ELECTRICAL ENGINEERING

6TH SEM

EECM (Electrical Energy Conservation and Management)

Unit 5: Energy Efficiency In Electrical Utilities

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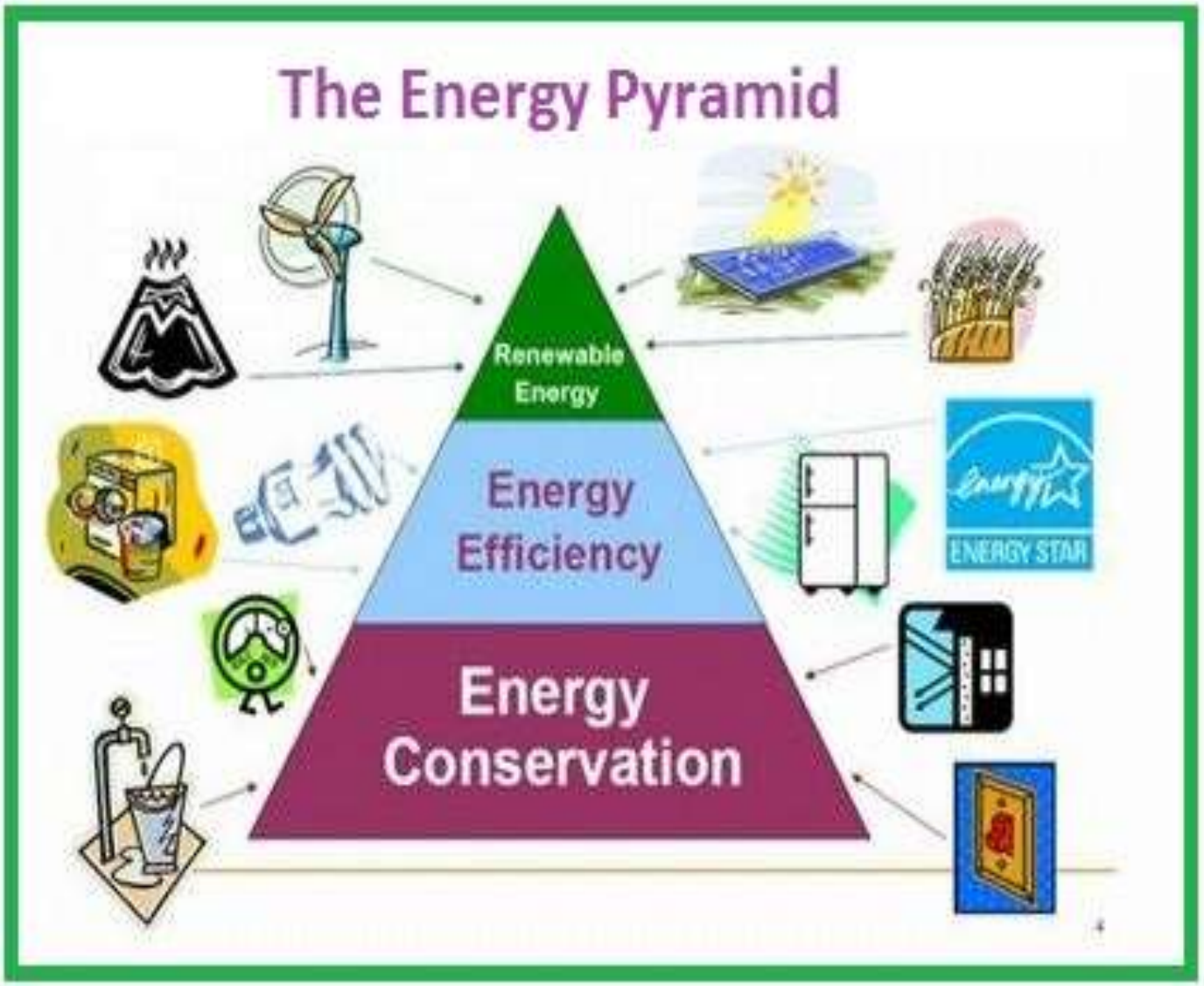
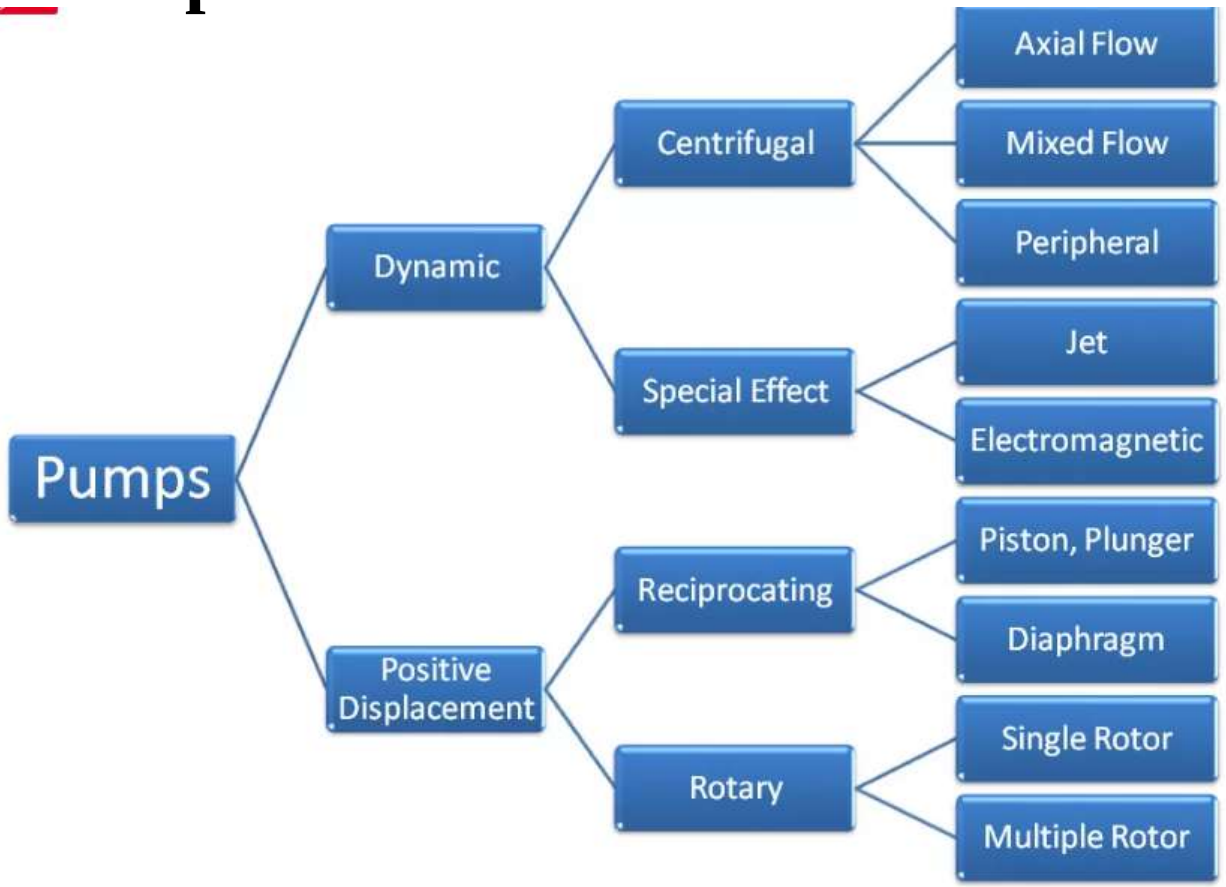
Energy Pyramid



