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 Degrees 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 ΔT (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	(1678)	$E = \sigma/\epsilon$
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 $E = f(\epsilon) \neq$ constant and R is not used when $R = f(I) \neq$ constant. Of these three laws or concepts, only Newton's has been applied to nonlinear phenomena —ie we retain h even when $h = f(\Delta T) \neq$ 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.