TRANSITION CONTROL ON LP TURBINES AT LOW REYNOLDS NUMBERS

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In high loaded LP turbines, operating at very low Reynolds numbers conditions, the laminar boundary layer is not able to overcome these strong adverse pressure gradients and tends to separate, increasing by the way the profile losses.

For several years artificial roughness has been investigated at VKI as a mean to induce transition. Based on the previous research results, a new type of linear roughness was developed. The shape of this linear roughness was designed as smooth as possible in order to reduce friction losses when operating at higher Reynolds numbers.

The test campaign was carried out on both profiles (smooth and rough) for a Reynolds range extending from 50 10^3 to 175 10^3. The static pressure distribution along the blade profile was measured with pressure taps. The downstream conditions (total and static pressure and flow angles) were investigated with a 5-holes probe at different spanwise positions.

From the results, the following conclusions can be drawn:

1. for Re<130 10^3, rough blade profile losses can be reduced up to 50% with respect to the smooth blade, whereas these losses increase (up to 35%) for higher Reynolds (Figure 1);
2. in the rough case, profile losses remain almost constant over a large part of the Reynolds range. The Reynolds number does not mainly affect the rough blade profile losses;
3. for the smooth blade, increasing separation bubble with decreasing Reynolds leads to increasing
4. except at the lowest Reynolds, separation bubble is avoided for the rough profile, resulting in a constant pitchwise flow angle.

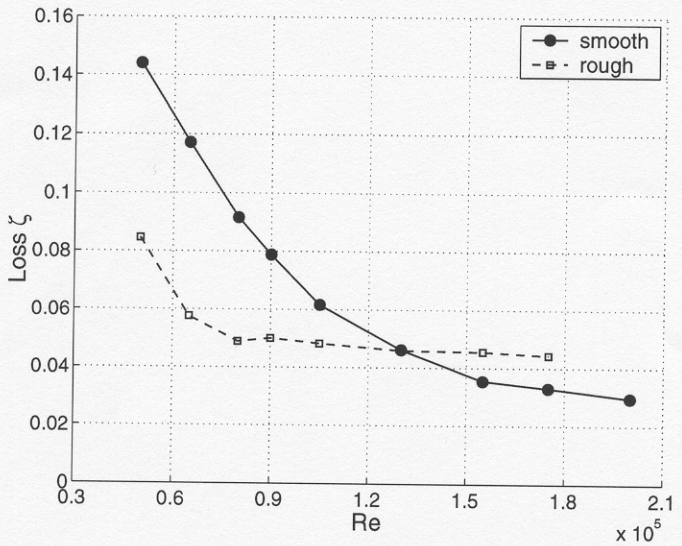

Figure 1: Average profile loss coefficient ζ_p evolution