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PIV INVESTIGATION OF THE INTERNAL FLOW STRUCTURE IN A CENTRIFUGAL PUMP IMPELLER

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ABSTRACT

The internal flow structure in a centrifugal pump impeller is investigated using Particle Image Velocimetry (PIV). The measurements are performed in a perspex model of an industrial centrifugal impeller employing fluorescent seeding particles to give full access to near-wall flows. A large number of velocity vector maps are acquired by conditional sampling in a horizontal constant-height plane between hub and shroud of the impeller, with the 93*94 mm field-of-view in effect covering a full impeller passage. Instantaneous and ensemble averaged vector maps are transformed to the moving frame and analysed for the purpose of identifying steady and unsteady flow phenomena at different flow rates, with the main focus on severe off-design conditions.

At the nominal design point, the mean field of relative velocity is vane congruent in the predominant parts of the impeller passage, showing well-behaved flow with no separation. High levels of turbulence are confined to near-wall regions along the suction side. At the one-quarter load, results show every second blade passage being stalled while the adjacent blade passage performed well, as indicated in the instantaneous vector map shown in **Error! Unknown switch argument.**. A large recirculation bubble formed on the suction side, in effect blocking most of the entrance to the stalled passage. Furthermore, a strong component of backflow was found at the pressure side near the impeller outlet. The detected stall phenomenon is stationary and non-rotating, and is not initiated via the interaction with any stationary components outside the impeller. In these respects, it differs from the phenomena commonly known as rotating stall.

The experimental setup and technique has proved to be efficient in providing reliable data over a full blade passage, also in the close vicinity of walls.

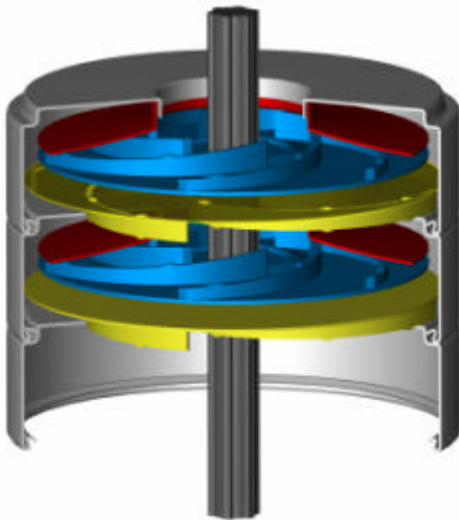


Figure **Error! Unknown switch argument.**: Multi-stage centrifugal pump showing the tested impeller geometry (Grundfos A/S).

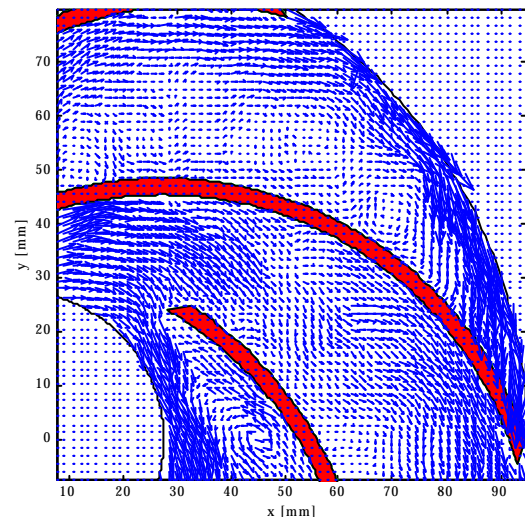


Figure **Error! Unknown switch argument.**: Sample instantaneous PIV vector map of the relative velocity \bar{w} in the impeller at part-load conditions. $Q=0.25Q_n$