Need and Scope for Energy Conservation in Domestic Refrigerators

Nilesh M. Bhatt

Mech. Engg. Dept.
Nirma University of Science and Technology

Abstract—**In the present era of energy crisis where electric energy cost increases day by day it is of prime importance to conserve energy in every field of life. Power consumption of modern domestic refrigerators is around 60 to 100 kWh for a capacity of say 210 liters depending upon the season. Improper usage and maintenance may increase this power consumption by as high as 20%. This also leads to additional financial burden to consumers. Scope of energy saving which may result due to proper usage by an awaken citizen is described in the paper.**

Key Words—**Energy Conservation, Refrigerators, Power Consumption.**

I. Need for Energy Conservation

It is evident that fossil fuel era is gradually coming to an end. Fossil fuel resources are fast depleting. Electric energy cost increases day by day. Hence there is a need to find alternate sources of energy. At the same time it is also necessary to conserve energy in every sector. In India around 25% of total energy consumption comes from domestic sector. Up to 70% of the domestic electrical consumption comes from domestic refrigerator and thus forms a major contributor to the domestic electric energy consumption. Thermostat and insulation have to a large extent reduced the energy consumption of these devices to 30% to 50% of the rated capacity of their compressor motor. Despite this the energy consumption of domestic refrigerator in India are very high. For example 165 and 210 liters single door models consume 40 to 70 kWh/month and 60 to 100 kWh/month respectively. In developed countries like USA, Japan, UK and others, the electrical energy consumption is around 15 kWh/month and 25 kWh/month respectively. From this, it is quite obvious that there is need and scope of energy conservation in domestic refrigerator.

II. Scope for Energy Conservation

Indian consumers are still uninformed on the possible implication in the terms of electrical energy consumption and the running energy cost of the device, which they buy. There is a need to understand the effect of various parameters like age of machine, ambient temperature, position of thermostat, location of refrigerator, usage pattern etc on the energy consumption of domestic refrigerator.

Domestic refrigerator are being available in wide range of sizes and configurations. 165 and 210 liters single door refrigerator is most widely used. Now a days 165 liters and 210 liters single door and 210 liters double door models with frost free technology is also being available. These are having a resistance heater and blower to prevent frost formation on the coolest portion of refrigerator that is the evaporator. Power consumption of 165 liters single door refrigerator is around 1.3 kWh/day to 2.5 kWh/day while it ranges from 1.4 to 4.2 kWh/day for frost-free refrigerator. These refrigerators also require small fan for circulation of air over the evaporator which adds to energy consumption and heat load for the refrigerators. Double door models require two such small fans.

Higher power consumption may be because of low voltage of main supply. Due to this the compressor motor draw higher current and power consumption is higher than rated capacity. This problem is more severe in the rural parts where due to unreliable power supply voltage fluctuate more frequently.

It has been observed that power consumption of the units with more than 10 years of service without any repairs is higher than those, which have been repaired at least once in the service of 10 years. This may be because rewinding and overhaul of compressor motor improve the electric efficiency of the compressor and its motor. Volumetric efficiency of the compressor decreases after 9 to 10 years of service due to wear and tear hence power consumption of the compressor will be higher. Also winding quality deteriorates with age of the unit and motor draw higher current. It is recommended to rewind the compressor motor and over haul the compressor after 7 to 10 year of service. It has also been observed that power consumption does depend upon the brand but it depends on particular machine.

It has also been observed that power consumption of the refrigerator having PUF and glass wool as insulating material does not show any significant variation in power consumption. However lower conductivity of PUF helps in making the refrigerator compact. Power consumption depends on the life of the insulation because the insulation quality deteriorates with age due to absorption of the moisture, which in turn increases the conductivity of the insulating material. This increases heat loss from refrigerated space. Moisture absorption of glass wool is higher than PUF. Deterioration of insulation can be identified by moisture condensation on outer surface. This lead to higher power consumption and hence insulation must be replaced to minimize heat loss from refrigerated space.

Performance of thermostat deteriorates with age of domestic refrigerator. With age thermostat does not show any appreciable difference in power consumption. Increase of door opening does not show any appreciable difference in energy consumption.

Condenser temperature of around 55°C is used in domestic refrigerator as air cooled condenser is used. Improper air circulation around the condenser leads to higher condenser temperature and hence higher power consumption. Sufficient spacing as per the recommendation given in users manual should be provided around the refrigerator. Periodic cleaning of condenser coil is also recommended since fouling on condenser coil increase the condenser temperature. Here it may be noted that it is easier to clean clean-back refrigerator where condenser coils are provided on inner surface of side and back walls of refrigerator. It is also desirable to keep domestic refrigerator in the coolest and clean room of the house in order to maintain lower condenser temperature and hence to reduce power consumption. It may be noted that kitchen is not the coolest and relatively clean place in a house. Relative humidity does not show any appreciable difference in the power consumption.

Switching of refrigerator during night hours does not show proportionate energy saving. This is due to fact that refrigerator has to once again cool the entire stored product in the refrigerator and hence during beginning hours running time will be higher. Energy consumption of loaded and unloaded refrigerator does not show any appreciable change in power consumption.

If cooling effect reduces, it may be because of poor charging of refrigerant or leakage of the refrigerant. Presence of any other gas or vapour increases the power consumption but do not contribute to refrigerating effect. Presence of moisture may clog the capillary tube. Under these circumstances it is recommended to recharge the system by a competent mechanics.

To prevent leakage of air from deteriorated door seal, it should be replaced immediately. As mentioned earlier poor thermal response of thermostat is a major cause of higher power consumption. It should be immediately replaced when its thermal response deteriorates. Due electric heater and fan, power consumption of frost-free refrigerator is higher than those without frost-free technology. In case of voltage variation, voltage stabilizer should be used to improve electrical efficiency of the compressor motor. After around 10 years of service, hermetically sealed compressor must be cut and overhauled by reputed refrigerator mechanics. Power consumption of refrigerator using non-CFC refrigerant like R134a is lower by 10-15% compared to those using R-12 as refrigerant.

III. CONCLUSIONS

Units with more than 10 years of service shows higher power consumption compared to those newly purchased or in service for 3-5 years. This is due to deterioration of insulation, gasket, lower compressor volumetric efficiency, lower electric efficiency of compressor motor and may be because of presence of non condensable gases in the refrigerant circuit. Area for energy conservation are re-insulation of door and sides, replacement of door gaskets, compressor overhaul by cutting open an replacement of piston rings, overhaul of motor, minimizing incondensable like nitrogen and air in the refrigerant circuit, optimal gas charging, replacement of thermostat. Some simple tips for energy conservation which can be easily implemented are also mentioned.

REFERENCES

1. Bhatt, M. Siddhartha and Nandakumar, V.N. "Energy Conservation in Domestic Refrigerator" background reading material for workshop on the consumer acceptance of energy efficient label formats and product standards Ahmedabd 1998.
2. ASHRAE Handbook Fundamental volume 2001.
3. Arora, C.P. "Refrigeration and Air Conditioning" 2nd Edition, Tata McGrawHill Publications, 2001.
4. User manual of different refrigerators.