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MAE 494: Applied CFD

Professor HP Huang

Homework 1 Report

1. Contour plots of velocity and temperature in the plane of symmetry, as well as a contour plot of temperature over the circular opening of the outlet.

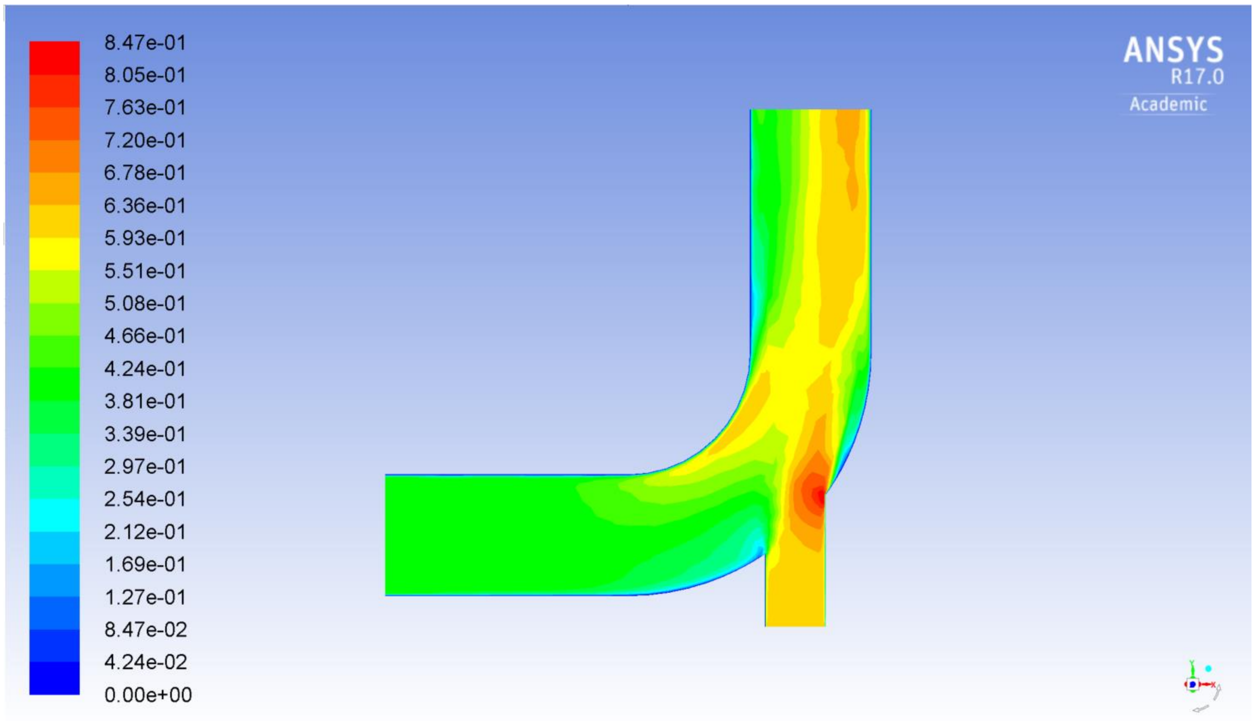


Figure 1: Velocity on plane of symmetry for the R=1in. inlet pipe, R=2in large inlet, and an inlet velocity for the small inlet of 0.6m/s.

