

Boundary Conditions

(January 7, 2005)

Inlet

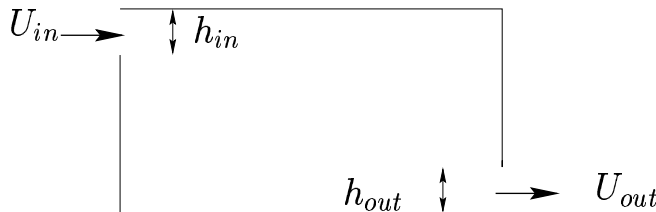
The velocity component normal to the inlet (e.g. U if inlet is a west boundary) is usually, as well other scalar variables such as temperature and concentration. Turbulent quantities, such as k and ε are normally not known, but they must be estimated. Usually k is set to $(\gamma U)^2$, where $0.01 \lesssim \gamma \lesssim 0.1$. The dissipation is set from

$$\varepsilon_{in} = c \frac{k_{in}^{3/2}}{L},$$

where $c = 0.54$, and $L = 0.1h$, where h denotes height of inlet. Note that the expressions for k and ε only are guide lines.

I: Exit velocity

For *small* outlets the exit velocity can be determined from global continuity. As the inlet is small a constant velocity over the whole outlet can be used.

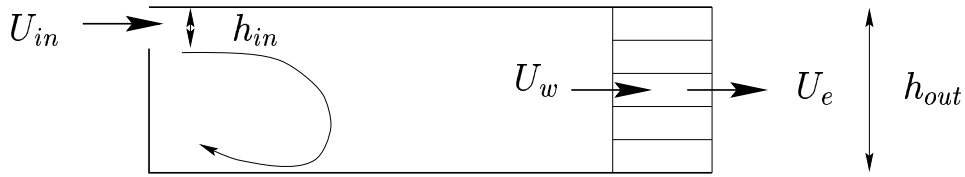


The exit velocity is set as (see figure above)

$$U_{in}h_{in} = U_{out}h_{out} \Rightarrow U_{out} = U_{in}h_{in}/h_{out}$$

For *large* outlets the exit velocity must be allowed to

vary over the outlet. The proper boundary condition in this case is $\partial U / \partial x = 0$. Hence it is important that the flow near the exit is fully developed, so that this boundary condition corresponds to the flow conditions. The best way to ensure this is to locate the exit boundary sufficiently far downstream. If we have a recirculation region in the domain (see the figure below), the exit should be located sufficiently far downstream of this region so that $\partial U / \partial x \simeq 0$.



The exit boundary condition is implemented as follows.

1. Set $U_e = U_w$ for all nodes (i.e. for $j = 2$ to 6, see the figure above);
2. In order to speed up convergence, enforce global continuity.
 - * Inlet mass flow: $\dot{m}_{in} = \rho \sum_{inlet} U_{in} \Delta y$
 - * Outlet mass flow: $\dot{m}_{out} = \rho \sum_{outlet} U_{out} \Delta y$
 - * Compute correction velocity: $U_{corr} = (\dot{m}_{in} - \dot{m}_{out}) / (\rho A_{out})$, where $A_{out} = \sum_{outlet} \Delta y$.
 - * Correct U_e so that global continuity (i.e. $\dot{m}_{in} = \dot{m}_{out}$) is satisfied: $U_e^{new} = U_e + U_{corr}$

II: Remaining variables

Set $\partial \Phi / \partial x = 0$, and implement it through $\Phi_{ni} = \Phi_{ni-1}$ each iteration.