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On the Effect of Non-Uniform Heating in 3D Channel Flows

S. Panday[1*] & J.M. Floryan[2]
[1,2]Department of Mechanical and Materials Engineering,
Western University, London, Ontario, N6A 5B9, Canada.
*e-mail spanday2@uwo.ca

ABSTRACT

The effect of differential heating in fully developed pressure-gradient driven flows was investigated. The fluid was assumed to be incompressible and variation of density was only considered in the buoyancy term. A sinusoidal heating pattern was applied at the lower wall while the upper wall was kept isothermal. The heating was constant along the flow direction. A very accurate spectral algorithm was used to analyze heating effect on the pressure losses. The algorithm relied on Fourier expansion in the horizontal directions and Chebyshev expansions in the vertical direction. Unlike non-uniform heating along the flow, reduction in pressure losses was not obtained. Results suggested that the net drag increases proportionally to $(Re)^1$ and the effect of temperature variation disappears for short wavelength heating. Analysis also showed that variation of the pressure losses as a function of the heating wavenumber depends on the heating intensity, measured in terms of Rayleigh number. This study was restricted up to the value of Rayleigh number 3000 to avoid secondary flows.