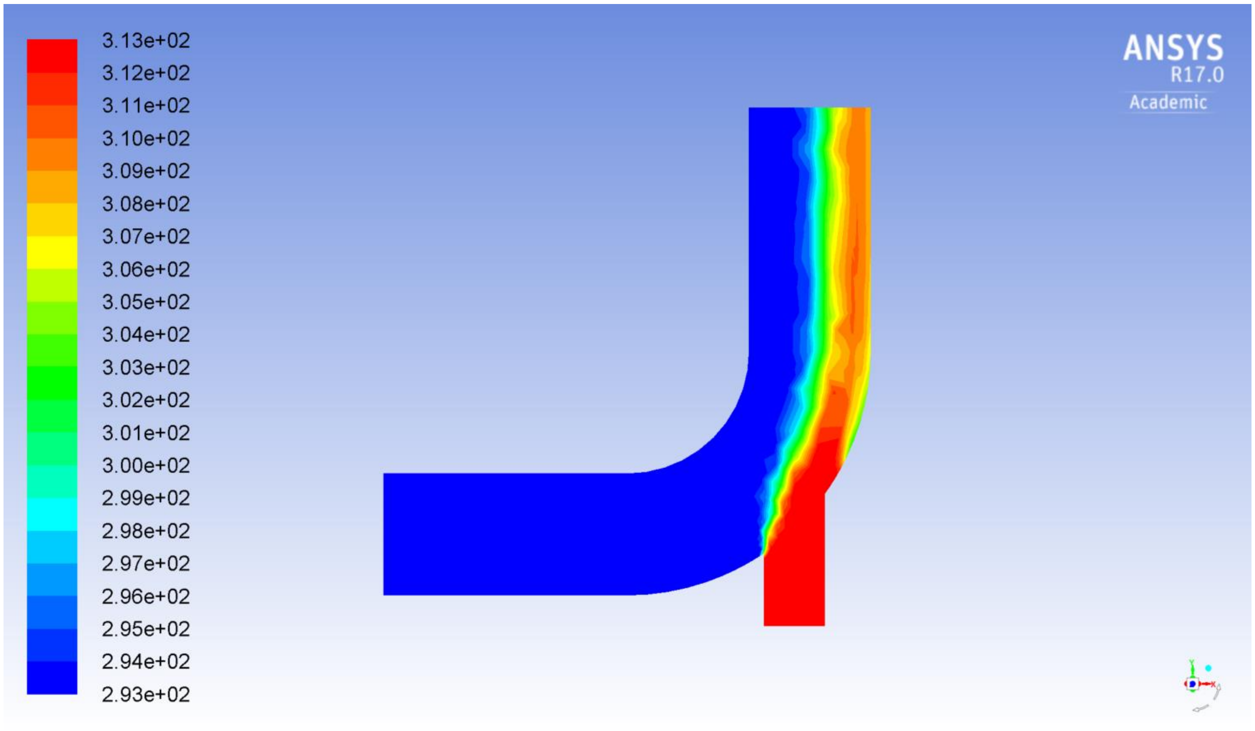


Figure 2: Temperature distribution on the plane of symmetry.

