Influence of adjusting control accuracy on pressure probe measurements in turbo machines

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Long Abstract

Introduction

This paper presents a new design of a probe adjusting device (PAD) intended to position pressure and temperature probes in a flow field. 5-hole (5HP), 3-hole (3HP) and temperature probes (TP) can be moved in radial direction and freely rotated about their axis. The high actuation accuracy of 3.9µm in radial direction and 0.09° in angular position is validated in a 2-stage- turbine test rig which is installed at the Institute of Power Plant Technology, Steam and Gas Turbines, RWTH Aachen University.
To meet the challenge to calculate the efficiency of a turbo machine which is mainly influenced by the temperature, all PADs are positioned simultaneously and controlled by the measuring acquisition system (MAS) so that the same radial position in each stage is measured at the same time. For this purpose a new program has been developed to synchronize actuation and measurement. The slim design of 60mm width allows measurement between the stages of turbomachines with small axial distances between vane and blade. In addition a CFD/FEA shows how the design and combination of materials compensate the thermal expansion of the engine during operation. This allows a minimal safety distance of 0.2mm between rotor and probe to enable measurement as close to the physical boundary as possible. The actuation accuracy is demonstrated with pressure, temperature and angle distribution plots. It is also shown that the resolution of the measuring points, and therefore the actuation distances, has a large impact on the flow field analysis and should be set as high as possible. However the measuring time has to be taken into account.