

# THE NEW HEAT TRANSFER

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## CHAPTER 1 The "old" Newtonian heat transfer— $h = q/\Delta T$

**Summary** It is generally agreed that Newton conceived of the heat transfer coefficient— $h = q/\Delta T$ —and that it was first described in his article "A Scale of the Degree of Heat" published in 1701. This concept of the heat transfer coefficient has been and is the foundation of all forms of heat transfer which depend on fluid transport—free convection, forced convection, boiling, condensation. Unfortunately, Newton's concept is oftentimes an ineffective tool for the design or analysis of heat transfer equipment because it confounds the primary variables  $q$  (heat flux) and  $\Delta T$  (thermal driving force) in  $h$  (heat transfer coefficient). Thus the entire field of heat transfer with fluid transport is based on a concept which dictates against separation of the primary variables—and instead requires the researcher, the analyst, and the designer to think, correlate, and analyze with the primary variables confounded! (Confounded variables are the opposite of separated variables. For example, the variables are confounded in the equation  $(y/x) = 3 + 2/x$  and separated in the equivalent and preferable form  $y = 3x + 2$ . It should also be noted that one of the first steps in the solution of equations is the separation of variables because this vastly simplifies the solution of the equations. Only when the variables are not separable is a solution normally attempted with the variables confounded.) The difficulty with Newton's concept may be better appreciated by noting that

Hooke's Law	(1687)	$E = \sigma/\epsilon$
Newton's Law	(1701)	$h = q/\Delta T,$
and Ohm's Law	(1827)	$R = V/I$

are very similar concepts and deal effectively only with highly linear phenomena. For this reason, Hooke's Law is not used in regions where there is plastic deformation of the material—and Ohm's Law is not used for nonlinear resistors. In other words,  $E$  is not used when  $E = f(\epsilon) \neq \text{constant}$  and  $R$  is not used when  $R = f(I) \neq \text{constant}$ . Of these three laws or concepts, only Newton's has been applied to nonlinear phenomena — ie we retain  $h$  even when  $h = f(\Delta T) \neq \text{constant}$ . The retention of Newton's concept for the analysis of nonlinear heat transfer phenomena such as free convection, boiling, and condensation adds a great deal of unnecessary complexity to the science of heat transfer. This artificial complexity can be removed only by discarding the concept of the heat transfer coefficient.

The New Heat Transfer presents an alternative to Newton's concept — a new concept formulated in such a way that it results in the separation of variables and thus provides a generally effective tool for the design and analysis of heat transfer equipment. The new heat transfer rejects the heat transfer coefficient for all nonlinear heat transfer phenomena. In the new heat transfer, there is no free convection  $h$ , no boiling  $h$ , no condensing  $h$ , no free convection Nusselt number, no boiling Nusselt number, etc. For these nonlinear phenomena, the new heat transfer science from research through design through analysis contains no heat transfer coefficient or Nusselt number. While this may seem a formidable task, it will be seen that the new heat transfer is easily and logically constructed without heat transfer coefficients—and that the design and analysis of heat transfer

equipment is accomplished more easily and more accurately with the new heat transfer than with the old heat transfer coefficients.

The New Heat Transfer will be presented in a series of short summaries of which this is the first. Each summary will describe the contents of a chapter in The New Heat Transfer. After publication of the summary, the complete chapter can be obtained from

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