FLUID MECHANICS LABORATORY D.P. Margaris, Professor

THESIS 2020-2021

Parametric analysis of curved and longitudinal vortex generators inside a duct of orthogonal cross-section, with the use of computational fluid dynamics CFD

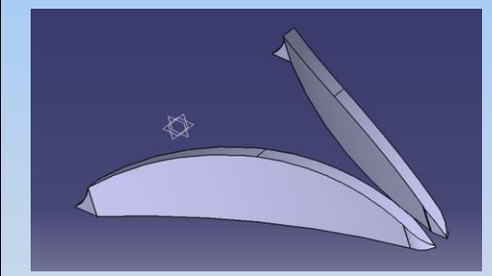
KOSTIS NIKOLAOS

Fluid Mechanics Laboratory
Mechanical Engineering and Aeronautics Dept.
University of Patras, Greece
margaris@mech.upatras.gr

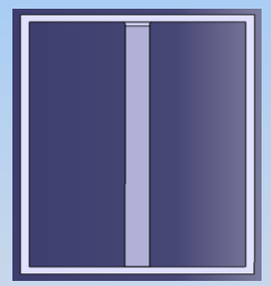
Abstract

Among the most crucial matters that modern society tries to arrange is the conception of efficient and eco-friendly designs that significantly reduce the energy consumption. The present research observes the behavior of two distinct types of geometries that produce vortices. These geometries are compared by their ability to create long-lasting and powerful vortices. The importance of studying longitudinal vortices inside pipes arises from the fact that they enhance heat transfer. The main advantage of the designed geometries is the fact that they do not require additional energy from an external source to disturb the flow, thus with an appropriate design that aims to keep the pressure drop low, an efficient layout can be acquired. The geometries were designed by using the designing program CATIA. Nine geometries were produced, from which five are curved vortex generators while the rest are longitudinal. Moreover, using the simulation package ANSYS-FLUENT, which utilizes the technique of finite volumes, the flow field of each geometry is examined.