Energy Efficiency in Pumps

Pump is a machine or mechanical equipment which is required to lift liquid from low level to high level or to flow liquid from low pressure area to high pressure area or as a booster in a piping network system. Principally, **pump** converts mechanical energy of motor into fluid flow energy.

Types of Pumps



Application of Pumps

- Piston pumps are frequently used in water irrigation, scenarios requiring high, reliable pressure and delivery systems for transferring chocolate, pastry, paint, etc.
- Diaphragm pumps used in transferring chemical, food manufacturing, underground coal mines, etc.

Energy Efficient operation of pumps

- Improper selection of pumps can lead to large wastage of energy. A pump with 85% efficiency at rated flow may have only 65% efficiency at half the flow.
- Use of throttling valves instead of variable speed drives to change flow of fluids is a wasteful practice. Throttling can cause wastage of power to the tune of 50 to 60%.
- It is advisable to use a number of pumps in series and parallel to cope with variations in operating conditions by switching on or off pumps rather than running one large pump with partial load.
- Drive transmission between pumps & motors is very important. Loose belts can cause energy loss up to 1-20%.
- Properly organized maintenance is very important. Efficiency of worn out pumps can drop by 10-15% unless maintained properly.

Energy saving opportunities in pumps

1. Energy conservation opportunities in pumping Operate pump near best efficiency point.
2. Replace old pumps by energy efficient pumps Reduce system resistance by pressure drop assessment and pipe size optimization.
3. Provide booster pump for few areas of higher head.

Energy Saving Tips in Pumps

1. Select the most efficient pump type for the application
2. Pump right-size
3. Trim the impeller
4. Minimize system pressure drop
5. Implement proper control valves
6. Implement variable speed drives (VSDs)
7. Use higher efficiency/proper pump seals

Energy Efficiency in Air Compressor

- A **compressor** is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

  Air compressors are categorized as either **positive displacement** or **dynamic displacement**, based on their internal mechanisms. The four most common types of air compressors you will see are:

1. Rotary Screw Compressor
2. Reciprocating Air Compressor
3. Axial Compressor
4. Centrifugal Compressor

Rotary Screw compressor

Key Feature

Common type of displacement compressor that works via two internal rotors

Uses

Designed for continuous use at large construction sites

Reciprocating Compressors

Key Feature

Common type of displacement compressor that works via a piston inside a cylinder

Uses

Designed for smaller sites such as home renovations, not for continuous use

Dynamic Compressors

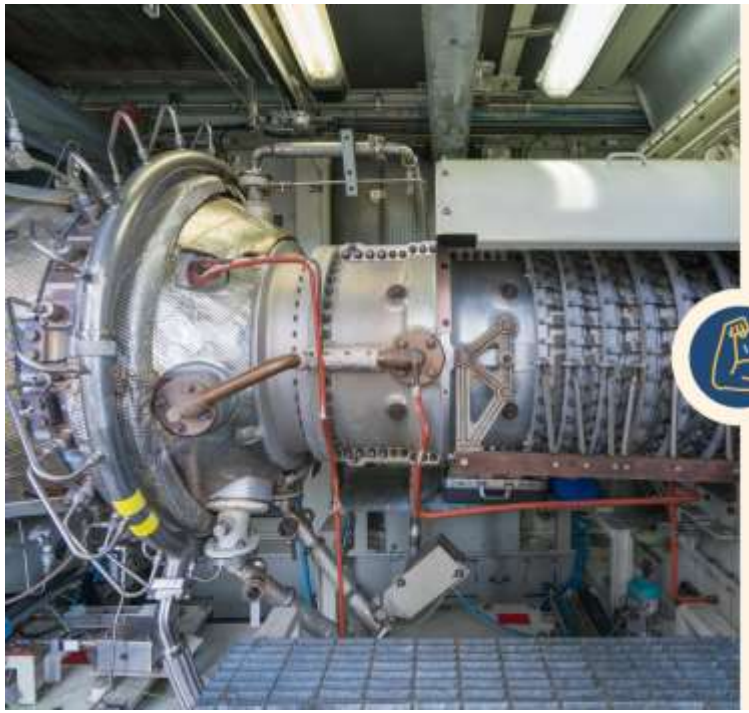
Key Feature

Also known as turbo or centrifugal compressors that utilize rapidly rotating blades to draw in air

Uses

Designed for large-scale projects such as chemical plants or steel manufacturers

Axial Compressors



Key Feature

Highly efficient and powerful, but very expensive

Uses

High-speed engines on ships or airplanes

Energy efficient operation of Compressed Air

- Compressed air is very energy intensive. Only 15-20% of electrical energy is converted to useful energy. Use of compressed air for cleaning is rarely justified.
- Ensure low temperature of inlet air. Increase in inlet air temperature by 3°C increases power consumption by 1%.
- It should be examined whether air at lower pressure can be used in the process. Reduction in discharge pressure by 10% saves energy consumption up to 5%.
- A leakage from a ½" diameter hole from a compressed air line working at a pressure of 7kg/cm^2 can drain almost Rs. 2500 per day.
- Air output of compressors per unit of electricity input must be measured at regular intervals. Efficiency of compressors tends to deteriorate with time.

