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A study on perforated plates

In process equipment, it is typical that uniform flow is desired upstream the component as this provides optimal performance. A well-known approach for creating uniform flows is using perforated plates. The perforated plate works by adding resistance governed by the flow velocity. As higher velocity will result in a higher resistance, the flow will profile smoothen. This approach, and the resistance coefficients, are well documented in literature. However, the literature does not present sufficient information on how the velocity profile is after the perforated plate, especially if the velocity components are not normal to the plate. This presents an issue when performing CFD (Computational Fluid Dynamics) analysis using perforated plates modelled as porous media, as the flow downstream the perforated plate will affect the reminding part of the simulation.

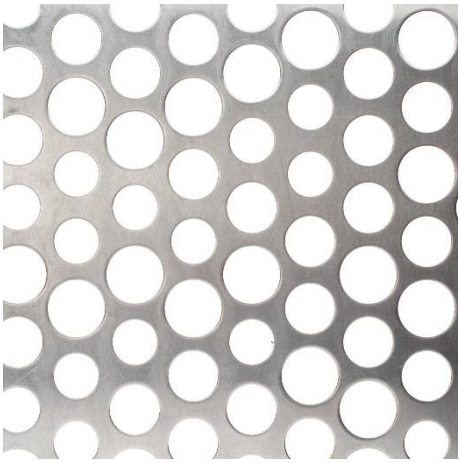

Figure 1: Perforated plate

Figure 2: To the left: Perforated plate with flow normal to the plate. To the right: Perforated plate with non-normal flow. This means that the coefficients are unknown, hence the flow downstream is unknown.

The goal of the project is to quantify the resistance components in each direction for highly turbulent flows. The resistance should be formulated such that it maximizes accuracy with respect to total pressure and velocity profile.

This project can be scoped freely. Project scope suggestions:

Scope 1:

- Simulate a resolved perforated plate using varying upstream flow profiles
  - Export pressure difference and velocity profiles.
- Simulate a perforated plate using porous media
  - Create accurate resistance coefficients.
  - Quantify error in pressure difference in velocity profiles.
- Simulate a perforated plate using momentum terms
  - Formulate a momentum term that increases accuracy.

Scope 2:

- Create an experimental setup for analyzing perforated plates for varying flow profiles.
  - Measure flow profile components upstream and downstream the perforated plate.
  - Measure pressure difference.
- Simulate a perforated plate using porous media
  - Create accurate resistance coefficients.
  - Quantify error in pressure difference for different velocity profiles.