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On determination of the basic characteristics of free convective heat exchange near a flat vertical surface

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Abstract

The results of mathematical modeling of free convective heat exchange near a semiinfinite, impermeable, flat vertical surface have been presented. The features of velocity and temperature fields as functions of the boundary conditions and the Prandtl number have been studied. Tables of numerical solutions have been given. The esults obtained have been compared to the numerical data of other authors.

References

1. O. G. Martynenko, Heat and mass transfer bibliography — CIS works, *Int. J. Heat Mass Transfer*, 41,No. 11, 1371–1384 (1998).

   MATH Article Google Scholar

2. S. Ostrach, An analysis of laminar free-convection flow and heat transfer about a plate parallel to the direction of the generating body force, *NACA Rep.*, No. 1111, 1–17 (1953).

   Google Scholar

3. J. L. Gregg and E. M. Sparrow, Low Prandtl-number free convection, *ZAMP*, 9,No. 4, 383–387 (1958).

   Article Google Scholar

4. A. A. Szewczyk, Combined forced and free convection laminar flow, *Trans. ASME. J. Heat Transfer*, 86,No. 4, 501–507 (1964).

Google Scholar

5. R. Vanier and C. Tien, Further work on free convection in water at 4°C, *Chem. Eng. Sci.*, 22,No. 12, 1747–1751 (1967).

Article Google Scholar

6. M. M. Hasan and R. Eichorn, Local nonsimilarity solution of free convection flow and heat transfer from an inclined isothermal plate, *Trans. ASME. J. Heat Transfer*, 101,No. 4, 642–647 (1979).

Google Scholar

7. V. P. Carey and J. C. Mollendorf, Variable viscosity effects in several natural convection flows, *Int. J. Heat Mass Transfer*, 23,No. 1, 95–109 (1980).

MATH Article Google Scholar

8. Y. Joshy and B. Gebhart, Effect of pressure stress work and viscous dissipation in some natural convection flow, *Int. J. Heat Mass Transfer*, 24,No. 10, 1577–1588 (1981).

Article Google Scholar

9. T. Cebeci and P. Bradshaw, *Physical and Computational Aspects of Convective Heat Transfer*, New York (1984).
10. B. Gebhart, Y. Jaluria, R. L. Mahajan, and B. Sammakia, *Buoyancy-Induced Flows and Transport*, Washington (1988).
11. D. A. S. Rees, The effect of steady streamwise surface temperature variations on vertical free convection, *Int. J. Heat Mass Transfer*, 42,No. 13, 2455–2464 (1999).

MATH Article Google Scholar

12. T. Fujii and H. Uehara, Laminar natural-convective heat transfer from the outer surface of a vertical cylinder, *Int. J. Heat Mass Transfer*, 13,No. 3, 607–615 (1970).

Article Google Scholar

13. E. M. Sparrow and J. L. Gregg, Laminar free convection from a vertical plate with uniform surface heat flux, *Trans. ASME. J. Heat Transfer*, 78,No. 2, 435–440 (1956).

Google Scholar

14. H. K. Kuiken, Axisymmetric free convection boundary-layer flow past slender bodies, *Int. J. Heat Mass Transfer*, 11,No. 7, 1141–1153 (1968).

MATH Article MathSciNet Google Scholar

15. G. Wilks, The flow of uniform stream over a semi-infinite vertical flat plate with uniform surface heat flux, *Int. J. Heat Mass Transfer*, 17,No. 7, 743–753 (1974).

MATH Article Google Scholar

16. R. L. Mahajan and B. Gebhart, High order approximations to the natural convection flow over a uniform flux vertical surface, *Int. J. Heat Mass Transfer*, 21,No. 5, 549–556 (1978).

MATH Article Google Scholar

17. V. P. Carey and B. Gebhart, Transport at large downstream distances in mixed convection flow adjacent to a vertical uniform-heat-flux surface, *Int. J. Heat Mass Transfer*, 25,No. 2, 255–266 (1982).

MATH Article Google Scholar

18. B. Gebhart, Effects of viscous dissipation in natural convection, *J. Fluid Mech.*, 14,No. 2, 225–232 (1962).

MATH Article MathSciNet Google Scholar

19. T. Fujii and M. Fujii, The dependence of local Nusselt number on Prandtl number in the case of free convection along a vertical surface with uniform heat flux, *Int. J. Heat Mass Transfer*, 19,No. 1, 121–122 (1976).

Article Google Scholar

20. Yu. A. Sokovishin and T. A. Pervitskaya, Free convective heat transfer on a vertical surface with a prescribed heat flux, in: *Coll. Papers of the Central Boiler and Turbine Institute* [in Russian], No. 112, 69–80 (1977).
21. S. L. Lee, T. S. Chen, and B. F. Armaly, Mixed convection along vertical cylinders and needles with uniform surface heat flux, *Trans. ASME. J. Heat Transfer*, 110,No. 2, 150–155 (1988).

Article Google Scholar

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- **Heat Flux**
- **Nusselt Number**
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- **Heat Mass Transfer**
- **Free Convection**