



Introduction to Rankine Cycles

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Overview of Rankine Cycle



Introduction to Rankine Cycle

The Rankine Cycle is a thermodynamic cycle used in power plants to convert heat into mechanical work.

Fundamental process in steam power plants and many other types of power generation systems.



Principle of Operation

Operates on the principle of converting heat into work through the expansion and compression of a working fluid.

Four main components: boiler, turbine, condenser, and pump.



Cycle Process

Cycle begins with the working fluid being heated in the boiler to generate high-pressure, high-temperature steam.

High-pressure steam enters the turbine, expands, and produces mechanical work.

Steam is condensed back into liquid form in the condenser by rejecting heat to a cooling medium.

Condensed liquid is pumped back to the boiler to complete the cycle.



Advantages of Rankine Cycle

Known for its simplicity, reliability, and efficiency.

Ability to generate large amounts of power efficiently.

Widely used in power plants to generate electricity for various applications.

Key Components of Rankine Cycle

01

Boiler

Responsible for heating the working fluid to generate high-pressure, high-temperature steam.

02

Turbine

Converts the thermal energy of the steam into mechanical energy to drive the generator.

03

Condenser

Cools and condenses the exhaust steam from the turbine into liquid form.

04

Pump

Pressurizes the condensed liquid to return it to the boiler for reheating.

05

Working Fluid

Typically water or steam, circulating through the cycle to transfer heat energy.



Working Principle of Rankine Cycle

Introduction to Rankine Cycle

The Rankine Cycle is a thermodynamic cycle that converts heat into work.

Operates on the principle of a closed-loop cycle where a working fluid is alternately vaporized and condensed.

Main Components of Rankine Cycle

- Boiler
- Turbine
- Condenser
- Pump

Process in the Boiler

Heat is added to the working fluid in the boiler.

The fluid vaporizes and expands.

Process in the Turbine

Expanding vapor drives the turbine.

Produces mechanical work for electricity generation.

Condensation and Pressurization

Vapor is condensed back into liquid in the condenser by rejecting heat.

Pump pressurizes the liquid back to the boiler pressure to complete the cycle.

Efficiency of Rankine Cycle

Efficiency of Rankine Cycle

The Rankine cycle typically operates at an efficiency ranging from 30% to 42%. The efficiency of the Rankine cycle is influenced by the pressure and temperature levels at various stages.

Factors Influencing Efficiency

Higher boiler pressure and lower condenser pressure can lead to increased efficiency in the Rankine cycle. The efficiency of the Rankine cycle can be improved by utilizing superheated steam in the turbine.

Benefits of Improved Efficiency

Improving the efficiency of the Rankine cycle can lead to significant energy savings in power generation applications.

Advantages of Rankine Cycle

01

High Efficiency

The Rankine cycle offers high thermal efficiency, typically ranging from 30% to 40%.

This makes it a cost-effective power generation option.

02

Versatility

This cycle can utilize various heat sources such as coal, natural gas, nuclear, or solar energy.

Provides flexibility in power generation.

03

Reliability

Rankine cycle power plants are known for their reliability.

Can operate continuously for extended periods, ensuring a stable power supply.

04

Scalability

The Rankine cycle can be easily scaled up or down to meet different power generation requirements.

Suitable for both large-scale and small-scale applications.

05

Low Environmental Impact

Compared to some other power generation methods, Rankine cycle power plants have lower emissions.

Contributes to a cleaner environment.



Disadvantages of Rankine Cycle

Low Thermal Efficiency

The Rankine cycle has lower thermal efficiency compared to other power cycles, such as the Carnot cycle.

Energy losses occur in the condenser and boiler.

Large Amount of Cooling Water Required

The cycle requires a significant amount of cooling water for condensation.

This can be a limitation in areas with water scarcity or environmental concerns.

Complexity and Cost

Implementing a Rankine cycle power plant can be complex and costly.

High-pressure boilers and turbines are needed, especially for large-scale applications.

Slow Start-Up Time

Rankine cycle power plants have a relatively slow start-up time.

Not suitable for applications requiring quick response to changes in power demand.

Environmental Impact

Combustion of fossil fuels in Rankine cycle power plants can contribute to air pollution and greenhouse gas emissions.

This impacts the environment.