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An analytical wall function for turbulent wall condensation in the presence of noncondensable gas with buoyancy, suction and interdiffusion convection

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The use of CFD for simulations of turbulent flow in industrial applications often requires using wall functions in order to reduce the computational cost. When wall condensation occurs, it creates density variations in the boundary layer that can lead to significant buoyancy effect. The aim of this work is to propose wall functions for velocity, temperature and steam mass fraction that can be applied for all convection regimes. The new model is an extension of the analytical wall function developed by Craft & al. [1]. This method also allows to account for the influence of suction and interdiffusion convection within wall functions. The suction effect describes the mass transfer normal to the wall induced by the steam condensation. Both suction and interdiffusion could have significant effect when high heat and mass transfer is considered.

In forced convection regime, the new wall functions have shown good agreement with the standard wall functions based on the Prandtl mixing length. For mixed and natural convection, the influence of buoyancy, suction and interdiffusion convection can be observed. The comparison between results from simulations and experimental data show that the implemented wall functions give a better estimation of the condensation heat flux than the standard wall functions, especially for mixed and natural convection.

References

- [1] T. J. Craft, A. V. Gerasimov, H. Iacovides, B. E. Launder, *Progress in the generalization of wall-function treatments*, International Journal of Heat and Fluid Flow, 23(2), 148-160, (2002).

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