LECTURE 10

Waste heat is heat generated in a process by way of fuel combustion or chemical reaction,which is then “dumped” into the environment and not reused for useful and economic purposes. The essential fact is not the amount of heat, but rather its “value”. The mechanism to recover the unused heat depends on the temperature of the waste heat gases and the economics involved. Large quantities of hot flue gases are generated from boilers, kilns, ovens and furnaces. If some of the waste heat could be recovered then a considerable amount of primary fuel could be saved. The energy lost in waste gases cannot be fully recovered. However, much of the heat could be recovered and adopting the following measures as outlined in this chapter can minimize losses.

Heat Pumps

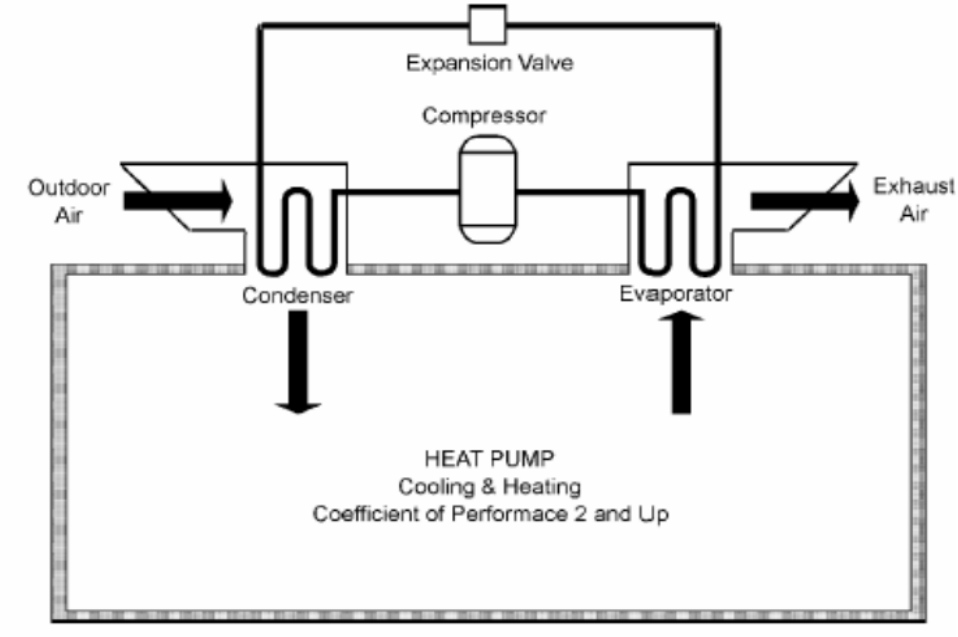
The majority of heat pumps work on the principle of the vapour compression cycle. In this cycle, the circulating substance is physically separated from the source (waste heat, with a temperature of Tin) and user (heat to be used in the process, Tout) streams, and is re-used in a cyclical fashion, therefore being called 'closed cycle'. In the heat pump, the following processes take place:

§ In the evaporator, the heat is extracted from the heat source to boil the circulating substance;

§ The compressor compresses the circulating substance, thereby raising its pressure and temperature. The low temperature vapor is compressed by a compressor, which requires external work. The work done on the vapor raises its pressure and temperature to a level where its energy becomes available for use.

§ The heat is delivered to the condenser;

§ The pressure of the circulating substance (working fluid) is reduced back to the evaporator condition in the throttling valve, where the cycle repeats. The heat pump was developed as a space heating system where low temperature energy from the ambient air, water, or earth is raised to heating system temperatures by doing compression work with an electric motor-driven compressor. The arrangement of a heat pump is shown in figure



The heat pumps have the ability to upgrade heat to a value more than twice the energy consumed by the device. The potential for application of heat pumps is growing and a growing number of industries have been benefited by recovering low grade waste heat by upgrading it and using it in the main process stream.

Heat pump applications are most promising when both the heating and cooling capabilities can be used in combination. One such example of this is a plastics factory where chilled water from a heat is used to cool injection-moulding machines, whilst the heat output from the heat pump is used to provide factory or office heating. Other examples of heat pump installation include product drying, maintaining dry atmosphere for storage and drying compressed air.

