TESTING OF HIGH LIFT HIGH LOAD TURBINE BLADE

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Highly-loaded low pressure turbines result in a lower number of blades and therefore offer reduced weight. In order to increase the work performed by the blades, the blades are front loaded. They operate at relatively low Reynolds numbers and this increases the possibility of flow separation occurring on the rear part of the blade. This work identified the conditions at which a separation bubble formed on the rear part of a highly-loaded low pressure turbine blade and shows the separation characteristics at different flow conditions.

In order to investigate the flow separation several parameters were taken into account, including the Reynolds number, Mach number, blade roughness, and incoming flow state. The measurements were performed by R. Houtermans as part of his PhD work.

The velocity distribution, acceleration parameter, wall shear stress, velocity fluctuation, losses and mean outlet yaw angle are presented for the smooth and rough blade cases. In the case of periodic incoming wakes the wall shear stress and fluctuation were performed for the blade equipped with the roughness element.

The results show that decreasing Reynolds number gives rise to the separation bubbles bursting, a wider and deeper wake, decrease of the outlet yaw angle. Decreasing outlet yaw angle causes reduced blade performance. Using the roughness element on the blade at the position of the separation bubble, the behavior observed by decreasing Reynolds tendency to decreasing Reynolds number remains the same but is not so significant. At lower Reynolds numbers, the difference in the performance of the blade with artificial roughness is very considerable and generally much better than the smooth blade. At higher Reynolds number the blade losses are very similar for both the smooth and the artificially roughened blades. The roughness induces transition and the turbulent boundary layer is robust enough to overcome the adverse pressure gradient, but it does not prevent separation at lower Reynolds numbers.

For periodic incoming wakes using the roughness element, the separation bubbles are much shorter than in the case of no wake, which has a positive effect on turbine performance.

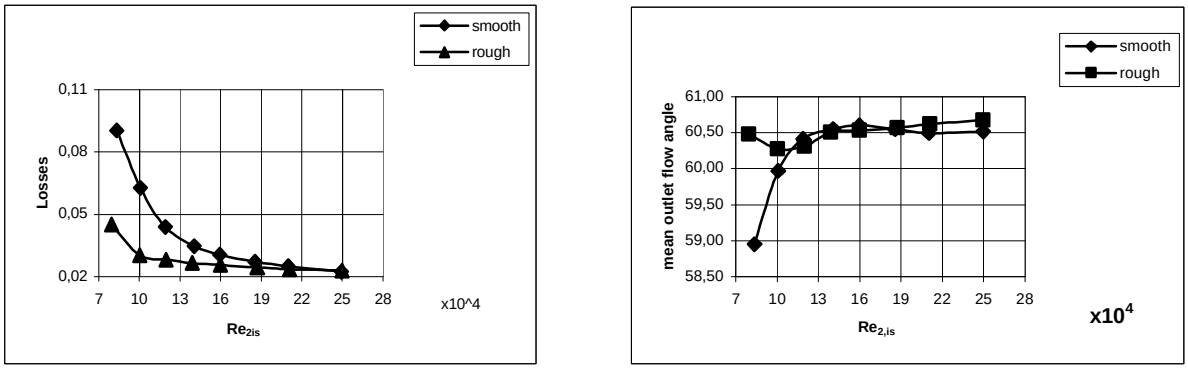

Figure 1: Left: Effect of Reynolds number on the losses for the case of smooth and rough blade for $Ma_{2,is} = 0,65$*; right: average outlet flow angle for smooth and rough case for* $Ma_{2,is} = 0,65$.