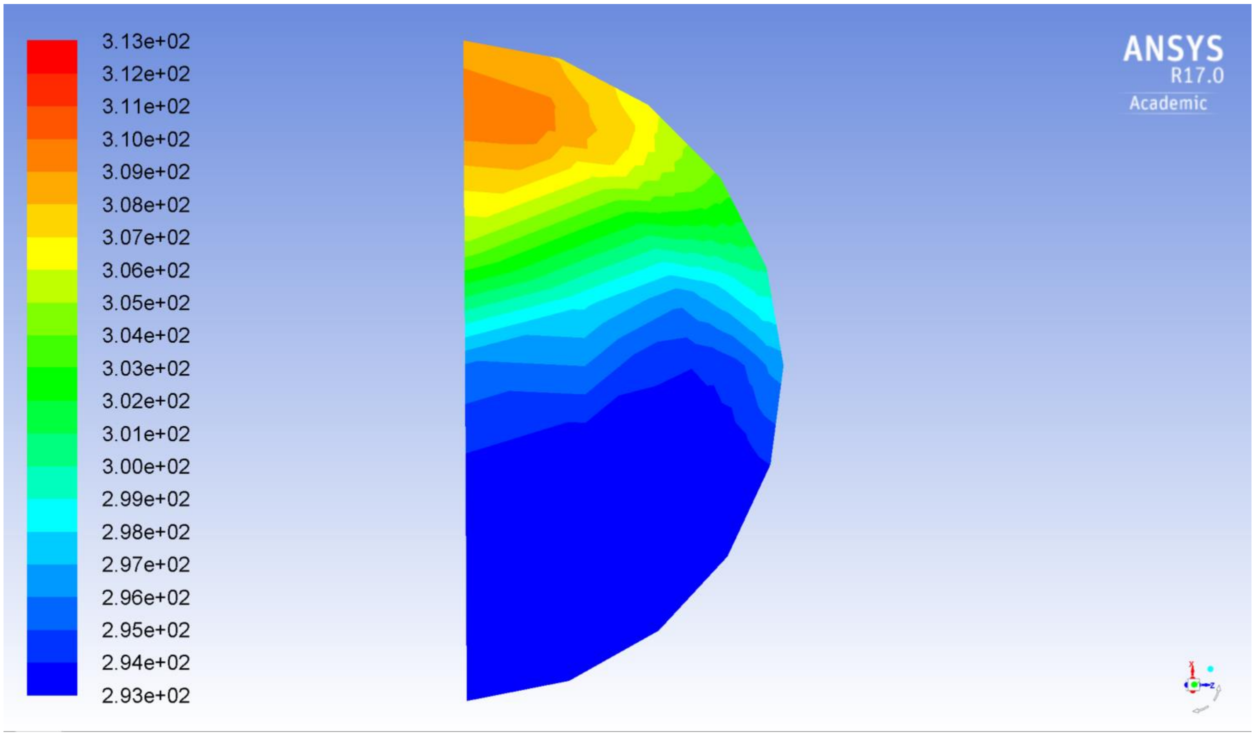


Figure 3: Temperature profile for the outlet.

2. Line plots of temperature and velocity along the line AB, with comparisons of profiles with their counterparts from the standard case in Task 0 (R=0.5in and V_inlet = 1.2m/s).

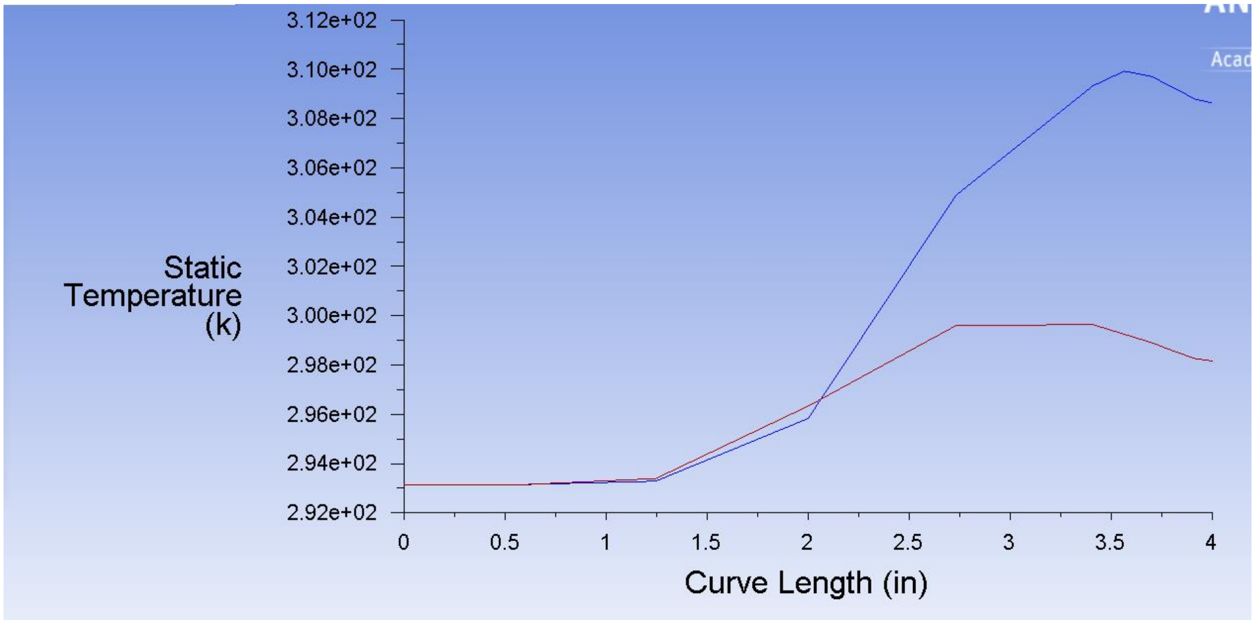


Figure 4: Static temperature across the line AB. The Small inlet diameter is depicted in red, while the Large inlet diameter is depicted in blue.

