International Journal of Research in Engineering, Science and Management
Volume-3, Issue-1, January-2020
www.ijresm.com | ISSN (Online): 2581-5792

Review of Energy Saving Techniques in Cold Storage Plant

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***Abstract*: As we seen in the last decade the demand of refrigeration as well as air conditioning has been increased, the cold storage plants are used for the commercial advantage over conservative plants. Wastage of electrical power in cold storage plants increases the temperature and causes increased the demand the electricity. Especially in fruits like apple cold store plant (CSP) for refrigeration process and other process electricity is required. By using some efficient equipment in cold store plant energy is saved in term of electricity. In this paper some electricity conservation techniques are proposed in major electricity consumed areas of CSP. In these energy saving techniques simply the efficiency of all the larger electricity consumed machine are enhanced as a result of which the 10-15% energy are saved by implementation of energy saving automatic star-delta-star, soft starter and V/f control techniques.**

***Keywords*: Cold store plant (CSP), Automatic star-delta-star technique, Soft starter technique, V/f control technique.**

1. Introduction

In recent years, the energy demand has increased in a drastic manner. But the expansion of power generation and transmission has been limited due to limited resources and environmental restrictions. The increasing demand for electricity has led to considerable fossil fuels burning which has in turn had an adverse impact on environment. In this situation efficient managing of energy is very important. It has been estimated that nearly 25,000MW can be saved by implementing end-use energy efficiency and demand side management measures an efficient use of energy and its conservation assumes even greater importance in view of the fact that one unit of energy saved at the consumption level reduces the need for fresh capacity creation by 2-2.5 times [1]. India is a country with having 17% of world population, widely spread agricultural land with mostly favorable meteorological conditions. Country is yet striving hard for self-sustenance in terms of all kinds of food products. There are nearly 5400 working cold storage units with over 23.6 million metric tons of storage capacity; and the expansion to higher capacity is desperately needed [2]. Cold storage is the one widely practiced method for bulk handling of the perishables between production and marketing processing. It is one of the methods of reserving perishable commodities in fresh and whole some state for a longer period by controlling temperature and humidity with in the storage system. Maintaining adequately low temperature is critical, as otherwise it will cause chilling injury to the produce. Also, relative humidity of the storeroom should be kept as high as 80-90% for most of the perishables, below or above which his detrimental effect on the keeping quality of the produce [3]. Himachal Pradesh, Jammu & Kashmir and some areas of Uttarakhand and UP are the major apple producing states of India. J&K has remained the leading apple producer accounting for 60% of the total production in the country. In HP also, apple is the most important crop accounting for about 90% of the total horticultural production. These two States accounted for 94% of the production of the crop in the country in 2001-02[5]. Albeit these states are responsible to contributing above 90% of the total apple production of the country, they are far behind their international peers like Australia, New Zealand, USA and some European Countries while it comes to apple produced per hectare. Though the climatic conditions and farming techniques in these countries are different, but a lot can be done and productivity can be doubled from the present production if India adopts an approach which is integrated in nature.

Fundamental problems in the apple growing regions of Himachal Pradesh like scarcity of water and poor condition of roads, demands setting up of cold storage plants to preserve the perishable crop for longer time periods. With more supply and low demand, the market crashes each year, resulting in less return to farmers. This situation could be avoided only if adequate storage facility is created. In this papers some energy saving techniques are proposed and implemented with latest technology in the major electricity consumed areas of cold store which leads in energy saving in term of electricity.

2. Cold storage plant

Cold storage plant (CSP) play significant role in stabilizing market prices of fruits and also evenly distributing them on demand and time bases. Fruit like apple is most beneficial for

human being. Apples have a longer storage life compared to other fruits but storability of different variety varies. Apples start deteriorating after climacteric stage. However, shelf-life of apples can be prolonged by prolonged by providing optimal storage conditions. The storage temperature for apple is -1.1 -0 C. A simple schematic of edible product movement from producer to consumer level is illustrated in Fig. 1.

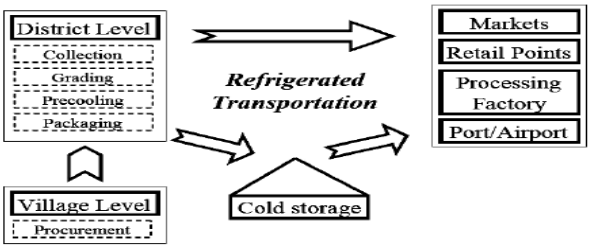

Fig. 1. Producer to Consumer Fruit Chain with Cold Storage Plant [5]

The Government of India also constituted a Central Cold Storage Advisory Committee consisting of official and nonofficial members representing the growers, owners, machinery manufacturers, research organizations etc. This Committee gives advice to the Government on all matters pertaining to enforcement of cold storage orders and the future development of the industry. Around the world, most cold storages plant provide additional services for their clients which include freezing fresh products, packing, transport, order picking, distribution, stock control etc. [5], [6]. The typical views of Himfresh Agro Produce Pvt. Ltd, Gumma, Shimla, Himachal Pradesh Apple cold storage plant is shown in Fig. 2.

