy P.F. (between 0.9 to 0.98) correction. Power factor in large establishment can be improved by employing a synchronous motor with over excited field (synchronous condenser) which will act as capacitor (Rajasekhar *et al.*, 2000).

$$\cos\phi = \frac{KW}{KVA}, KVAR = KVA \times \sin\phi = KW \tan\phi$$

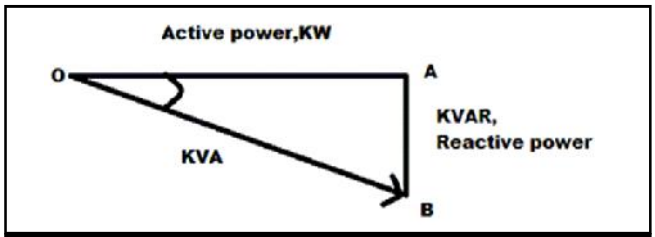

Fig. 1 : Power triangle

where,
OA is active component;
OB is apparent components.

$$\cos\phi = \frac{OA}{OB} = \frac{KW}{KVA}$$

KVAR = KVA x sin ϕ = KW tan ϕ.

Load factor improvement:

Load factor represents the capacity utilization of the power by the industries and can be calculated as :

$$\text{Load factor} = \frac{\text{KWH consumption}}{\text{Max. demand x power factor x No. of working hours}}$$

In many industries, Maximum demand occurs only for short period. Users should analyze the demand pattern in

Table 1 : Electrical motor efficiency

Loading (%)	100	75	50	40	25
Power factor	85	82	77	70	60
Efficiency	85	84	82	80	70

Table 2 : Recommended minimum standards of illumination for dairy plants

Section	Minimum Lumen/M^3	Illumination W/m^2
Receiving room	530	20
Scales	750	29
Can washing	330	13
Filling	1080	41
Processing	1080	41
Inspection	1080	41
Laboratories	1080	41
Cold storage room	330	13
Boiler room, compressor room	330	13
Office	800	301
Corridor and stairway	220	9
A toilet and wash room	330	13

Source: Tufail Ahmad (1997)

terms of daily and seasonal variations. Many non-essential loads like lighting and smaller loads can be switched off during peak hours. Large drives for pumping of water, heating or chilling plants which run for few hours in a day can be scheduled during off peak hours. The improvement in load factor will help in accomonding more loads.

Lighting system:

Selection of the proper type of lighting system is more important in any food industry. Excessive lighting can damage the eyes and can give a raise in the energy consumption bill. Recommended minimum standards of illumination for the dairy plants are presented in Table 2. While considering lighting of the plant, the following points may be taken into consideration.

– Lighting level required for different work areas.

– Light sources-fluorescent tubes instead of incandescent lamps.

– Maintenance and control of illumination

– Use of day light for illumination.

– Using electronic chokes

– Accommodation of light sources at lower ceiling height will reduce number of light sources for same illumination level.

Conclusion:

For Electrical energy conservation in dairy industry, focus point include use of the Soft starter to reduce starting current in rushes and can made a compressor of refrigeration plant, more life span; Variable frequency drive (VFD) to reducing maintenance and repair costs, and extending the life of the motor and the driven equipment; installing high efficiency motors can reduce energy use, as pumps and aeration systems can contribute 50-90% of the total energy; capacitor can be connected across large motors to maintain healthy P.F. (between 0.9 to 0.98) correction . The improvement in load factor will help in accomonding more loads. Incandescent lamps should be replaced by either fluorescent light or higher power factor tube light to conserve the electricity Accommodation of light sources at lower ceiling height will reduce number of light sources for same illumination level. Adopting recommended minimum standards of illumination for dairy plants can save energy as well as eyes.

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