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Enhancement and reduction of Nusselt numbers in unsteady laminar parallel flows by macroscopic flow control Y. JIANG, G.J. BRERETON, Dept. of Mech. Eng., Michigan State University — In fully developed laminar pipe and channel flows that undergo transients from a known initial state, exact analytical solutions for the momentary velocity field as a functional of the flow rate can be determined from the Navier-Stokes equations, for arbitrary flow unsteadiness [*Phys. Fluids* **12, 3**, 518, (2000)]. When these flows experience heat transfer at their walls, the companion thermal energy equation can be linearized and may also be solved analytically when flow transients are large. Under this restriction, solutions can be found for the instantaneous temperature field, for arbitrary time unsteadiness in both the flow and the wall heat flux. Expressions for Nusselt numbers in convective heat transfer in duct flows with arbitrary temporal flow and heat flux unsteadiness can then be found, which illustrate how the flow and heat flux transient histories determine whether the unsteadiness enhances or reduces the overall heat-transfer effectiveness. These expressions are used to show how significant enhancements or reductions in the average Nusselt number can be achieved in duct flow by applying appropriate temporal bulk-flow control.

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