Principles of energy conservation:

1. Maximum thermodynamic efficiency
2. Maximum cost effectiveness

Energy Conservation measures in industry:

1. The selection and process should be such that it involves efficient use of energy.
2. The plant and equipment should be selected with special emphasis on reliability, maintainability and energy efficiency vis-à-vis quality and control of output.
3. The location of plant and equipment should be such that energy costs of transportation of raw materials and finished products are minimum.
4. The use of renewable sources of energy i.e. solar, wind, etc. should be encouraged to reduce the consumption of non-renewable source of energy i.e. electricity oil etc.
5. The regular cleaning, inspection, and lubrication should be adhered with a view to eliminate unreliability in production and have a proper quantity quality to output.
6. The production schedule and service should be planned and implemented with minimum use of resources i.e. labors, machine, materials etc.
7. Expensive purchase of raw material and stocking of finished products should be avoided.
8. The wastage in production and service must be kept at minimum.
9. all motors, cables, switches, gears etc. of the production machines should be adequately loaded. Overloading and under loading should be avoided.
10. The latest maintenance techniques and tools should be used to prolong the life of machines like preventive maintenance, predictive maintenance etc. based on requirements.
11. The lighting in and around the factory area should be as per the standard and with minimum requirements.
12. Use of waste heat from the process of plants should be effectively used.
13. The use of service facilities like air cooling, air conditioning, humidification, steam, water, compressed air etc. should be very efficiently and effectively used.
14. The peak load of the electricity requirements should be kept as near the average load as possible to control the maximum demand i.e. to reduce loads factors.
15. The power factor of the electrical load should be kept higher than 0.90 to 0.95

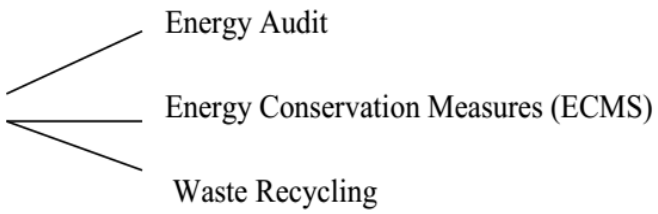
Energy Conservation and Management

Terms:-

Energy Management EM: - The EM is the practical science of techniques and dynamic processes of setting/objectives (tasks), planning, organizing, arranging material/ finance/ human and other required resources, executing, supervising monitoring, removing bottlenecks to achieve objectives and to set new objectives.

The energy management involves, planing, directing, and controlling the supply and consumption of energy to maximized productivity and comforts and to minimize the energy costs and to minimize the pollution, with consensus, judicious and effective use of energy.

3 steps of EM



Steps of Energy Management:-

1. Strategies.
2. Administrative actions.
3. Policy
4. Organizational charges.
5. Training and awareness programmes.
6. Association of working personnel's.
7. Energy Audit.
8. Energy consecration measures,

9 Evaluation of the present energy consumption.

10 Implementation of ECMs.

11 Monitoring of EC efforts.

EC: - It involves wastage of energy and adsorption of methods to conserve energy, without affecting productivity & comforts, more energy efficient processes should be replaced by less efficient processes.

Energy Conservation opportunities ECOs.

These are the avenues/ opportunities, which are open to implement energy conservation activities.

Energy Audit:-

It is an official scientific study/ survey of energy consumption of a region/ organization/ process/ plant/ equipment aimed at the reduction of energy consumption and energy costs, without affecting productivity and comforts and suggesting methods for energy conservation and reduction in energy costs.

Steps involved in energy management.

1 Energy management as policy and commitment

2 Management commitment

3 Selection of the Energy Manager

Responsibilities of Energy Manager:-

- Energy planning

- Energy consumption monitoring
- Planing energy conservation
- Implementing energy conservation measures
- Organization of HRD programmes
- Achieve EC objectives.

4 Formulation of supply strategies and energy conservation plans

5 Awareness and Involvement.

6 Introduce suggestions, schemes and award schemes.

7 Appoint or select energy Audit Team or consultants.

8 To obtain report on EC measures.

9 To obtain technical assistant report (TA-report)

Instructions in TA report

a) EC measures
b) Do or Don't
c) Operation and maintenance instructions.
d) Recommendation of a new technology.

10 Implementation of TA report and EC measures.

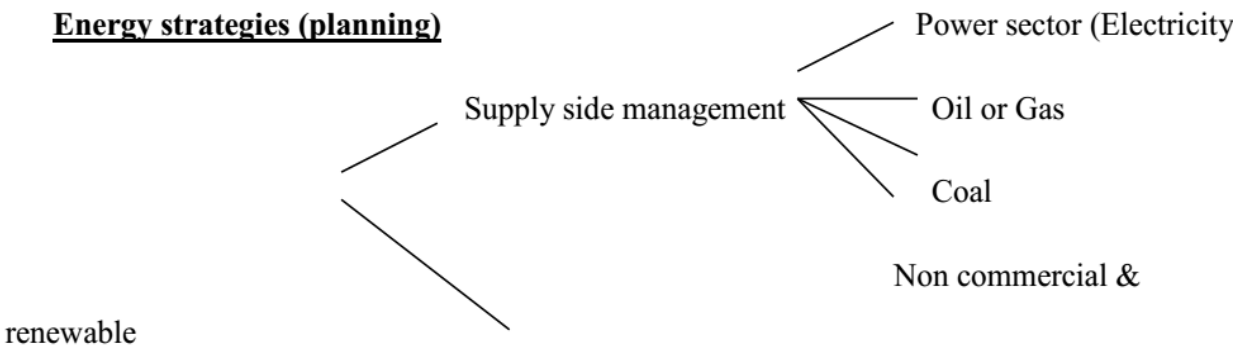
11 Implement E-optimized operation and maintenance practices.