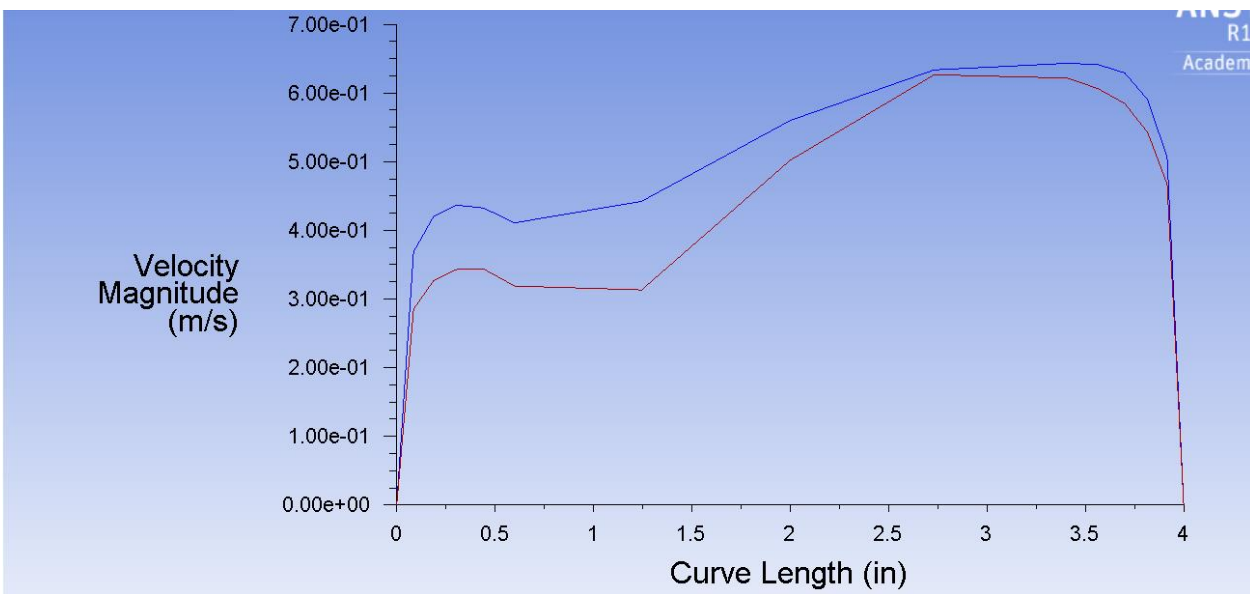


Figure 5: Velocity magnitude across the line AB. The Small inlet diameter is depicted in red, while the Large inlet diameter is depicted in blue.

3. Check the energy balance and mass balance of the system. Calculate the three values of H and three values of M to show the requirements of energy and mass balance are satisfied.

In order to perform the surface integrals, custom field functions were defined for heat flux and mass flux; one for the large inlet and one for the two outlets (both have velocity vectors in the y direction). The general solution steps are as follows, with figures to visually show the windows and equations:

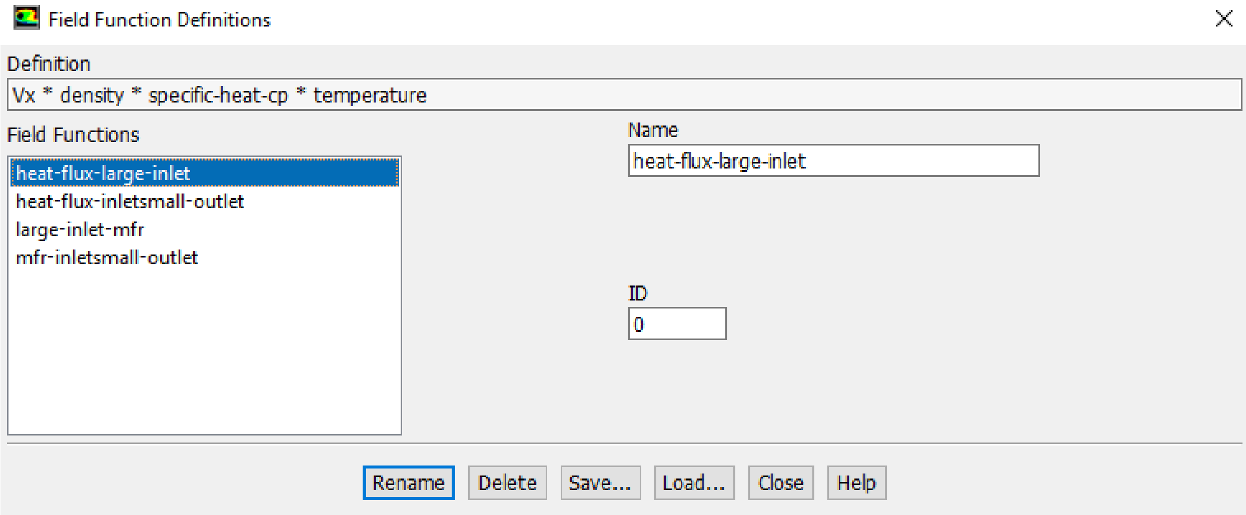


Figure 6: Custom Field Function for calculating surface integrals for heat flux (large inlet depicted)

