ISSN:0971-1260
Vol-22-Issue-37-December -2019

Drag Reduction of Bluff Body using Splitter Plate

GopinathShanmugaraj, J. V. MurugaLal, Vijay Kumar Singh
School of Mechanical Engineering
Lovely Professional University, Phagwara, Punjab, India

Abstract

This paper aims at exploring the effects of a splitter plate on the drag reduction of flow over the cylinder body. A splitter plate is provided at the aft of the cylinder. Providing the splitter plate significantly affects the flow pattern. It reduces the Cp at the front and also significantly reduces the Cd.

Introduction

Drag reduction is a relevant and exciting study that applies to a wide range of applications in the field of aerospace, automobile, civil engineering. Because of the complications associated with experimental analysis, drag reduction studies were more aligned to computational studies because of its simplicity, and a number of body configurations can be studied with relatively low cost [1]. At lower Reynolds numbers, large wakes and periodic vortex shedding were the main factors that characterize the flow over bluff bodies. Because of these effects, the time-averaged drag co-efficient values have more potential in predicting the performance of the bluff bodies [2].

In the past years, several studies have been reported on drag reduction of bluff bodies. Most of them are experimental and related to the present study [2-6]. In previous years both forward and backward splitter plates have been tested, and the results were positive and desirable. This study reports the effect of the splitter plate in the aft section of the circular cylinder and its effects on the flow field, and varying the length of the splitter plate relevant to the cylinder diameter yields exciting results.

Computational Model

A circular cylinder is placed inside a uniform flow. The splitter plate is provided at the front of the cylinder serves as a drag reduction device. The length of the splitter plate is considered to be half of the circular diameter and equal to the circular diameter, which has an L/D of 0.5 and 1, respectively. The flow velocity is equal to 50m/s. A hybrid meshing is used to mesh the domain. To capture the boundary flow details accurately, fine meshes were used in the near-surface region of the model, and uniform mesh size is maintained all over the domain.

ISSN:0971-1260
Vol-22-Issue-37-December -2019

Inlet specified with velocity boundary conditions, the outlet is a pressure boundary, and the wall condition was given as no-slip condition. The reference pressure is 1atm, and the reference temperature is 300K.

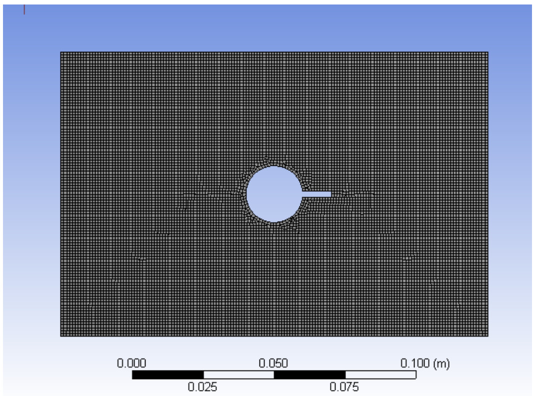
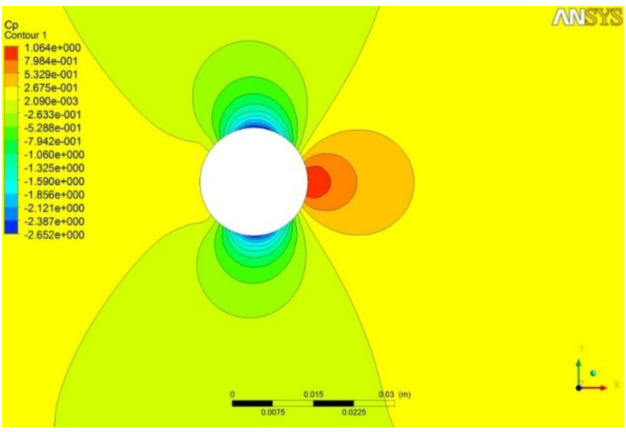


Fig 1 Mesh distribution

Results

The center of pressure and coefficient of drag were analyzed for different configurations considered and discussed in this paper. Figure 2a shows the Cp distribution of the standard model, which has no splitter plate. It can be observed that at the front of the body, the Cp is much higher than the other locations, and the lowest value of Cp is observed at the top and bottom of the body. It occurs the flow is accelerated to the maximum velocity at the top and bottom surface. Figure 2b shows the Cp distribution of the cylindrical body with a splitter plate at the aft section. The l/d value of the splitter plate is 0.5 in this case. The size of the dark red region significantly reduces for this case.



