Perspective

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Der Chemica Sinica
ISSN 0976-8505

2021
Vol.12 No.6:29

Thermodynamics: An Overview

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Received: June 21, 2021; Accepted: June 26, 2021; Published: June 31, 2021

Citation: Boyadjiev C (2021) Thermodynamics: An Overview. Der Chem Sin Vol.12 No.6:29

Perspective

Thermodynamics is a branch of physics that studies heat, work, and temperature in relation to energy, radiation, and matter's physical properties. The core insight is that heat is a type of energy that corresponds to a specific amount of mechanical work. The performance of these quantities is regulated by the four laws of thermodynamics, which demonstrate a quantitative description using measurable macroscopic physical quantities but can be described by statistical mechanics in terms of microscopic constituents. Thermodynamics applies to a wide range of scientific and engineering topics, particularly physical chemistry, biochemistry, chemical engineering, and mechanical engineering, but also to more complex fields such as meteorology. Thermodynamics is thus concerned with several properties of matter, the most important of which is heat. According to Energy Education, heat is energy that is transferred between substances or systems due to a temperature difference. Heat, as a form of energy, is conserved, which means it cannot be created or destroyed.

According to Energy Education, the amount of heat transferred by a substance is determined by the speed and number of atoms or molecules in motion. The higher the temperature, the faster the atoms or molecules move, and the more atoms or molecules in motion, the more heat they transfer. Heat energy is transferred from one body to another or between a body and its surroundings using one of three methods: conduction, convection, or radiation. The transfer of energy through a solid material is referred to as conduction. Conduction occurs when two bodies come into direct contact, and molecules transfer their energy across the interface. The transfer of heat to or from a fluid medium is referred to as convection. Molecules in a gas or liquid that come into contact with a solid body transmit or absorb heat from that body and then move away, allowing other molecules to move into place and repeat the process. A thermodynamic process is the energetic evolution of a thermodynamic system from its initial state to its final state. Process quantities can be used to describe it. Typically, each thermodynamic process is distinguished from others in terms of energetic character by the parameters that are held constant, such as temperature, pressure, or volume, etc.

Three laws were originally used to express the fundamental principles of thermodynamics. Later, it was discovered that a more fundamental law had been overlooked, ostensibly because it seemed so obvious that it did not need to be stated explicitly. Ralph H. Fowler devised a solution to the dilemma and dubbed the new law the "Zeroth Law." In a nutshell, these are the laws:

According to the Zeroth Law, if two bodies are in thermal equilibrium with a third body, they are also in thermal equilibrium with each other. Temperature is now recognised as a fundamental and measurable property of matter.

According to the First Law, the total increase in energy of a system equals the increase in thermal energy plus the work done on the system. This statement states that heat is a type of energy and thus subject to the principle of conservation. The first law is applied by considering the flow of energy across the boundary that separates a system from its surroundings. The concept of energy, or the ability to do work, is central to thermodynamics. The total energy of a system and its surroundings is conserved by the First Law. Energy can be introduced into a system by heating, compressing, or adding matter, and it can be extracted from a system by cooling, expanding, or extracting matter. In mechanics, for example, energy transfer equals the product of the forcible and no forcible forces.

As per the Second Law, heat energy cannot be transferred from a lower temperature body to a higher temperature body without the addition of energy. This is why running an air conditioner costs money.

The legacy of thermodynamics as a scientific discipline usually starts with Otto von Guericke, who in 1650 built and designed the world's first vacuum pump and demonstrated a vacuum using his Magdeburg hemispheres. Guericke was driven to create a vacuum in order to disprove Aristotle's long-held belief that "nature abhors a vacuum." Professor Joseph Black developed the fundamental concepts of heat capacity and latent heat, which were required for the development of thermodynamics, at the University of Glasgow, where James Watt worked as an instrument maker.