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Control of the turbulent flow in a plane diffuser through optimized contoured cavities.
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Eur. J. Mech., B, Fluids 48, 254-265 (2014).

Summary: A passive control strategy, which consists in introducing contoured cavities in solid walls, is applied to a plane asymmetric diffuser at a Reynolds number that implies fully-turbulent flow upstream of the diffuser divergent part. The analysed reference configuration, for which experimental and numerical data were available, is characterized by an area ratio of 4.7 and a divergence angle of 10° . A large zone of steady flow separation is present in the diffuser without the introduction of the control. One and two subsequent contoured cavities are introduced in the divergent wall of the diffuser and a numerical optimization procedure is carried out to obtain the cavity geometry that maximizes the pressure recovery in the diffuser and minimizes the flow separation extent. The introduction of one optimized cavity leads to an increase in pressure recovery of the order of 6.9% and to a significant reduction of the separation extent, and further improvement (9.6%) is obtained by introducing two subsequent cavities in the divergent wall. The most important geometrical parameters are also identified, and the robustness of the solution to small changes in their values and in the Reynolds number is assessed. The present results show that the proposed control strategy, previously tested in the laminar regime, is effective also for turbulent flows at higher Reynolds numbers. As already found for laminar flow, the success of the control is due both to a virtual geometry modification of the diffuser and to a favourable effect of the cavities in reducing the momentum losses near the wall.

MSC:

- [76F65](#) Direct numerical and large eddy simulation of turbulence
- [76F60](#) k - ε modeling in turbulence
- [76D55](#) Flow control and optimization for incompressible viscous fluids

Keywords:

passive flow control; contoured cavities; flow separation; high Reynolds diffuser

Software:

[STAR-CD](#)

Full Text: [DOI](#)

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