FLUID MECHANICS LABORATORY P. PAPADOPOULOS, Professor

Diploma Thesis 2021-2022

COMPUTATIONAL STUDY AND COMPARISON OF THE FLOW AND THERMAL FIELD OF CURVED AND STRAIGHT TUBE THROUGH A PARAMETRIC INVESTIGATION OF THEIR BEHAVIOUR FOR DIFFERENT VALUES OF FLUID AND THERMAL CONDITIONS

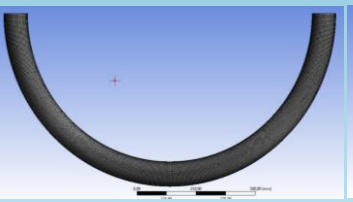
Fluid Mechanics Laboratory
Mechanical Engineering & Aeronautics Dept.
University of Patras, Greece
Επιβλέπων: Π. Παπαδόπουλος, Επίκουρος Καθηγητής
p.papadopoulos@des.upatras.gr

CHOTZARA ONTETA

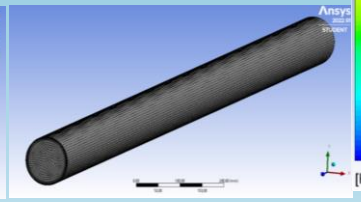
Abstract

The subject of the present diploma thesis is a computational study about laminar and turbulent water flow through straight and curved ducts. Ansys fluent is a computational program used in fluid mechanics applications, which was also used for the study carried out in this thesis. The process in fluent starts by designing the geometries which in our case are a straight duct of circular cross-section and a curved duct (U-tube) also of circular cross-section. The next step is to create the appropriate mesh for each geometry, then we continue with the modeling part and the process ends with the results and the analysis. In this thesis, four Reynolds numbers (500, 1500, 3000, 8000) were used for both geometries and two different turbulence models (k-epsilon and sst k-omega) for the turbulent flows. The results in all flow cases revealed much better heat transfer to the center of the fluid in the case of the curved duct compared to the straight duct.

Geometries

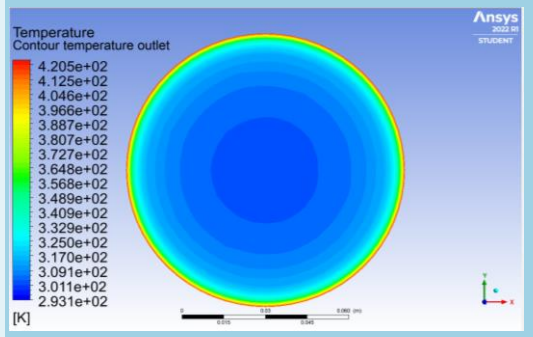


Ratio of curvature:65cm, Diameter:10cm

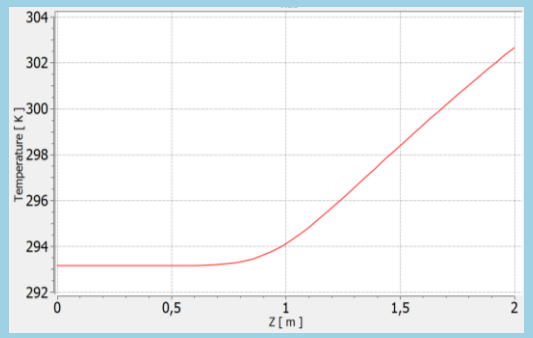


Length:200cm, Diameter:10cm

Allocation of temperature at the highest outlet temperature of the straight duct

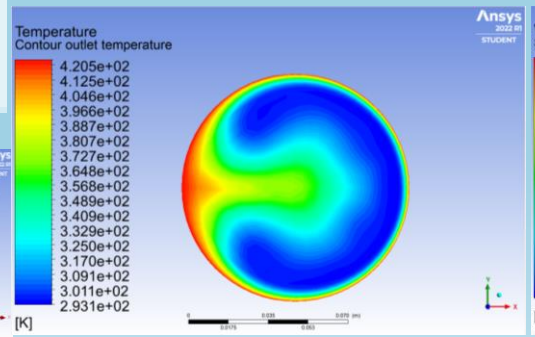


Temperature at outlet

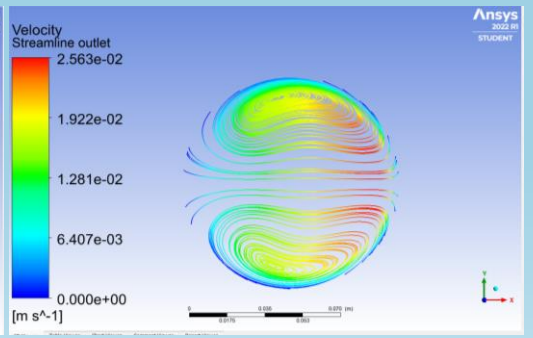


Temperature through the center

Allocation of temperature at the highest outlet temperatures of the curved duct and Dean's cells appearance



Temperature at outlet



Dean's cells

Results

Flow type	Turbulence model	T.out, Straight duct	T.out, Curved duct
Laminar Reynolds=500	Laminar	293.15K	359K
Laminar Reynolds=1500	Laminar	293.15K	365 K
Turbulent Reynolds=3000	k-epsilon	302.5K	312K
Turbulent Reynolds=8000	k-epsilon	301.75K	307K
Turbulent Reynolds=3000	SST K-omega	294.7K	317K
Turbulent Reynolds=8000	SST K-omega	293.85K	307K

Conclusions

- The results in all flow cases revealed much better heat transfer to the center of the fluid in the case of the curved duct compared to the straight duct.
- The maximum outlet temperature of all cases was T=365K in the curved duct for Reynolds number 1500.
- The maximum outlet temperature for the straight duct was T=302.5K for Reynolds number 3000.
- The difference that occurs between the results of the two turbulence models is due to the different way each one approaches the flow. SST K-omega turbulence model gives better results close to the wall while shows weaknesses far from it.