Fig. 2. Outside and Inside Views of Himfresh Agro Produce Pvt. Ltd., Gumma, Shimla, Himachal Pradesh

The cold storage plant (CSP) consists of compressor, evaporator, condenser and physically functioned extension valve. The schematic representation of a typical single-stage vapour compression refrigeration system is shown in Fig.3 and the components of a typical CSP are explained in subsequent sections.

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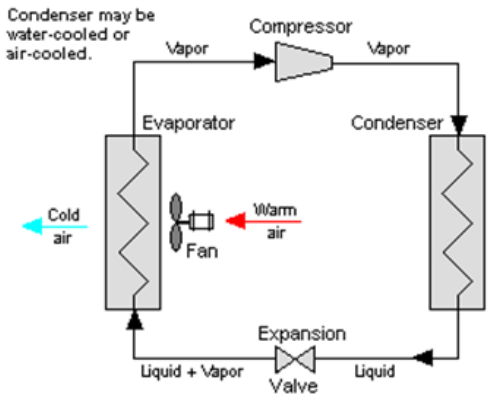

Fig. 3. Typical Single-Stage Vapour Compression Refrigeration System [7]

A. Evaporator

In evaporators wherever the actual cooling takes place in the air conditioning and the refrigeration systems. Evaporators are temperature exchanger which removals the heat from material to the refrigerant. Evaporators are used for wide-ranging diversity of diverse applications in air conditioning and refrigeration processes. In CSP the refrigerant arrives at actual pressure and temperature subsequently passing over the expansion valve. Here refrigerant occupies the heat from the material which is to be cooled thus the refrigerant becomes heated and the material gets cooled. After cooling the material, refrigerant temperature leaving the evaporator is not as much of the material [7].

B. Compressor

Compressor is the core of CSP as and when pressure is increased of the refrigerant gas to the necessary condensing pressure corresponding to condenser temperature. It was invent from the study of dissimilar CSP that the quality of water used for compressor is not good, i.e. water is dense in environment, comprising salts. These salts pledge on the outward of the freezing cover round the compressor origins reduced heat removal from compressor chamber. The resultant unsatisfactory freezing of the compressor effects in high emancipation heat of the refrigerant gas, which eventually escalations electrical power ingestion and harmfully distresses the excellence of lubricating oil. Thus, it is suggested that indulgent water must be used to calm the compressor [6], [7]. The views of views of compressor units of, Gumma, Shimla, Himachal Pradesh cold storage plant is shown in Fig. 4.

Fig. 4. View of Compressor units of Himfresh Agro Produce Pvt. Ltd. Cold Store Plant

C. Condenser

In the Indian cold stowing manufacturing, moody kind of condenser is used, where a stem scheme gulfs the water flow decided a quantity of straight ducts in which refrigerant summarizes. The chilling effect in this scheme completely hinge on the distinctive heat and virtual moisture. Yet, the evaporative condensers are considered to be advantageous over atmospheric one because in a hot and humid weather, it is possible to give the lowest condenser pressure and therefore lower power consumption. The wetting of evaporative condenser requires 1% of the total power consumption and reduces the energy consumption by 30% as compared to air-cooled condenser [7].

The details of maximum electricity consumed equipments of Himfresh Agro Produce Pvt. Ltd. cold store plant is given in table 1.

Table 1
Major Electricity Consumed Equipment's of Cold Storage Plant

Name of the Machine/ Equipment	Quantity	Specifications
Air Compressor unit 1 with motor	1	100 HP, 75 kW,128A
Air Compressor unit 2 with motor	1	50 HP,37 kW
Motors in Conveyor System	24	1.5 kW, 2 HP
Air Compressor unit 3 with motor in Grading Machine	1	11 kW,13.6 A
Motors in Grading System	15	0.5 kW,50 Hz
Induction Motor in Stapling Machine	1	1.1 kW, 4.6 A
Induction motors in Compressor unit 1	3	0.75 kW.0.6 A
Induction motor in Compressor unit 2	1	1.5 kW, 6.67A

3. Major Energy Saving Opportunities

In context of Himfresh Agro Produce Pvt. Ltd cold store plant the major unit of electricity consumption are in compressor unit, conveyor system, grading machine system and stapling system units. These all unit uses the induction motors of rating kW- MW. The energy can be saved by identifying the opportunities by improving the efficiency of individual units, reducing the losses at all stages of power conversion stages and by reducing the waste energy during cooling process to maintain the temperature of cold storage plant in optimum limit. In this paper some technologies are proposed to improve the efficiency of induction motor as a result of which energy is saved. The propped energy saving techniques are as;

