Numerical analysis of propeller effects on wing aerodynamic: tip mounted and distributed propulsion

P. Della Vecchia[*]
[*]*University of Naples Federico II*
Phd, Assistant Professor
Via Claudio, 21 80125, Naples
pierluigi.dellavecchia@unina.it

D. Malgieri[*]
Master of Engineering

F. Nicolosi[*]
Associate Professor

A De Marco
Phd, Assistant Professor

ABSTRACT

The purpose of this investigation is determinate the effects of propeller on wing aerodynamic, both for a propeller mounted in the middle of the wing, and for tip mounted propeller. Especially, it is investigated how a tip-mounted propeller can decrease wing induced drag, and how distributed propulsion can increase the high-lift aerodynamic. Analyses are carried out using a Virtual Disk Model on CFD software, showing a good agreement comparing numerical results with experimental data obtained by previous works. Wing tip engine with propeller, has been employed on a general aviation aircraft wing with an installed thrust to accomplish with cruise performance, reducing the induced drag. Distributed propeller engines on the wing allows improving of low speed performance, increasing the aircraft lift coefficient. Induced drag can be reduced of about 2-3% a low cruise lift coefficient, until 8-10% at relative high cruise lift coefficient. Maximum achievable lift coefficient could be increased of about 20-30% in clean configuration, and more than 50% in flapped configuration.

KEYWORDS: *aircraft propeller simulation, tip propeller effects, distributed propulsion*

NOMENCLATURE

AR - Aspect Ratio
C_D - Drag Coefficient
C_l - 2D lift coefficient, along wing span
C_L - Lift Coefficient
$C_{L,MAX}$ - Maximum Lift Coefficient
d - Propeller Diameter
J - Advance Ration of Propeller
M - Mach Number
MAC - Mean Aerodynamic Chord
Re - Reynold's Number
T_c - Thrust Coefficient
V_{stall_clean} - Clean (Flap up) Stall Speed
V_{stall_flap} - Flap down Stall Speed
α - Angle of attack
$\beta_{0.75}$ - Blade angle at 75% of radius
δ_F - Flap deflection, positive down