Geometries in CATIA

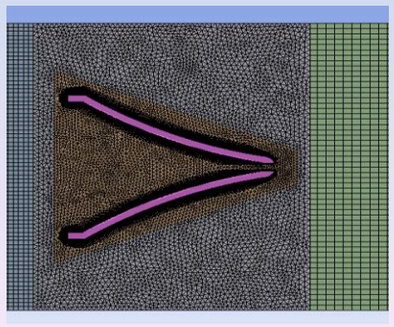


Curved geometry with variable height



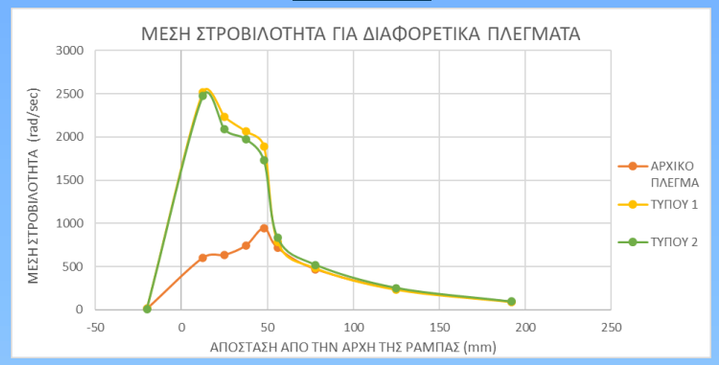
Longitudinal geometry

Mesh

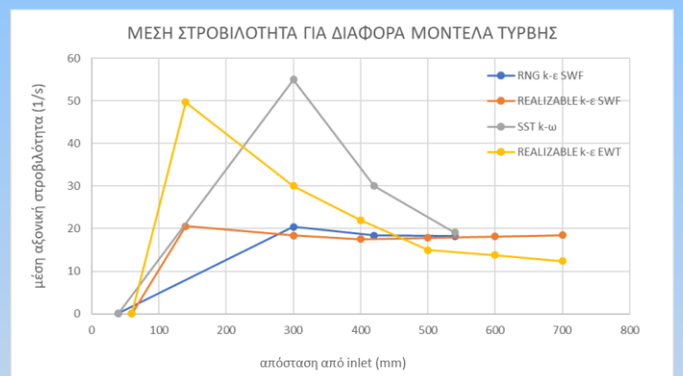


Areas of structured and unstructured grid using block meshing technique

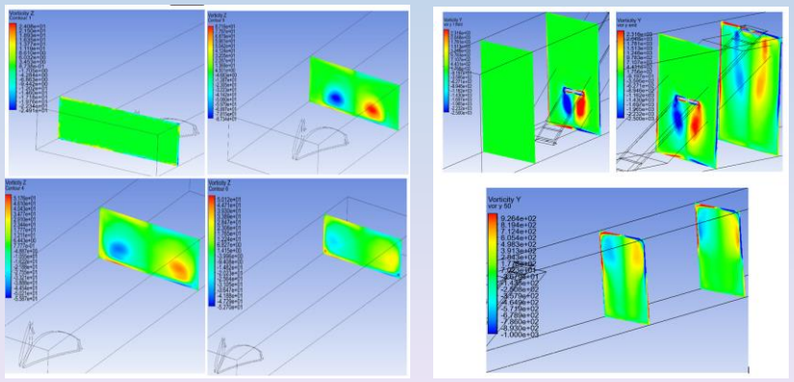
Results



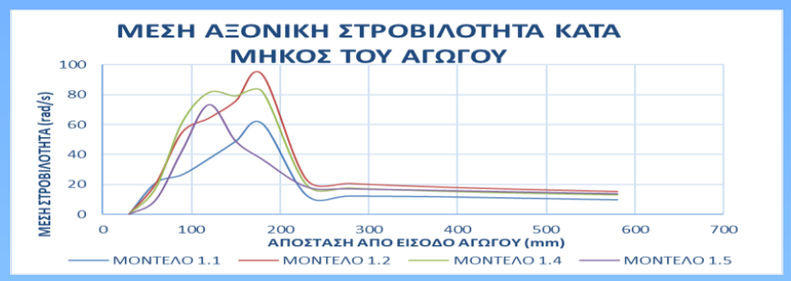
Grid independency check



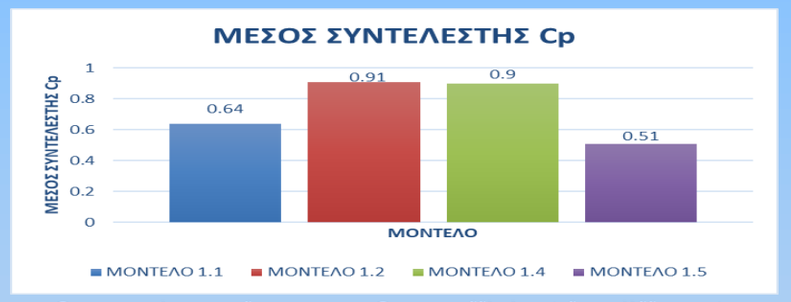
Average vorticity for different turbulence models



Longitudinal vortex Contours inside the duct Vorticity Y (rad/sec)



Average vorticity comparison throughout the duct for different geometries



Comparison of average Cp coefficient for different geometries

Conclusions-Comments

- **Keeping elements number around 1.150.000 achieves grid independence.**
- **Increasing height on curved surfaces, increases the intensity of the vortices if it does not exceed a limit after which it prevents the free development of the flow.**
- **The holes do not increase the intensity of the vortices but help maintain the intensity for a longer flow length.**
- **Increasing the width of longitudinal geometries results in higher vortex intensity and Cp coefficient.**
- **Longitudinal geometries fail to produce long lasting vortices.**
- **Curved surfaces create long lasting vortices while longitudinal do not. Moreover, they also keep the Cp coefficient at lower levels. However longitudinal geometries can produce more intense vortices.**