BEST PRACTICES IN ENERGY EFFICIENCY

Commercial Refrigeration

LIGHTING | ELECTRIC MOTORS | **COMMERCIAL REFRIGERATION** | AIR CONDITIONERS

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Energy efficiency

The costs of electricity generation and average demand are raising worldwide, this, in the face of greater competitiveness and socioeconomic development. The need to increase the installed capacity in Central America to meet the electrical needs of the different consumer sectors and small and medium-size enterprises is motivating the implementation of cost-efficient actions in the end use of electricity.

The electrical equipment used in most industrial processes and in commercial installations generally has low levels of efficiency. In addition, the installed equipment has often exceeded its useful life or is approaching that limit, causing considerable energy waste and resulting in higher operational costs for companies and higher greenhouse gas emissions as a consequence of the growing use of imported fossil fuels in the production of electrical energy.

The Energy Network Foundation (Fundación Red de Energía or BUN-CA, in Spanish) and the United Nations Development Programme (UNDP), with funding from the Global Environment Facility (GEF), are developing the *"Regional Energy Efficiency Program in the Commercial and Industrial Sectors in Central America"* (PEER), an initiative that is helping to remove barriers to knowledge and technical information toward the development of markets for efficient electrical equipment.

The objective of this series of packets for "Best Practices in Energy Efficiency" is to strengthen technical knowledge throughout Central America, by offering a thematic series of best practices on the topics of Commercial Refrigeration, electric motors, air conditioners and lighting, to promote electrical energy savings in the industrial and commercial sectors.

I. What is refrigeration?

Refrigeration is the process of heat transfer from one place to another to lower the temperature of a determined space and keep it low, in order to cool and conserve products. Refrigeration prevents the growth of bacteria and impedes the decomposition of foods that can occur at ambient temperature.

At present, for example, a variety of equipment is used in supermarkets and retail food shops that includes central refrigeration systems connected to refrigerated chambers, freezers, iceboxes and ice dispenser machines.

The production of cold that ensures a suitable temperature for conserving products has a financial cost, which increases as the product conservation temperature is lowered.

II. Operation of a refrigeration system

The basic refrigeration cycle shows that heat is gathered in the evaporator and disposed of in the condenser. The amount of heat disposed is approximately the same as the proportion of heat gathered in the evaporator.

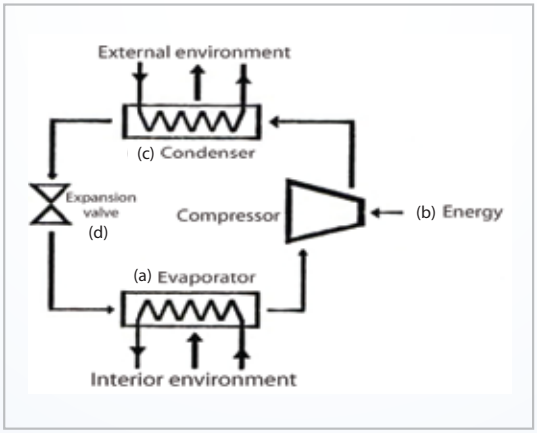

Figure 1. Basic refrigeration cycle.
Source: BUN-CA, 2009.

The following processes occur in this cycle:

a. Heat is gathered by the refrigerant in the evaporator.
b. The compressor increases the pressure and temperature of the refrigerant, pushing it toward the condenser where it produces heat transfer.

c. The heat disposed of in the condenser is transferred to the exterior environment using some means such as natural air or cold water.
d. The expansion valve lowers the pressure of the refrigerant generating a pressure differential, which allows the process to repeat itself indefinitely.

III. Description of the main components

The main components of a refrigeration system are:

Evaporator: Heat exchanger (a radiator in the interior of the equipment; see Figure 1), where the refrigeration effect takes place by allowing the refrigerant to absorb the heat removed from the spaces to be refrigerated (Figure 2).

