Flow Physics of a Porous Cylinder

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ABSTRACT

This study investigates the flow physics and wake dynamics around porous and solid circular cylindrical blockages using 2D numerical simulations at Reynolds numbers 50 and 100. Permeability, which determines the ease with which fluid traverses a porous medium, is a fundamental parameter for understanding and predicting flow behavior around these blockages. The project aims to compare the flow past and through a porous blockage with a solid blockage at Darcy numbers ranging from 10^{-9} to 0.1, with a detailed focus at a Darcy number of 1/500. The goal is to understand flow patterns, force coefficients, and wake dynamics for both types of blockages. The study reveals that at Reynolds number 50, both blockages exhibit steady flow, with porous blockages having a slightly larger re-circulation region. At Reynolds number 100, the flow becomes unsteady, with porous blockages demonstrating greater stability but higher drag coefficients compared to solid blockages. These findings enhance the understanding of flow behavior around porous structures, which is vital for applications in filtration, aerodynamics, and environmental engineering.

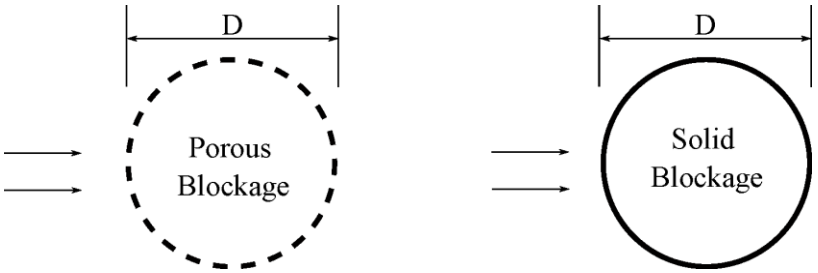

Figure 1. Schematic diagram of porous and solid circular cylindrical blockage

Table 1. Details of geometry and flow conditions

Geometric Detail	Diameter of the blockage = 1m
Fluid Property	Kinematic Viscosity = $0.005 m^2/s$
	Density = $1 Kg/m^3$
Darcy number	$[10^{-9}, 1]$
Reynolds Number	50 and 100