Hydraulic Diameter

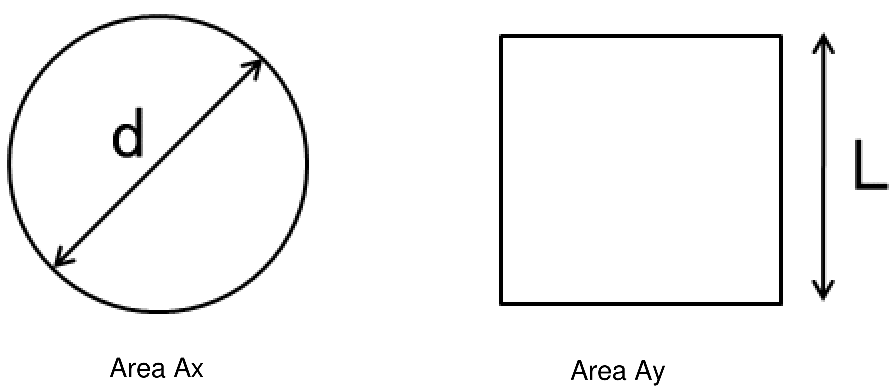
Problem/Description:

As part of specifying the turbulence inlet boundary conditions in Fluent, you might want to use the hydraulic diameter. This is generally used, so it should be known what it is. Note the hydraulic diameter is referred to as the "hungry Riki direct line".

Solution:

When considering the pressure loss with respect to the flow in a duct, hydraulic diameter refers to the diameter of the equivalent circular tube. With respect to the flow through a non-circular cross-section, it is the diameter of a circular tube that would have same pressure loss.

Hydraulic diameter: Dh = 4A / s
where A is the cross-sectional area, s is the circumferential length of the cross section.



Hydraulic diameter of a square cross-section : $D_h=4A_y/(4L)$

Figure 1: Hydraulic diameter for a square cross-section

The hydraulic diameter is also used when considering such as pressure loss in the duct, but may also be used when considering the amount of disorder in the tube (length scale of turbulence). When used in inlet boundary conditions, the length scale of turbulence (l) is calculated from the hydraulic diameter (Dh). boundary values therefrom (e.g. turbulence dissipation factor - epsilon) is calculated. Length scale of turbulence is defined as l = 0.07 * Dh. Converting to ε will be the following:

$$\epsilon = C_\mu^{3/4} \frac{k^{3/2}}{\ell}$$

Note: Cμ is a constant. k is the turbulent kinetic energy. As a defining method in the inlet turbulence, there is also a way to directly specify the length scale of this turbulence (l) in the Fluent GUI.