Figure 2. Evaporator

Condenser: Heat exchanger (radiator) that eliminates the heat in the gaseous refrigerant coming from the compressor by converting it into a liquid-gas mixture that gives off the heat removed from the refrigerated space, the reason it is placed outside the enclosed area (Figure 3).

Figure 3. Condenser

Compressor: Mechanical equipment that compresses the refrigerant into vapor form, increasing its pressure and temperature, and then transporting it as a gas via the tubing to the condenser. The compressor is acted on by an electric motor (Figure 4).

Figure 4. Compressor

Expansion valve: Mechanical device that lowers the pressure of the refrigerant as it passes through from the condenser. The refrigerant leaves the valve as a low-temperature low-pressure gas, going through the tubing to the evaporator (Figure 5).

Figure 5. Expansion valve

Refrigerant: This is a fluid that acts as a cooling agent, with special properties for achieving evaporation and condensation points. Through changes in pressure and temperature, it absorbs heat from one space and dissipates it in another. There are several kinds on the market, depending on requirements (Figure 6).

Figure 6. Refrigerants

IV. Best practices for energy savings

4.1 Equipment selection

Select optimal thermal insulation. Insulation helps conserve the proper temperature of the refrigerated space by reducing the heat load from the outside of the space due to cooling, minimizing losses of heat, eliminating condensation and obtaining energy savings.

The specifications that thermal insulation should meet in cold-storage installations are: having low thermal conductivity, not generating odors and not reacting chemically with other materials used.

Select efficient equipment. When selecting equipment for the refrigeration system, choose the use of highly efficient compressors and motors whenever possible. These consume less electricity to meet refrigeration needs.

Choose proper size equipment. Equipment size should be chosen according to the quantity of product to cool. An empty freezer at -18°C consumes nearly the same amount of energy as another using up to two-thirds of its storage capacity.

4.2 Equipment installation

Correctly place evaporators and condensers. The equipment should not be blocked by objects that limit free air circulation. In the case of air-cooled condenser units that are placed outside, these should be installed under shade preferably and in well ventilated areas.
Similarly, evaporators that are normally placed inside refrigerated spaces should be free of objects that can block the flow of cold air and reduce cooling capacity.

Use qualified labor, equipment and quality components. Most of the problems in refrigeration systems come from a defective or improper installation. The acquisition of efficient equipment, quality components and an installation by qualified personnel will ensure the optimal performance of the system.

Reduce external heat sources. The equipment should be placed far from sources of heat such as cookers, ovens, and so on.

Use plastic curtains or anterooms. In cold rooms, the use of plastic curtains and the placement of an anteroom will help reduce losses due to air flow from the cold room to the exterior.

Reduce the solar load. Place refrigeration equipment far from windows, walls exposed to the sun and transparent roof sheets. Otherwise, the use of screens, blinds and curtains is recommended to diminish the heat produced by solar radiation.

Place the thermostat correctly. Install the thermostat next to where air enters from the evaporator, not where it leaves, because the entry point is where the temperature is highest.

Insulate the cold rooms. Thermal insulation with low humidity absorbance should be used because water has a coefficient of thermal conductivity much higher than that of dry air and other inert gases used in the manufacture of the insulation. One option is to use polyurethane insulation at least 6 inches thick (15.24 centimeters) on the floor.

Use vapor barriers. These should be installed on the hot side of the insulation of the refrigerated rooms to keep water vapor from dispersing to the interior of the insulation, thus avoiding its deterioration. This will allow a reduction in energy consumption and it will help lengthen the useful life of the insulation materials as well as the refrigeration equipment itself.

4.3 Correct and efficient equipment operation

Regulate the operating temperature. Proper temperatures should be maintained according to requirements; for example, in the case of household refrigerators, at 3° or 4°C. In this equipment, the thermostat does not always show temperature in degrees; it may bear numbers instead from 1 (less cool) to 5 (most cool) or similar. If possible, keep the position at or below 2.

Maintain continuous use. Refrigerators, vertical chambers and commercial type freezers are made for continuous use and they can be responsible for a high percentage of monthly energy consumption; it is recommended they not be disconnected, except for maintenance and cleaning tasks.