a) L/D = 0

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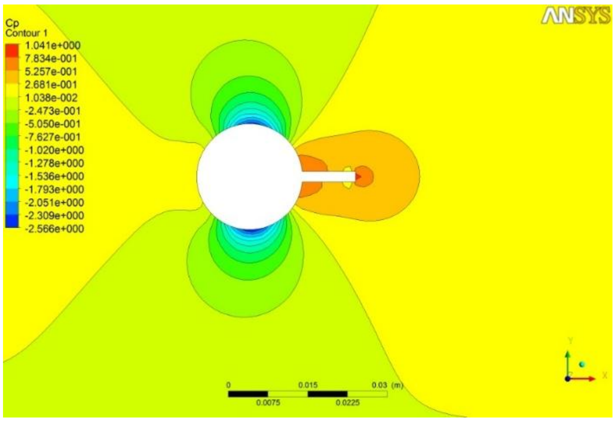
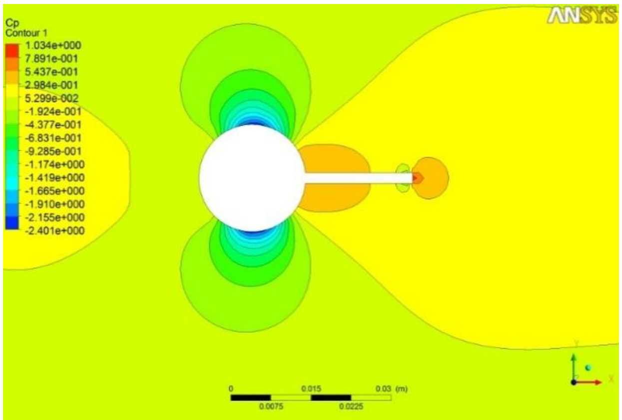


b) L/D = 0.5



c) L/D = 1

Fig 3 Contour plot of Cp distribution

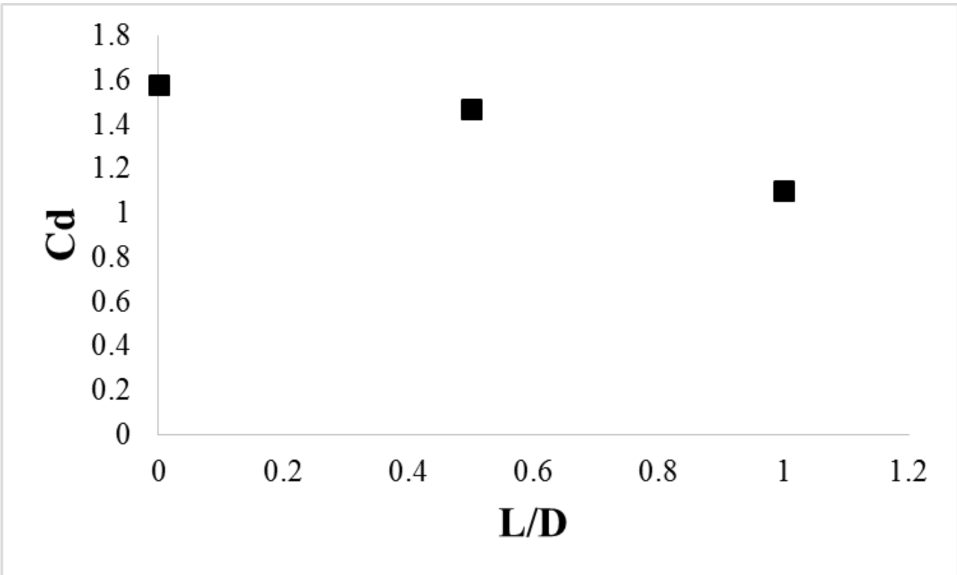


Fig 4 Cd vs L/D

ISSN:0971-1260
Vol-22-Issue-37-December -2019

The maximum value is also comparatively lower for the latter case. A small amount of high Cp contour is observed near the aft surface of the cylinder. Figure 2c shows the Cp distribution of cylinder with the splitter plate, which has the L/D value of 1. It indicates that the length of the splitter plate and diameter of the cylinder is equal. The size of the maximum Cp contour is significantly small for this configuration. The maximum Cp value is also comparatively lower for this case.

Figure 4 shows the Cd vs. L/D value of the models that considered for comparison. For a standard model, the Cd value observed is equal to 1.6. The effect of the splitter plate is evident in this plot. When the splitter is provided, there is a considerable reduction in Cd value were observed.

Conclusion

A uniform circular cylinder is considered as a test model to study the effect of the splitter plate and its L/D value in the drag reduction. Providing the splitter plate has a significant effect on its Cp distribution and Cd value. The size of the maximum Cp is significantly reduced, and the Maximum Cp value is considerably lower. Cd is also significantly reduced by comparing the standard model.

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