

# 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 the 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 PMM of the Third Kind
  2. A gas in a perfectly insulated, frictionless piston-cylinder device that is compressed and then expanded.
    - ▶ Note this breaks PMM of the Third Kind

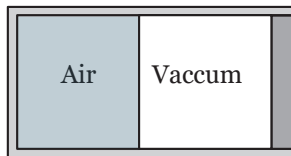


# Irreversibility

- ▶ 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

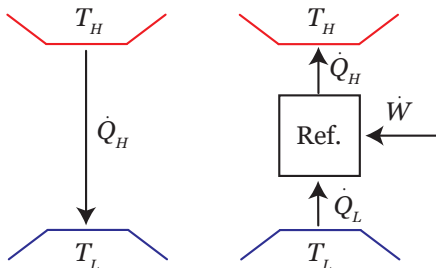
#### 5.3 - The Reversible Process

#### 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

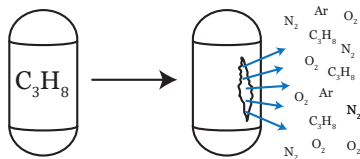
5.4 - Factors That  
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Irreversible

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 the 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.

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