

NSAERO APPLICATION

Winglet Design For Commercial Aircraft

Introduction

This application note demonstrates the capability of NSAERO to predict shock induced separation within a full commercial aircraft configuration. NSAERO is a multi block computational fluid dynamics software package available from Analytical Methods, Inc. The current application is the prediction of the flow field at cruise condition for commercial aircraft and assess the benefit of winglet.

Problem Description

Winglet has proven to be an efficient way to reduce wing vortex concentration, thereby reducing the drag. The design of the winglet must be carefully undertaken in order to maximize the drag reduction and to avoid any penalties at different flight conditions. In this technical note, some aspect of the flow field around the wing with and without the winglet is presented.

Problem Setup

The computational domain was broken into 258 zones generated with Gridgen V15. NSAERO can deal with different types of grids, therefore mixture of structured and unstructured meshes is generated accordingly to the accuracy requirement. In general, structured meshes are preferred around the bodies, where viscous effects must be carefully modeled. It is noted that geometries are slightly different for the two cases as aerodynamic loading is different. The surface mesh around the nacelle pylon and faring is depicted in Figure 1. Table 1 resumes the grid size, CPU time and memory requirement.

Results

The flow fields for two configurations are computed in parallel mode with 40 CPUs. Figure 2 shows the pressure contours of the winglet configuration. Shock induced separation is captured for both cases. The angle of attack is adjusted to reach a fixed aircraft lift coefficient. An improvement in drag is observed for the winglet configuration.

Surface points	250,000
Off-body points	17,000,000
CPU Time	22 hours (40 CPU AMD Opteron)
Memory	15 GB

Table 1 Mesh size, CPU time and memory requirement

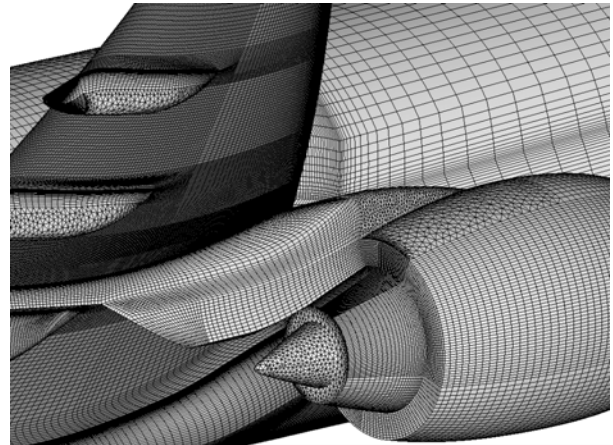


Figure 1 Surface mesh showing structured and unstructured patches



Figure 2 Pressure contours

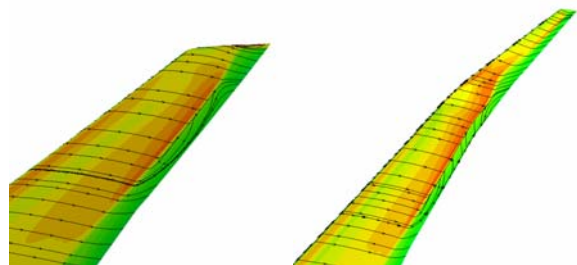


Figure 3 Surface streamlines with and without the winglet