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FLOW DIODES FOR APPLICATION IN TURBULENT FLOWS

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Flow diodes like e.g. the well known “Tesla valve” are simple devices with directional dependent fluid flow resistance, featuring a lower resistance coefficient in forward direction, and a higher resistance coefficient in reverse (blocking) direction – typically without moving parts. One obvious application could be the use as a drop in replacement for valves for flow control. The simplicity of the devices should make production cost cheap, the lack of moving parts allows for the use in extreme environments, would increase their durability and life expectancy, while reducing the maintenance demands. Of course there are also drawbacks: Real flow diodes are not able to shut off the flow completely and most reported developments of flow diodes are limited to laminar systems and the majority of applications can be found e.g. in microfluidics [1]. Few technial references on the use in larger scale equipment can be found, e.g. [2], but not many details are available.

In this study, Computational Fluid Dynamics (CFD) simulations have been used to investigate flow diodes for a less common field of applications, for the use with turbulent flows. Simple venturi style pipe geometries were investigated for use as flow diodes for turbulent gas flows within a Reynolds number range of $8800 < Re < 70500$. Parameters like the cone length and the diameter of the constricted section have been varied to analyze the dependency of the diodicity on the geometry.

It was shown from the simulation results that even such simple flow geometries feature a non-unity diodicity, for the same flow rate the forward pressure drop is significantly lower than the reverse flow pressure drop. This behaviour may be useful to dampen pulsating flows, for example downstream of fluid machinery. The dependency of the diodicity on the Reynolds number has also been investigated, as well as the cost for the flow control in terms of relative pressure drop compared to a non-controlled fluid flow path. Other simple geometries are proposed for further investigations of fluid diode effects for turbulent streams.

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