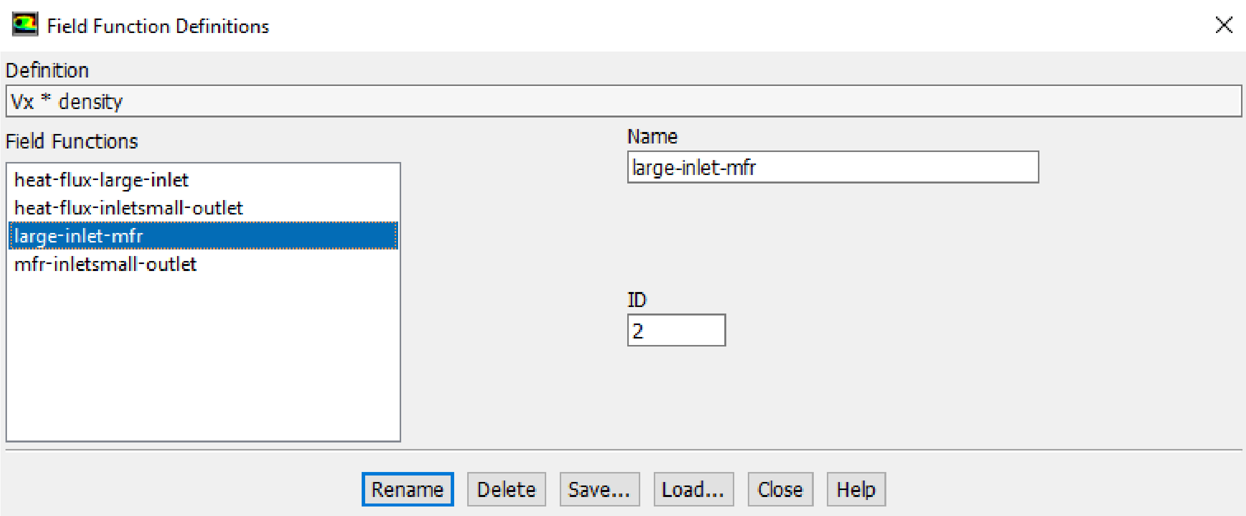


Figure 7: Custom Field Function for calculating surface integrals for mass flux (large inlet depicted)

