

**BLADE VIBRATIONS IN A RADIAL INFLOW TURBINE
WITH VARIOUS NUMBERS OF NOZZLE GUIDE VANES**

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ABSTRACT

Radial inflow turbines of modern turbochargers are exposed to high dynamic loadings. Transient pressure distributions on the turbine blades caused by the tongue of a volute or by the interaction of nozzle guide vanes and the turbine blades itself can induce blade vibrations of high frequency potentially leading to high cycle fatigue. This paper presents an experimental investigation of turbine blade vibrations in a radial inflow turbine with different numbers of nozzle guide vanes. Three stators with 12, 21, and 22 vanes have been combined with a turbine rotor with 11 blades. The vibrations of two blades have been measured during operating conditions using two strain gauges on each blade. The signals of the strain gauges, which have been applied to the turbine blades at positions of high stresses and low stress gradients, have been transferred into the stationary system by a telemetric system. The measured vibration frequencies and rotational speeds respectively at which resonance conditions have been observed can be calculated with an accuracy of $\pm 5\%$. A comparison of the results shows the dependency of the excited mode shape and the stress level of the vibration on the number of nozzle guide vanes at a given number of turbine blades. Critical mode shapes and excitation conditions have been identified and also the behaviour of nodal diameters and the general influence of mistuning has been analysed.

Keywords: Turbine blade vibration, nozzle guide vane, radial inflow turbine