1. Energy saving automatic star-delta-star starter technique.
2. Energy Saving Soft Starter Technique.
3. Energy Saving V/f Control Technique

A. Energy saving automatic star-delta- star starter technique

In this proposed technique, all the induction motors of CSP units which have variable load conditions may be started with automatic star-delta-star starter. The starting current of induction motor is 10 times more than normal load current it draws. In this techniques the induction motor of compressor and grading machine are stared with automatic star-delta starter as and when there is variation in load current sensor sense compare the its value with reference value which create the logic circuit and operate the star-delta-star relay driver circuit. The reference value is 50% of motor load current if the load current value decreases this value motor automatically changes from delta to star operating mode. The schematic representation of energy saving automatic star-delta-star starter technique is shown in Fig. 5.

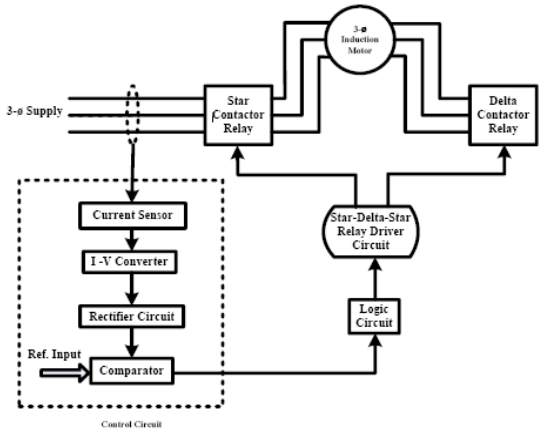

Fig. 5. Proposed energy saving automatic star-delta-star starter technique

B. Energy saving soft starter technique

In this proposed technique, all the induction motors of CSP units which are running almost at constant load conditions may be started with help of soft starter. The latest soft starter is solid state type starter. Soft starter replaces mechanical components with electrical components like SCR. During motor acceleration, this device controls motor voltage, current and

torque and solid state soft starter controls the current draw and the starting torque. The SCR has the ability to rapidly switch heavy currents which allows the soft starter to provide smooth step less acceleration along which energy saving by improving the efficiency of system. The schematic representation of energy saving soft starter technique is shown in Fig. 6.

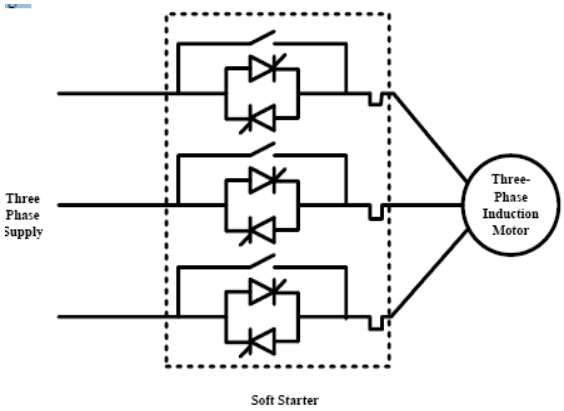

Fig. 6. Proposed energy saving soft starter technique

C. Energy saving V/f control technique

In this proposed technique, all the induction motors of all grading machine operates from no load to full load current at constant speed. This energy saving V/f control techniques are employed on the grading machine having slip ring induction motor. The constant speed requirement from no load to full varies the flux requirements the grading machines draw the rated voltage and frequency at all the load conditions. In this proposed energy saving V/f control technique, initially V/f is done on slip ring induction motor and voltage is reduced until no change in the output power to increases the efficiency of grading machine. The increased efficiency directly leads to saving in energy. To control the inverter output voltage LM controller is used at rated speed. The schematic representation of energy saving V/f control techniques are shown in Fig. 7.

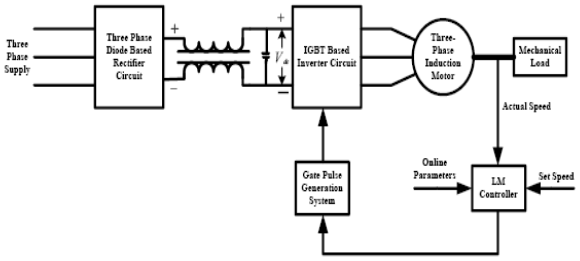

Fig. 7. Proposed energy saving V/f control technique

4. Conclusion

By implementing energy saving automatic star-delta-star, soft starter and V/f control techniques which can save the energy in different load requirements of compressor, grading machine and others machine where induction motors are used. These energy saving techniques can save 25% of power as compare to conventional starting and controlling techniques of clod store plant. In additional to energy saving power factor of CSP will improved, usage of capacitor banks to improve power factor will reduced, size of the conductor can be reduced and also stress on power grid when starting will reduced.

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