Thermodynamics & Energy

This is the first of a three-part series on Thermodynamics and Energy

By Lee Langston, Ph.D.

Thermodynamics is the science and engineering of transformation of matter and energy. Life is matter and energy is the basis of all life, so thermodynamic laws and principles touch all of us. Given the importance of energy and energy usage in our daily life, thermodynamics should be taught in our schools.

The word thermodynamics, coming from the Greek words for “heat” and “power”, was coined by James Joule, British scientist and brewer, in 1858. Thermo, as it is more popularly known by engineering and science students, grew up at the start of the Industrial Revolution. Contributors to thermo include scientists Lord Kelvin (England) and Rudolf Clausius (Germany) and engineers Sadi Carnot (France), James Watt (England) and J. Willard Gibbs (life-time Connecticut resident).

There are two basic laws of thermodynamics: the First Law which deals with energy and the Second Law which deals with entropy. Let us deal first with energy in this chapter and the next, and save entropy for Chapter Three.

Energy has been defined as the capability to produce an effect. It is a fundamental concept, such as mass and force, and, as with such concepts, it is difficult to define. (For instance, try to define “sky”.) It is derived from Greek, meaning “force in action” which physicists and engineers call work (force times a distance). But energy has many forms, such as heat, which is energy transfer by virtue of a temperature difference. Other forms you have probably had in science courses include kinetic energy (a body with motion), elastic energy (a coiled spring), electrical energy (the flow of electrons) and chemical energy (reaction of air and gasoline to power a car).

Energy can be stored, transmitted and transformed, but it must always be conserved. This is the First Law of Thermodynamics and one of the most important in all of science and engineering. Energy can be neither created nor destroyed; it can only be changed in form. This is also known as the Conservation of Energy.

It is remarkable that we commonly speak of “energy production” or of “energy consumption”. Taken by themselves, these are incorrect statements, for energy is neither produced nor consumed. The amount of energy in the universe is constant (consequence of the First Law) and is just changed in form.

Almost all of our energy here on earth comes from nuclear fusion reactions in the sun. It exists on earth in many forms such as daily radiant energy or as radiant energy from the past - which is stored in existing plants and animal life or in fossil fuels such as coal, oil or natural gas.

In the next chapter we will look at how energy is measured. Using the First Law for everyday energy calculations is no more difficult than balancing a checkbook in a variety of different currencies.


NIE thanks Lee Langston, Professor Emeritus of Mechanical Engineering, University of Connecticut, and Member, Connecticut Academy of Science and Engineering.

Scientists & Engineers Suggest ENERGY Course

“Kids Need a Course in Energy” - That was the headline on a commentary piece by Lee S. Langston, published in the Hartford Courant on August 19, 2007. Dr. Langston commented on a recent report presented to the Connecticut General Assembly. The report recommending that thermodynamics (the science of energy and energy conversion) be a required subject in high schools.

The commentary stated, “Thermodynamics is the study of energy, and energy is the basis of all life. The public needs a basic understanding of energy to make informed choices in our democratic society. With energy-conversion schemes proliferating and energy costs rising, we need an energy policy that helps the public make comparisons on energy issues. Education is key.”

The report was prepared by the Connecticut Academy of Science and Engineering. The Academy identifies and studies issues and technological advances and provides unbiased, expert advice on science- and technology-related issues. The Academy is comprised of distinguished scientists and engineers from Connecticut... The Academy publishes the Bulletin of the Connecticut Academy of Science and Engineering, a quarterly publication... available at www.ctcase.org/cr.html.

ICY-ROAD SCIENCE

FROM THE CONNECTICUT SCIENCE CENTER

Salt is the most common material used to treat icy roads. Water normally freezes at 32°F forming ice. By adding salt to roads the freezing point is lowered preventing the formation of ice, or interacting with the thin layer of water on top of any existing ice to begin the melting process.

However, at temperatures between 0°F and 20°F, depending on the amount of salt in the mixture, it is relatively ineffective because at these temperatures, even saltwater freezes.