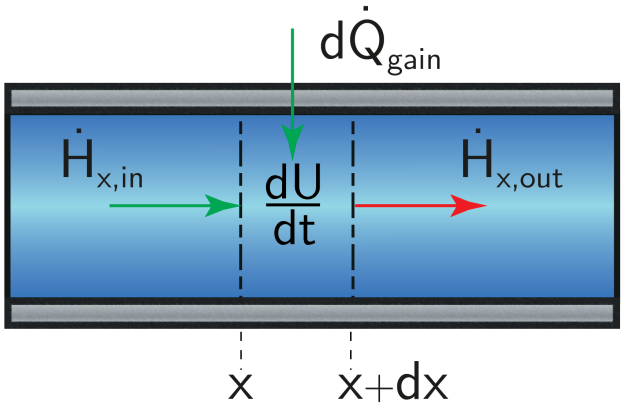
Boundary Conditions - Conv. - IE 2

A fluid flows through a long cylindrical tube. A constant heat flux density $\dot{q}''$ is imposed on the fluid. Initially, before heating, the pipe is at a uniform temperature T_1. During the process, the fluid always enters the pipe at a temperature of T_1.

Give the correct conditions to solve the given differential equation for deriving the temperature profile in the flow direction.



Given the differential equation:

$$\frac{\rho c \pi D^2}{4}\frac{\partial T}{\partial t} = -\frac{u \rho c \pi D^2}{4}\frac{\partial T}{\partial x} + \dot{q}'' \pi D$$

In order to solve the differential equation, one boundary condition and one initial condition are required. This can be seen from the fact that the variable T has been differentiated once with respect to x and once with respect to t.

Boundary and initial conditions:

$$T(x = 0) \;=\; T_1$$

The boundary condition above describes that the temperature of the fluid equals T_1 at the entrance of the pipe, as can be seen from the figure.

$$T(t = 0) \;=\; T_1$$

The initial condition above describes that the temperature of the fluid is uniform for the entire domain T_1 at $t = 0$.