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Power Engineering 2017- Beyond classical heat transfer- L Q Wang - The University of Hong Kong

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Abstract

Unlike the past century that was blessed with ever-abundant cheap oil, this century energy has been rated as the single most important issue faced by humanity. Over 80% of all the energy we are using today is produced in or through the form of heat. Engineering heat-transfer process and medium with super thermal performance is thus vital for addressing the terawatt challenge faced by us. Driving force for heat transfer can be direct or indirect. The former is temperature gradient with conduction, convection and radiation as its three fundamental ways of heat transport. The latter comes from cross-coupling among different transport processes in the medium and transports heat in thermal waves which can be in various forms and tunable via manipulating the cross coupling. The first part of this talk is on developing a universal relation between heat flux and temperature gradient in temperature-gradient-driven heat transfer by finding both the necessary and sufficient conditions in a systematic, rigorous way for a heat transfer process to satisfy fundamental laws like the second Law of Thermodynamics. This leads to a generalized Fourier law that provides effective means for engineering temperature-gradient-driven heattransfer processes with super thermal performance. It is normal that two or more transport processes occur simultaneously in heat-transfer media. Examples include mass, heat, chemical, electrical and magnetic transports. These processes may couple (interfere) and cause new induced effects of flows occurring without or against its primary thermodynamic driving force, which may be a gradient of temperature, or chemical potential, or reaction affinity. Two classical examples of coupled transports are the Soret effect (also known as thermodiffusion) in which directed motion of a particle or macromolecule is driven by flow of heat down a thermal gradient and the Dufour effect that is an induced heat flow caused by the concentration gradient. While the coupled transport is well recognized to be very important in thermodynamics, it has not been well appreciated yet in the society regarding its potential of generating and manipulating thermal waves and resonance.

Vitality is preserved by the primary law of thermodynamics; its quality corrupts continually because of entropy age, constantly law of thermodynamics. It is accordingly imperative to analyze the entropy age in regards to the best approach to diminish its greatness and the constraint of entropy age as time keeps an eye on unendingness with respect to whether it is limited or not. This work starts such an investigation with one-dimensional warmth conduction. The work not just offers some crucial bits of knowledge of universe and its future, yet in addition develops the connection between the second law of thermodynamics and numerical disparities by means of building up the last of either new or old style nature. A succinct survey of entropy is additionally included for the enthusiasm of playing out the examination in this work and the comparative investigation for different procedures later on.

It is notable that old style hypothesis of warmth conduction depends on the Fourier law of warmth conduction and the principal law of thermodynamics, with a point of anticipating and controlling the rate at which warmth is led. The previous is the constitutive connection of warmth motion that corresponds the temperature angle (the main impetus and the reason for heat-conduction process) and the warmth move rate (the result and the impact of warmth conduction process). The last is the protection connection of vitality, one of the most essential laws of nature expressing that vitality can't be made or devastated. The old style and general methodology of contemplating heat-conduction forms comprises essentially of two stages: (I) getting temperature fields by either from heat-conduction conditions or from trial estimations, and (ii) acquiring heat move rate and the best approach to control it by means of the Fourier law of warmth conduction. The traditional warmth conduction condition originates from the use of the principal law of thermodynamics to warm conduction with the Fourier law of warmth conduction as the constitutive connection of the warmth transition rate The outcomes from such an old style investigation of warmth conduction contain for the most part the temperature field, the warmth move rate, and the best approach to controlling them.

Vitality is rationed by the main law of thermodynamics, entropy speaks to the piece of framework vitality that can't be changed into valuable work with the goal that any entropy age will debase the nature of vitality. It is accordingly imperative to look at dSgen/dt in regards to the best approach to decrease its greatness and limt→∞Sgen with respect to whether it is limited or not. From the perspective of thermodynamics, the activity of person is to make Sgen very much controlled, the eventual fate of individual will be certain if Sgen is limited for all procedures. We endeavor to address these significant inquiries with heat conduction process, a commonplace case of irreversible procedures. This contrasts in a general sense from different investigations of the second law examination that mostly target improving/redesigning/streamlining execution of commonsense procedures.

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