- Replacement of inefficient aluminum or fabricated steel fans by molded fiber reinforced plastic (FRP) fans with aerofoil designs results in electricity savings in the range of 15-20%.
- Install automatic ON-OFF switching of cooling tower fans and save up to 40% on electricity costs.

Leakage Detector

Ultrasonic instruments are available which can be used to detect leaks of compressed air and other gases which are normally not possible to detect with human abilities.

Energy Saving Tips in Air Conditioners

1. Use ceiling or table fan as first line of defense against summer heat. Ceiling fans, for instance, cost about 30 paise an hour to operate - much less than air conditioners (Rs.10.00 per hour).
2. You can reduce air-conditioning energy use by as much as 40 percent by shading your home's windows and walls. Plant trees and shrubs to keep the day's hottest sun off your house.
3. One will use 3 to 5 percent less energy for each degree air conditioner is set above22°C (71.5°F), so set the thermostat of room air conditioner at 25°C (77°F) to provide the most comfort at the least cost.
4. Using ceiling or room fans allows you to set the thermostat higher because the air movement will cool the room.
5. A good air conditioner will cool and dehumidify a room in about 30 minutes, so use a timer and leave the unit off for some time.
6. Keep doors to air-conditioned rooms closed as often as possible.
7. clean the air-conditioner filter every month. A dirty air filter reduces airflow and may damage the unit. Clean filters enable the unit to cool down quickly and use less energy.
8. If room air conditioner is older and needs repair, it's likely to be very inefficient. It may work out cheaper on life cycle costing to buy a new energy-efficient air conditioner.

Energy conservation in HVAC and Refrigerator

Energy efficiency ratio

- It is measure of efficiency of heating and cooling system.
- An energy efficiency ratio is the ratio of the cooling capacity of an air conditioner measured in British Thermal Units (BTU) per hour to the total electrical input measured in watts. Air conditioners having high EER are considered to be most cost effective.
- For room air conditioners, it is called energy efficiency ratio or EER.
- For central air conditioners, it is called seasonal energy efficiency ratio or SEER.

Energy saving opportunities in Refrigerator

1. Use water-cooled condensers rather than air-cooled condensers.
2. Challenge the need for refrigeration, particularly, for old batch processes.
3. Avoid over sizing – match the connected load.
4. Consider gas-powered refrigeration equipment to minimize electrical demand charges.
5. Use free cooling to allow chiller shutdown in cold weather.
6. Use refrigerated water loads in series if possible. Convert firewater or other tanks to thermal storage.
7. Don’t assume that the old way is still the best – particularly, for energy intensive low temperature systems.
8. Correct inappropriate brine or glycol concentration that adversely affects heat transfer and/or pumping energy. If it sweats, insulate it, but if it is corroding, replace it first.

Energy saving opportunities in HVAC

1. Increase the chilled water temperature set point if possible. Use the lowest temperature condenser water available that the chiller can handle. (Reducing condensing temperature by 5.5 0C, results in a 20 – 25 per cent decrease in compressor power consumption)
2. Increase the evaporator temperature (5.50C increase in evaporator temperature reduces compressor power consumption by 20 – 25 per cent)
3. Clean heat exchangers when fouled. (1 mm scale build-up on condenser tubes can increase energy consumption by 40 per cent)
4. Optimize condenser water flow rate and refrigerated water flow rate.
5. Replace old chillers or compressors with new higher-efficiency models.
6. Use water-cooled rather than air cooled chiller condensers.
7. Use energy-efficient motors for continuous or near-continuous operation.
8. Specify appropriate fouling factors for condensers.