Chapter 4 - Energy Analysis for a Control Volume

Lecture 27
Sections 4.4-4.5

MEMS 0051 Introduction to Thermodynamics

Mechanical Engineering and Materials Science Department
University of Pittsburgh

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Student Learning Objectives

At the end of the lecture, students should be able to:

- Apply the Conservation of Energy and Conservation of Mass to open and closed heat exchangers

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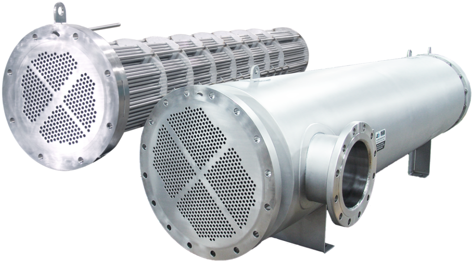
Heat Exchangers

- A heat exchanger is a device that transfers heat from a high-temperature reservoir to a low-temperature reservoir



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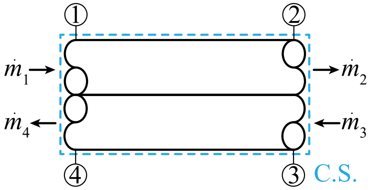
Example #1

- Consider a cross-flow heat exchanger shown below. Steam enters the condenser at 10 [kPa] and a quality of 95% and exits as a liquid at a temperature of 45 °C. Cooling water enters the heat exchanger, in a separate stream, as a liquid at 20 °C and exits as a liquid at 35 °C. Determine:
  1. The ratio of mass flow rate of cooling water to condensing steam
  2. The rate of energy transfer from the condensing steam to the cooling water



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Example #1

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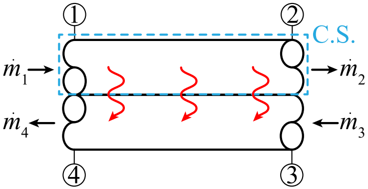

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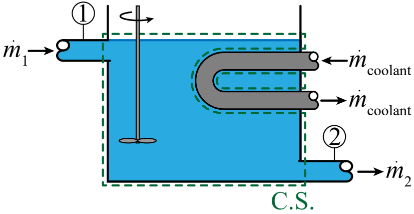
Example #2

- A tank initially contains 45 [kg] of liquid water at 45 °C. Liquid water enters at 45 °C with a mass flow rate of 270 [kg/hr]. A cooling coil removes energy from the water at a rate of 7.6 [kW]. A paddle mixes the water such that the temperature can be assumed uniform, but through viscous dissipation, introduces 0.6 [kW] of energy. Determine the variation of temperature with time.



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Example #2

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Student Learning Objectives

At the end of the lecture, students should be able to:

- Apply the Conservation of Energy and Conservation of Mass to open and closed heat exchangers
  - The CoE applied to heat exchangers must be developed on a per-case basis, however, work is always set to zero, for these devices neither require nor produce work. The application of the C.S. dictates the form of the CoE equation, but more importantly, the heat transferred.

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Suggested Problems

- 4.62, 4.65, 4.68, 4.70, 4.74, 4.91, 4.95, 4.100, 4.105, 4.107, 4.110, 4.113

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