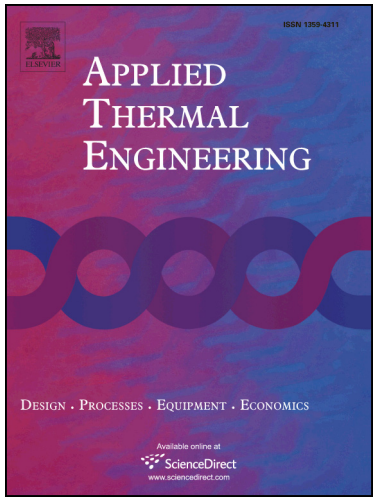

Research Paper

Transient Convection Heat Transfer for Helium Gas at Various Flow Decay Times

Qiusheng Liu, Li Wang, Katsuya Fukuda

PII: S1359-4311(16)32839-3
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.12.097
Reference: ATE 9717

To appear in: *Applied Thermal Engineering*

Received Date: 28 October 2016
Accepted Date: 21 December 2016

Please cite this article as: Q. Liu, L. Wang, K. Fukuda, Transient Convection Heat Transfer for Helium Gas at Various Flow Decay Times, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.12.097

Transient Convection Heat Transfer for Helium Gas at Various Flow Decay Times

Qiusheng LIU*, Li WANG, and Katsuya FUKUDA

Kobe University
5-1-1, Fukae-minami, Higashinada-ku, Kobe, 658-0022, Japan
*****qsliu@maritime.kobe-u.ac.jp

ABSTRACT

Transient convection heat transfer was experimentally studied for a horizontal cylinder in helium gas under flow decay conditions. The experiment was conducted by using helium gas as the coolant, and a platinum cylinder as the test heater. A uniform heat generation rate was applied to the cylinder. The cylinder temperature was maintained at a design value under a specific initial flow rate and heat generation rate. Then, the flow rate of the helium gas started to decrease according to the designed linear functions, with different flow decay times. The surface temperature of the cylinder and the heat flux were measured during the flow decay transient process for various flow decay times, initial flow velocities, and heat generation rates. It was found that the temperature of the cylinder increased rapidly for a shorter flow decay time during the flow decay process. The increment of the surface temperature difference was higher for a higher heat generation rate. The transient heat transfer coefficient was also obtained during the flow decay process. It was clarified that the heat transfer coefficient decreased to a constant value for each flow decay time for a definite heat generation rate and a definite initial flow velocity, and the decrease rate was higher for a shorter flow decay time.

Keywords
Convection heat transfer, Transient, Helium, Decreasing flow rate, Flow decay time, Horizontal cylinder, VHTR

Nomenclature

c_h : Specific heat of test heater [J/(kg·K)]
D : Diameter of the test heater (cylinder) [m]
h : Heat transfer coefficient [W/(m^2·K)]
$\dot{m}$: Flow rate [L/min]
$\dot{Q}$: Heat generation rate per unit volume [W/m^3]
q : Heat flux [W/m^2]
r : Radial distance in the cylindrical coordinate system [m]
R : Radius of the test heater (cylinder) [m]
T : Temperature [K]
T_a : Average temperature of the test heater [K]
T_b : Bulk temperature [K]
T_s : Average surface temperature [K]
ΔT: Surface temperature difference, $\Delta T = T_s - T_b$ [K]
t : Time [s]
t_{decay} : Flow decay time [s]
U : Velocity [m/s]
α : Thermal diffusivity [m^2/s]
λ : Thermal conductivity [W/(m·K)]
ρ_h : Density of test heater [kg/m^3]