Advanced Power Cycles

Power Engineering Department
Honors Elective

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Syllabus

General introduction; performance parameters of power cycles.

Properties of ideal working fluid for vapor power cycles. Practical losses in Rankine and Reheat cycles. Supercritical cycles, Organic Rankine Cycles; Practical Regenerative cycles with open and closed feed water heaters, choice of heaters, heater arrangements and optimum degree of regeneration. Supercritical pressure cycle. Heat Balance Diagram and its utility.

Thermodynamic Availability analyses of closed and open systems, 2nd law efficiency. First and Second Law analyses of practical vapor power cycles. Effects of operating parameters on steam power plant performance.

Gas turbine cycles: Ideal and actual Brayton cycles; GT cycle performance parameters, Gas turbine cycles with intercooling, reheating and regeneration.

Combined Cycles: Definition and classification, simple thermodynamic analyses of coupled cycles. Binary vapor power cycle, Gas Turbine Combined Cycle, STIG, IGCC, Cogeneration, CHP applications.

Course Outcome

CO1: Review different vapor and gas power cycles and recognize their salient performance parameters (**K2**)

CO2: Calculate the performance parameters of steam, gas and combined cycles (**K3**)

CO3: Compare the performance of different advanced power plant cycles (**K4**)

CO4: Interpret the concept of thermodynamic availability in analyzing thermodynamic system performances (**K4**)

Why study this subject?

Present challenge

- Dwindling reserve of fossil fuels
- Concerns over greenhouse gas emission
  - *Minimization of CO_2 emission through improved thermal efficiency*
  - *Use of carbon neutral fuels (Biomass, rice husk, bagasse, etc.)*
  - *Use of renewable energy along with energy storage*
  - *Hydrogen energy (typically using fuel cells)*

Solution

- Improvement in conventional cycles to improve efficiency
- Advanced cycles to accept new fuels (e.g., low-grade fuels, carbon-neutral fuels)

Hydrogen Energy

- Hydrogen is a clean fuel
  - Used in a fuel cell, produces only water.
  - Can be produced from a variety of domestic resources, such as natural gas, nuclear power, biomass, and renewable power like solar and wind.
  - Attractive fuel option for transportation and electricity generation applications (can be used in cars, in houses, for portable power, and in many more applications).
- Hydrogen is an energy carrier that can be used to store, move, and deliver energy produced from other sources

Hydrogen fuel can be produced through

- Natural gas reforming
- Coal gasification
- Biomass gasification
- Reforming of renewable liquid fuels
- Electrolysis

Home assignment: What are the advantages and challenges of hydrogen energy?