12 Establish practice of monitoring energy consumption and effectiveness of ECM's.

13 Recycling of scrap, waste material, etc.

14 To review and optimize new design of the plant and equipment and to allocate finds for retro fitting.

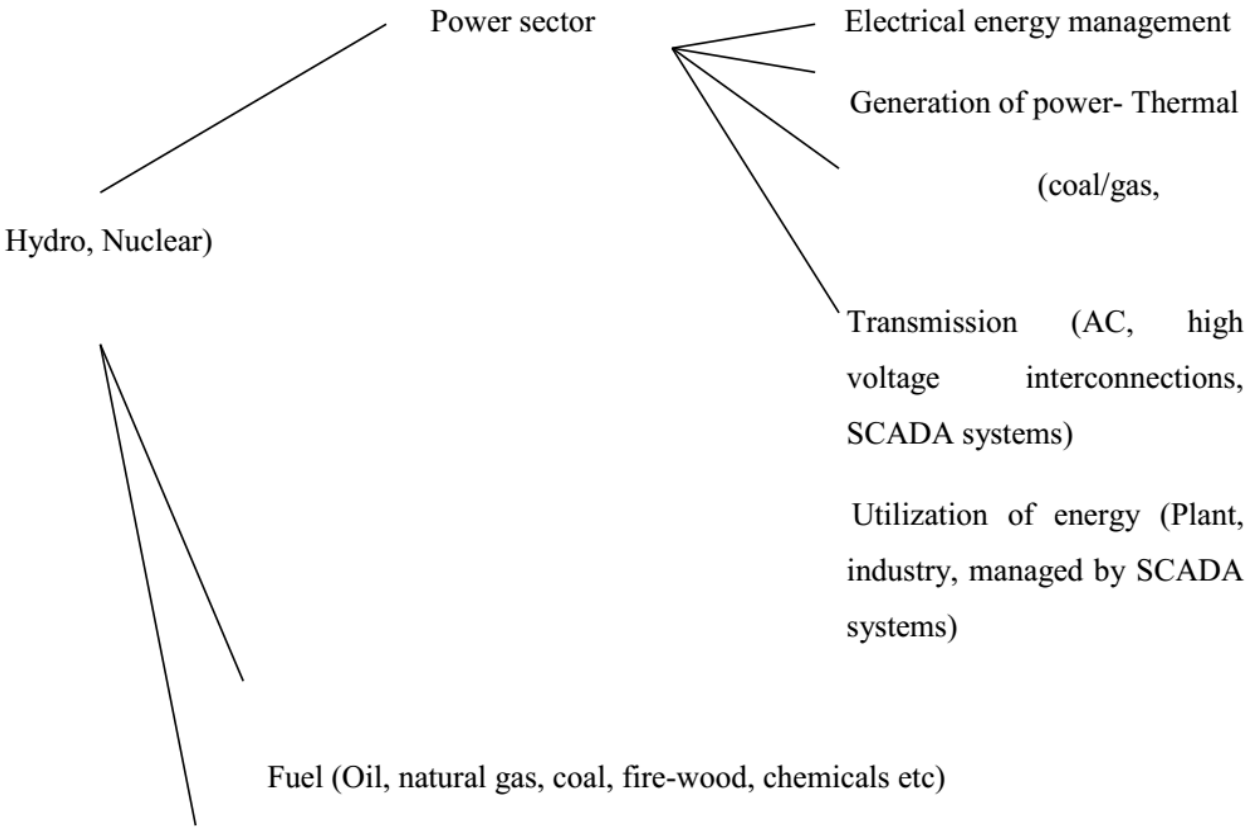
Energy strategies (planning)



Consumption/ demand side

- Industrial sector
- Agricultural
- Household (domestic) & commercial
- Transport
- Others

Supply side



Non commercial/ renewable energy

(a) Land biomass, solar, wind, geothermal, tidal etc.
(b) human energy (labor)
(c) Animal energy