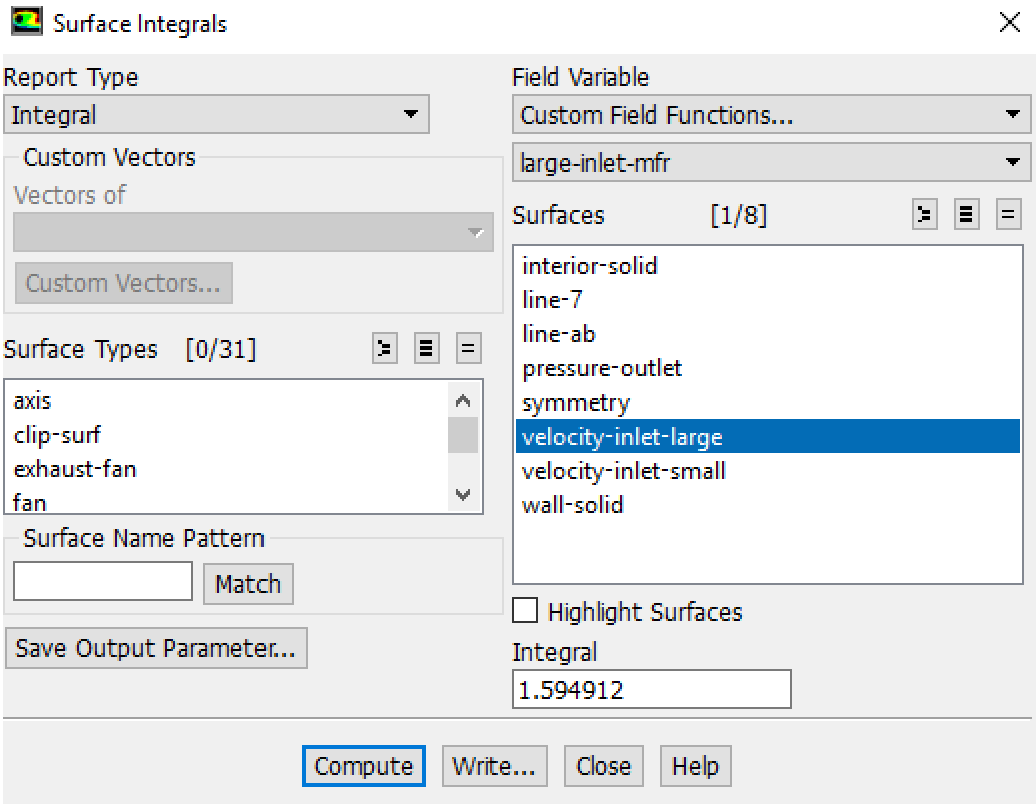


Figure 8: Using Surface Integrals to compute large inlet mass flux

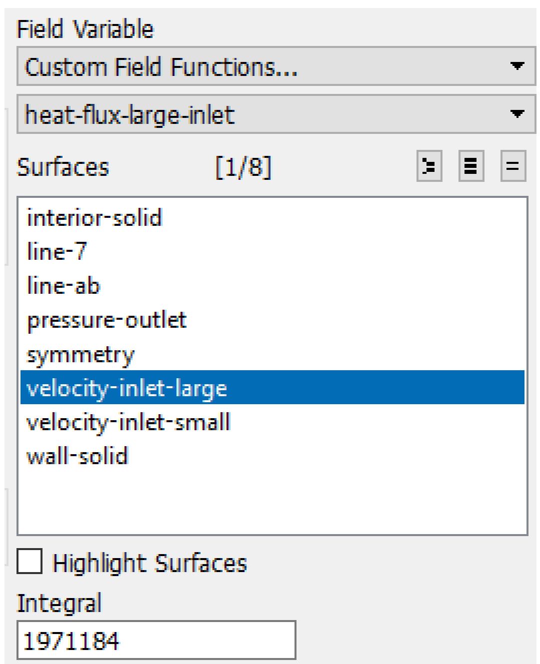


Figure 9: Surface Integral for large inlet heat flux

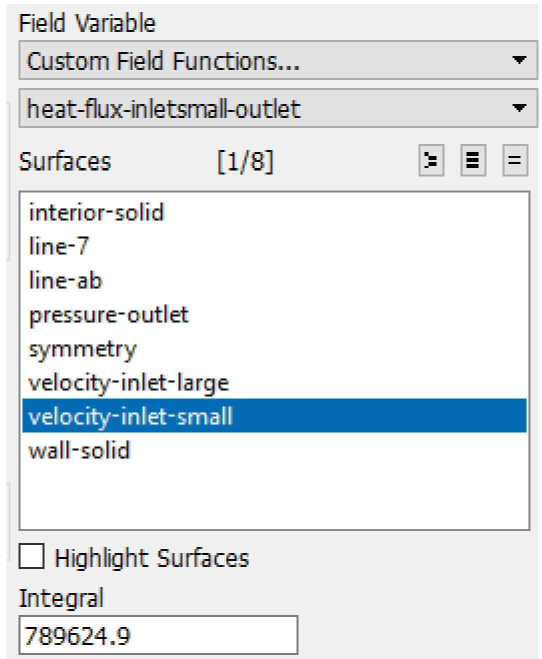


Figure 10: Surface Integral for small inlet heat flux

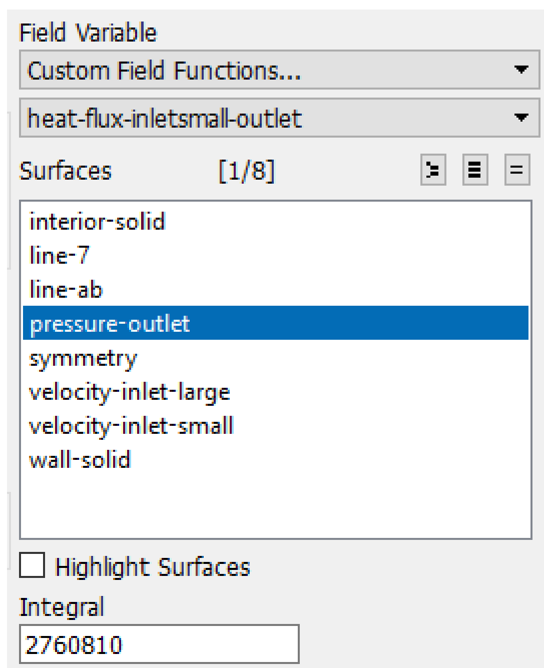


Figure 11: Surface Integral for outlet heat flux

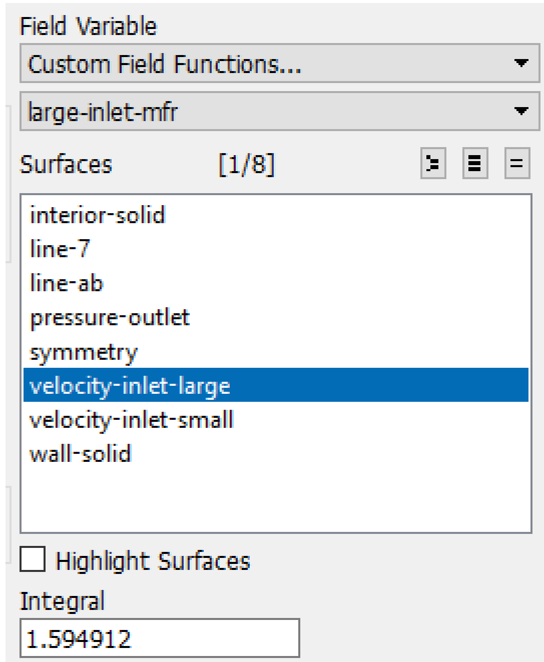


Figure 12: Surface Integral for large inlet mass flux

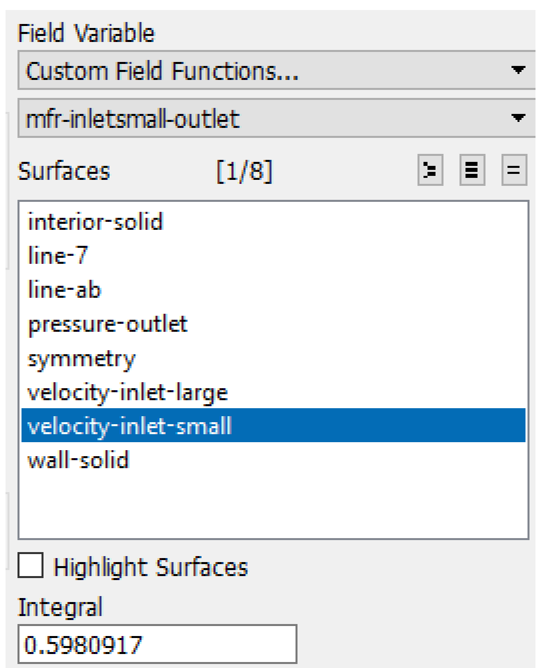


