EFFECT OF TIP CLEARANCE ON THE PERFORMANCE OF DUCTED PROPELLER

A.Abou El-Azm Aly
M.T.C., Kobry El-kobba, Cairo, Egypt.

Abstract

Tip clearance between the rotor blade and casing is a major source of performance deterioration for axial turbomachines. Ducted propeller tip clearance causes a leakage of air across the blade tip from the pressure side to the suction side. This tip leakage interacts with the primary air stream and wall boundary layer. In fact, tip leakage flow dominates the behaviour of the end-wall flow and the blade-to-blade flow in the tip regions, as it has a strong impact on performance, efficiency and stability of ducted propeller.

In this study a set of three dimensional, unsteady, viscous, incompressible flow governing equations representing the real flow field is solved using commercial code Fluent 6.3.26., where RNG K turbulence model is employed. In the present work, the effect of tip clearance on ducted propeller performance is numerically investigated. This is carried out by changing the clearance ratio (the ratio between the clearance height and the mean rotor chord) from 0 to 3%.

It is found that the ducted performance parameters (thrust, torque and efficiency) are deteriorated as the clearance ratio increases. For eliminating the effect of tip clearance, casing treatment is carried out by cutting circumferential grooves in the casing opposite to rotor blade tip.

A parametric investigation for the shape, inclination angle and number of circumferential grooves is developed in the present study. Five radial and inclined grooves in the casing have efficiency higher than the other number of grooves (two, three and four grooves) and the constant clearance gap =1.5% of rotor chord.

Concerning inclination angle, five grooves with 1350 inclination angle has higher efficiency than other angles (450, 600, 900 and 1200) and the untreated casing. Moreover, five grooves with trapezoidal shape have higher efficiency close to the radial shape.