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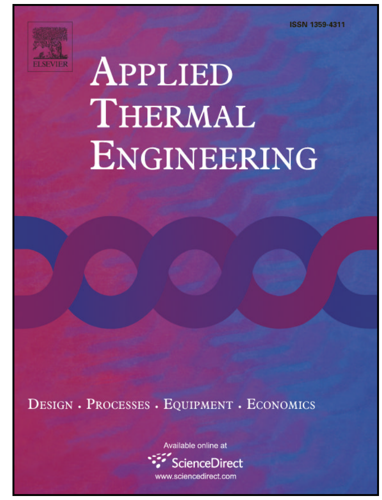

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Amirhosein Hadipour, Mehran Rajabi Zargarabadi

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Heat transfer and flow characteristics of impinging jet on a concave surface at small nozzle to surface distances

Amirhosein Hadipour, Mehran Rajabi Zargarabadi*
Department of Mechanical Engineering, Semnan University, P.O.B. 35131-191, Semnan, Iran

ABSTRACT

Experimental and numerical investigations were carried out to analyze the flow and heat transfer characteristics of an impinging jet on a concave surface at small jet-to-surface distances. Constant heat flux of 2000 W/m^2 is applied on the concave surface using a silicon rubber heater mat. In the steady-state condition, the temperature distribution of the concave surface is measured with an infrared camera. In the experimental study, a jet with 24 mm diameter and cylindrical surface with the curvature radius of 12 cm (C_r=0.1) has been considered. The study of flow and heat transfer characteristics have been performed for different jet Reynolds numbers (10000-35000) and various nozzle diameters (18-30 mm). The distributions of velocity and Nusselt number for small jet-to-surface distances (H/D<1.0) have been compared with large jet-to-surface distances (H/D≥1.0). Comparisons between numerical results and experimental data confirm that the numerical predictions performed by SST k-ω model fairly predict the velocity and Nusselt number distributions. Experimental and numerical results confirm that the jets with small nozzle-to-surface distances (H/D=0.1, 0.2 and 0.4) provide a much more Nusselt number distributions in comparison with the surfaces with the large nozzle-to-surface distances (H/D=1.0, 2.0 and 4.0). The correlated equations of the averaged Nusselt number reveal that the $\overline{Nu}$ is related to $(H/D)^{-0.54}$ and $(H/D)^{-0.14}$ for small (H/D<1.0) and large (H/D>1.0) jet-to-surface distances respectively.

KEYWORDS

Impinging jet, Small distance, Heat transfer, Concave surface, Nusselt number

Nomenclature

C_p	specific heat (N.m kg^{-1} K^{-1})	s	circumferential direction
C_r	D/2R, relative curvature	T	temperature (K)
D	nozzle diameter (mm)	u	velocity (m s^{-1})
H	nozzle-to-surface spacing (mm)	x_i	coordinates (x, y, s)
k	turbulence kinetic energy (m^2 s^{-2})	y^+	dimensionless distance
Nu	local Nusselt number	**Greek symbols**	
P	static pressure (Pa)	ε	turbulent dissipation rate, m^2/s^3
q"	heat flux (W/m2)	k	turbulent kinetic energy, m^2/s^2
Re	Reynolds number	μ	dynamic viscosity (N s/m^2)
R	Curvature radius	ρ	density (kg/m^3)

* Corresponding author.
E-mail address: rajabi@semnan.ac.ir (M. Rajabi Zargarabadi)