Figure 13: Surface Integral for small inlet mass flux

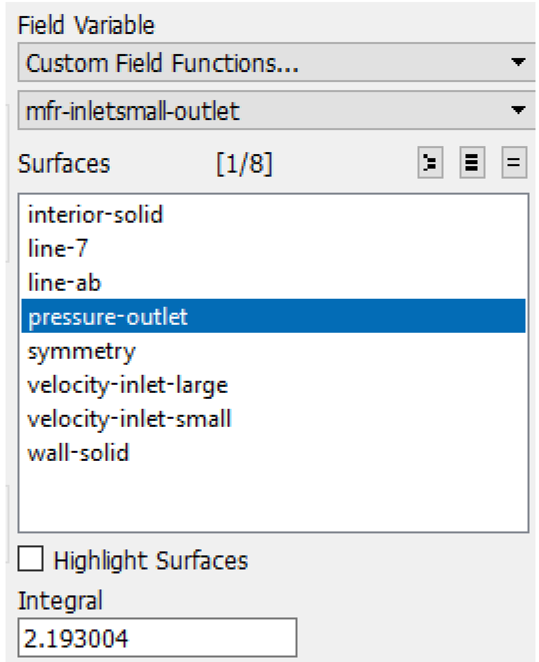


Figure 14: Surface Integral for pressure outlet mass flux

$$M = 1.594912 + 0.5980917 - 2.193004 = -0.0000003\ kg/s$$

$$H = 1971184 + 789624.9 - 2760810 = -1.1W \text{ (w/ constants)}$$

Mass was conserved within 0.00003% which is a very good approximation from the software. The difference in Heat with the constants of Cp and density included results in a difference of 1.1W, which is nearly negligible considering the order of magnitude of the fluxes (~ e+06).