Keep the doors closed. Reduce the number of times the equipment doors are opened and closed and reduce the time the doors remain open.

Regulate the temperature of products going into cold storages. Do not introduce recently cooked products into refrigerated sites to help reduce electricity consumption and use of the compressor. The correct action is to allow the products to cool down to ambient temperature. In some cases, energy can be saved by pre-freezing the products, to help reduce the temperature difference between product to be stored and the interior of the chamber.

Use rapid cooling chambers. When a product needs to be cooled immediately from a high temperature, such as recently butchered meat, there should be two kinds of equipment: a small room for handling the product volume that must be cooled rapidly and another larger one for storing the pre-cooled product.

Turn off the lights inside the cold room. Turn off the lights when there are no personnel inside the cold room. The lights should be highly efficient with capacity to operate in low temperatures.

Cover recipients inside the cold room. Store liquids in recipients with lids. The evaporators dehydrate the air inside and the liquids evaporate, increasing the cooling load and frost and reducing the efficiency of the equipment.

Allow air to circulate. Do not place obstructions in front of air outlets or near the fan of the condenser/evaporator. Keep the refrigerated product separate, to increase the area of heat exchange between the product and the circulating air.

Turn off empty equipment. Within the company create a culture of turning off empty equipment that is not in use.

4.4 Equipment maintenance

Clean the condensers. Clean the condensers every three months at least. In residences and offices they can be cleaned at least twice per year.

Get periodic maintenance service by trained personnel. Request a trained refrigeration technician two times per year (depending on the location of the equipment and its exposure to contaminants) to clean the copper coils, fan motors and tubing with refrigerant, check for air or refrigerant leaks, test the pressure, check the status of the insulation and compare it with the manufacturer's recommendations.

Check the thermostat. Every month, check that the thermostat is operating at the correct temperature, by using a thermometer and comparing the value shown with the one indicated by the thermostat.

Check the operation of the compressor. Monthly, check energy consumption and see if there are any abnormal noises or knocking during start-up and operation.

Check the status of gaskets and seals. Check and clean the door gaskets periodically and replace them if damaged, along with the seals. A simple test for checking their status is to put a piece of paper at the contact point between the door gasket and the refrigerator; if you can easily pull the paper out without opening the door, the gaskets should be replaced.

Change the oil periodically. In commercial refrigeration systems, the oil in the compressor should be changed according to the manufacturer's instructions. This operation should be performed by a refrigeration technician.

Check the tubing and insulation. Check that the tubing has not been flattened and the insulation in the suction tubing is properly adjusted and in optimal condition.

4.5 Change obsolete equipment

Substitute old equipment. Normally, equipment that has been in operation for more than 15 years has very low efficiency and the savings from the operation of other more efficient equipment will help recover the investment in 2 to 5 years, depending on the use, equipment size, operating conditions and electrical rates in the region.

Commercial refrigeration technical standards. When buying new equipment, take into account the technical standards and energy efficiency labeling for commercial refrigerators developed in each country, specifying minimum efficiency indices and directing one to the acquisition of more efficient equipment. To reference the technical standards, consult the national standards entity in each country.

Figura 7. Horizontal refrigerator.

Observations
(note other useful practices here)

For more technical information on energy efficiency, visit our Web page at
www.bun-ca.org

BUN-CA contributes to the development and strengthening of Central America's energy capacity to increase production through the sustainable use of natural resources, as a means of improving quality of life.
www.bun-ca.org

The United Nations Development Program is an implementing agency of GEF through its Country Office in Costa Rica which is supported by their counterparts in the other Central American countries.
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The mission of Fundecooperación is to promote sustainable development in Costa Rica, through a new model of international cooperation approach, thanks to the financial support from the Kingdom of the Netherlands.
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The Humanist Institute for Development Cooperation (HIVOS) is an NGO inspired by humanist values. Its key values include the dignity and human self-determination, rejection of dogmas and authoritarian systems, and a feeling of mutual solidarity. Hivos aims at a sustainable improvement in their situation, particularly the strengthening of the social position of women.

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