Energy Cycles and Efficiency

1. Course Description:

Energy efficiency is becoming a major driving force behind every aspect of economic development in energy sector that requires highly educated and trained workforce. The objective of this course is to impart knowledge in different energy generation and conversion cycles such as Rankine, HVAC cycle (heating and cooling) CHP and other fluid circuits pertaining to energy transmission using modeling and analysis techniques.

2. Course Details

A. Course Outline

- Modeling Principles (Transient & Steady state) for Energy systems
- First Law and steady flow systems
- Thermodynamic & Transport properties of fluids
- Energy Conversion and Transmission Losses
- Rankine Cycle Modeling and Analysis
- Combustion modeling and Heat balance sheet
- Applied psychometrics
- HVAC Cycle Modeling and Analysis
- Fluid Circuit Modeling and Analysis for Pipeline Audit
- Comprehensive Energy Auditing

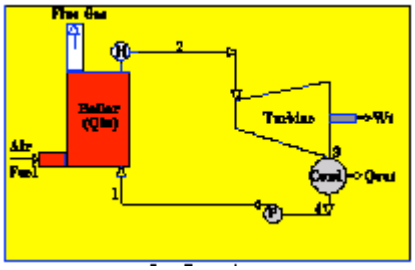
B. Course Objective

The main objective is to enhance the analytical ability of practicing engineers in order to perform an in depth design analysis in the following five areas of energy cycles.

1. Rankine Cycle (Energy generation using pressurized steam from fossil fuels)
2. CHP cycle (Combined Heat and Power)
3. HVAC Cooling Cycle (Optimization of system parameters with cooling load)
4. HVAC Heating Cycle (Optimization of system parameters with heating load)
5. Fluid Circuits (Pressure energy losses in piping systems and optimization)

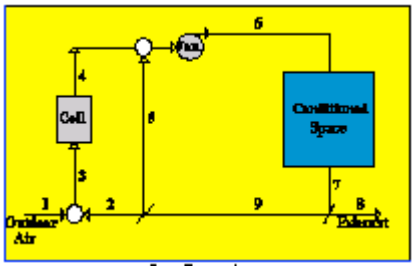
C. Course perspective and vision

Rankine cycle:

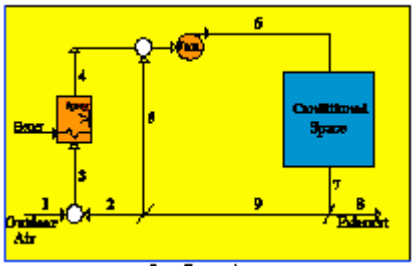


The above Rankine cycle model is the simplest in its form but not very efficient. Its efficiency is normally improved using HP/IP/LP stages of turbine with re heaters; feed water heaters, economizers etc. A thorough flue gas analysis as well as heat balance sheet is often pre-requisite to optimize conversion efficiency. It also covers computations of key efficiency factors such as Carnot efficiency, Rankine efficiency, and Boiler efficiency.

HVAC – Cycle



Cooling cycle



Heating cycle

The space heating and cooling constitute more than 20% of all energy consumption in US. A thorough understanding of conditioned space, infiltration and system heat balance can save over 30% of this energy bill in commercial establishments. A sound background on applied pyshrometry is a must for a thorough design analysis. Further, course explores standards for different commercial applications covering following fan-coil processes and respective cooling and heating load computations as per recommended practice.

- Cooling and dehumidification
- Sensible cooling
- Evaporative cooling
- Cooling and humidification
- Heating and humidification
- Sensible heating.

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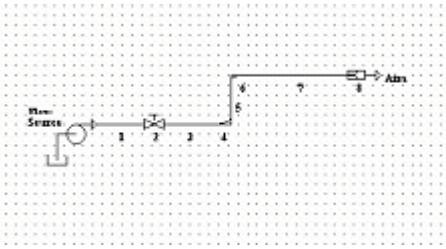
Fluid Circuits



Transmission losses are energy losses that occur between two energy conversion devices. Transmission loss in case of electrical energy system can be as high as 10% from the generating source to the consumer. Similarly, flow energy (pressure) loss coupled with heat in case of fluids can be much greater. For example, a 5% reduction in diameter due to scaling in the above circuit can cause almost 27% increase in the pressure drop for the water to flow at the same original designed rate. Consequently, it needs 27% more energy to pump water through this conduit. This can also further offset the pump efficiency due to the increase in the total head. A fluid circuit model consists of standard pipes and pipefitting, needs a closer look from energy consumption as well as maintenance perspective; a trade off between maintenance resources and future energy bill.

The above concepts will be suitably supplemented with number of case exercises. Please refer to the file on modeling exercises enclosed separately with this file.

D. Course logistics and duration

The program needs individual computer on which a restricted version of software Flow Joule V3.1 will be installed for the duration of the program or smart phone apps can also be used during the course. All modeling exercises are dealt both analytically as well as using this software to confirm the results obtained. Power point presentation slides will be used for major part of the instructions.

The duration for each module is given below assuming a fair knowledge on basics of thermo-dynamics, heat transfer and fluid mechanics. If not, additional hours may be needed to cover the basics.

1. Equipment efficiencies (10 hours)
    a. Pump
    b. Compressor
    c. Fan
    d. Heat Exchangers
    e. Boilers
2. Rankine Cycle (5 hours)
3. HVAC Cooling cycle (3 hours)
4. HVAC heating cycle (3 hours)
5. Fluid circuits (3 hours)