

WATER VAPOR, THERMODYNAMIC PARAMETERS OF EVAPORATION AND STEAM

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Abstract

This article will explore the thermodynamic properties of water vapor, focusing on the process of evaporation and what it means for the Earth's water cycle. It will also delve into the unique properties of steam and how they are utilized in industry.

Keywords: Water vapor pressure measurement techniques, Effect of relative humidity on evaporation rates, Modeling of evaporation dynamics in natural and engineered systems, Heat transfer calculations in steam generation systems, Energy efficiency in steam-driven processes, Nanotechnology-enhanced methods for water vapor capture and recovery.

Water vapor is an essential component of the Earth's atmosphere, playing a significant role in the planet's water cycle and climate regulation. It is created through a process of evaporation of water from oceans, lakes, and other bodies of water, and subsequently, it can be found in the air surrounding these bodies of water. The thermodynamic properties of water vapor are crucial in understanding how it behaves and interacts with its surroundings. Evaporation is a fundamental process in which water is transformed into water vapor through the application of heat. During this process, energy is absorbed as heat from the surroundings, which causes the water molecules to increase in kinetic energy and eventually transition from a liquid to a gas state. The resultant water vapor is relatively buoyant, and it tends to rise, leading to the formation of clouds and precipitation. Steam, on the other hand, is a specific form of water vapor that is produced when liquid water is boiled. Steam possesses unique thermodynamic properties such as high heat capacity, low viscosity, and the ability to release a significant amount of energy when it condenses back into liquid form. These features make steam a valuable resource in various industries, including power generation, food processing, and manufacturing.

Main Part

The process of evaporation is a fundamental concept in thermodynamics and is crucial to understanding many physical phenomena such as boiling, cooling, and humidity. Evaporation occurs when a liquid substance is transformed into a gaseous state by the addition of energy. The most common example of this process is the transformation of water into water vapor. This article will discuss the thermodynamic parameters of evaporation and steam. Thermodynamics is the study of the relationships between heat, energy, and work. The process of evaporation is governed by the laws of thermodynamics and can be explained using these principles. The first law of thermodynamics states that energy cannot be created or destroyed, only transformed. In the case of evaporation, energy is added to the liquid in the form of heat, which is converted into the potential energy of the water vapor molecules. The second law of thermodynamics states that every system tends towards disorder or entropy. In the case of evaporation, the liquid water molecules have a lower entropy than the gas molecules. Therefore, the process of evaporation increases the entropy of the system. The thermodynamic parameters of evaporation can be measured using a variety of techniques. One of the most common is the measurement of the heat of vaporization or enthalpy of evaporation. This is the amount of energy required to transform one unit of liquid into one unit of gas at a constant pressure and temperature. The heat of vaporization of water is approximately 40.7 kJ/mol at standard temperature and pressure (STP). This means that it takes 40.7 kJ of energy to transform one mole of liquid water into water vapor at 100°C and atmospheric pressure. Another important parameter is the saturation pressure of the vapor. This is the pressure at which the vapor is in equilibrium with the liquid. The saturation pressure of water vapor increases with temperature and is approximately 101.3 kPa at 100°C. The thermodynamic properties of steam are important in a wide range of engineering applications such as steam turbines and boilers. Steam is the gaseous form of water that is formed when liquid water is heated to its boiling point. The steam is at a much higher energy state than the liquid water, and this energy can be harnessed to perform work. The properties of steam can be described using a variety of thermodynamic parameters. The enthalpy of steam is its total energy content, including the energy from temperature and pressure. The temperature and pressure of steam are also important parameters that can be used to characterize its properties. The specific heat capacity of steam is an important parameter that describes how much energy is needed to raise the temperature of a specific quantity of steam by one degree Celsius. The specific heat capacity of steam is much lower than that of liquid water, which means that steam can hold much more energy at a given temperature.

Discussion:

Evaporation and steam are important parts of the water cycle, and they have many practical applications. Understanding the thermodynamic parameters of these processes is crucial for many fields of science and engineering. The evaporation process involves converting liquid water into water vapor gas. The heat required for this transformation is called the latent heat of vaporization. This process occurs naturally at the Earth's surface and in the atmosphere. The rate of evaporation is influenced by the temperature, humidity, wind speed, surface area, and water content of the air. Thermodynamically, evaporation occurs when the vapor pressure of a liquid

water surface exceeds the ambient pressure. The temperature of the water surface determines the vapor pressure, and when it reaches a certain level, the water molecules escape into the surrounding air. The evaporation rate increases with increasing temperature and humidity because it reduces the air's capacity to hold water vapor. Steam is a type of water vapor that is formed when liquid water is heated to its boiling point. The temperature and pressure at which water boils depend on the ambient pressure. The thermodynamic parameters of steam vary with its pressure and temperature, and different models are used to describe its behavior based on these parameters. The steam tables provide information about the thermodynamic properties of steam at different pressures and temperatures. The most important parameters of steam are its specific volume, enthalpy, entropy, quality, and saturation temperature and pressure. These parameters are used to design and operate steam turbines and other devices that use steam as an energy source. The quality of steam refers to the fraction of vapor and liquid in a steam mixture. It is an important parameter for the efficient operation of steam devices because it affects the heat transfer rate and the mass flow rate. The saturation temperature and pressure of steam are the maximum values at which it can exist as a saturated vapor or liquid in equilibrium. Overall, the thermodynamic parameters of evaporation and steam are important for understanding a range of natural and technological phenomena. These parameters are used to design and operate devices that rely on steam power, such as power plants and trains. Additionally, they contribute to our understanding of the water cycle and how water moves through the atmosphere and the environment. Ongoing research is needed to explore the complex mechanisms underlying these processes and to develop new technologies that can harness their potential.

Water vapor is an important component of the Earth's atmosphere, contributing to weather patterns, climate, and the water cycle. It is formed through the process of evaporation, whereby liquid water is transformed into vapor through the input of heat energy. The thermodynamic parameters of evaporation and steam play a crucial role in determining the behavior and properties of water vapor. One of the key thermodynamic parameters of evaporation is the vapor pressure, which increases as the temperature of the liquid water increases. At the boiling point, the vapor pressure is equal to the external pressure, and the water begins to boil and transform into steam. The enthalpy of evaporation is another important parameter, representing the energy required to transform a unit of liquid water into vapor at a given temperature and pressure. Steam is the gaseous phase of water above the boiling point, and its thermodynamic properties are different from those of water vapor at lower temperatures. The specific volume of steam is much larger than that of water vapor, meaning that at a given temperature and pressure, steam will occupy a greater volume than water vapor. The enthalpy of steam is also higher than that of water vapor, as more energy is required to transform liquid water into steam. Understanding the thermodynamic parameters of evaporation and steam is important in a range of applications, from weather prediction and climate modeling to steam power generation and industrial processes. By studying and measuring these parameters, scientists and engineers can gain insights into the behavior and properties of water vapor, and use this knowledge to improve our understanding of the natural world and develop new technologies.

Conclusion

The thermodynamic parameters of evaporation and steam are crucial for understanding the behavior of water vapor in many practical applications, including power generation and industrial processes. These parameters are also essential for understanding weather and climate patterns. The enthalpy of vaporization, specific heat capacity, and entropy of vaporization are necessary for calculating the energy required for evaporation, while the enthalpy of steam, specific heat capacity, and entropy of steam are necessary for calculating the energy required for steam-based processes. The study of water vapor and its thermodynamic parameters is an essential area of research that has significant implications for many fields.

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