

Chapter 5 - Second Law of Thermodynamics

Lecture 14 Sections 5.3-5.4

MEMS 0051 Introduction to Thermodynamics

Mechanical Engineering and Materials Science Department
University of Pittsburgh



Student Learning Objectives

Chapter 5 - Second
Law of
Thermodynamics

MEMS 0051

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

- ▶ Identify a reversible and irreversible process
- ▶ Understand that factors that contribute to irreversibility

Learning Objectives

5.3 - The Reversible
Process

5.4 - Factors That
Render Processes
Irreversible

Summary



- ▶ An **ideal process**, also known as a **reversible process**, is one where we can go from an initial to final state, and then back to our initial state, with no change in our systems or surroundings
 - ▶ This is purely hypothetical
- ▶ The opposite to a reversible process is an **irreversible process**, one where the system and/or surroundings cannot be restored to their initial states after the process has occurred
 - ▶ This is all “real” processes



- ▶ Some hypothetical reversible processes:
 1. A pendulum swinging in a vacuum with zero-friction bearing between the pivot and arm
 - ▶ Note this breaks PPM of the Third Kind
 2. A gas in a perfectly insulated, frictionless piston-cylinder device that compressed and expanded.
 - ▶ Note this breaks PPM of the Third Kind

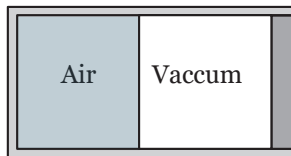


Irreversibility

- ▶ Irreversibility occurs in all of the following, and more
- 1 Friction - in both sliding of objects and the flow of fluid - kinetic energy is converted to thermal energy



2 Unrestrained expansion a gas/liquid to a lesser pressure



Learning Objectives

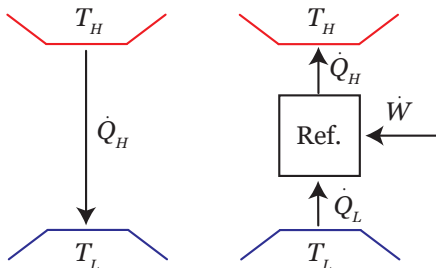
5.3 - The Reversible Process

5.4 - Factors That Render Processes Irreversible

Summary



3 Heat transfer through a finite temperature difference (i.e. high to low, via conduction, convection and/or radiation)



Learning Objectives

5.3 - The Reversible
Process

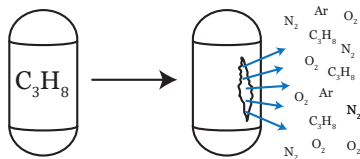
5.4 - Factors That
Render Processes
Irreversible

Summary



Irreversibility

- 4 Any chemical reaction, mixing of matter with different compositions or states, Joule heating, inelastic deformation, etc.



Learning Objectives

5.3 - The Reversible Process

5.4 - Factors That Render Processes Irreversible

Summary



Student Learning Objectives

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

- ▶ Identify a reversible and irreversible process
 - ▶ A reversible process is where we can go from an initial to a final state, and then return to the initial state, with no change of our system properties, or a change to the environment (i.e. increase of energy)
 - ▶ An irreversible process is one where a change of our system and/or surroundings occurs when we go from an initial to final state, and then back to our initial state.
- ▶ Understand that factors that contribute to irreversibility
 - ▶ Friction, rapid expansion of a gas, heat transfer, chemical reactions, etc.



Suggested Problems

- ▶ Our text does not provide problems associated with the identification of reversible and irreversible processes.

