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AN EXPERIMENTAL STUDY ON THE INTERNAL FLOW CHARACTERISTICS OF A VERY LOW SPECIFIC-SPEED CENTRIFUGAL PUMP

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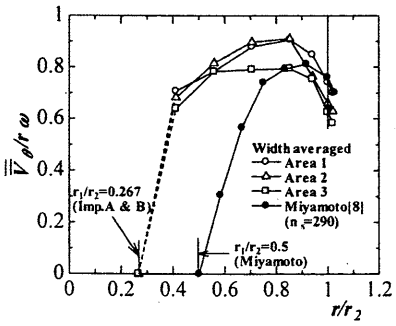
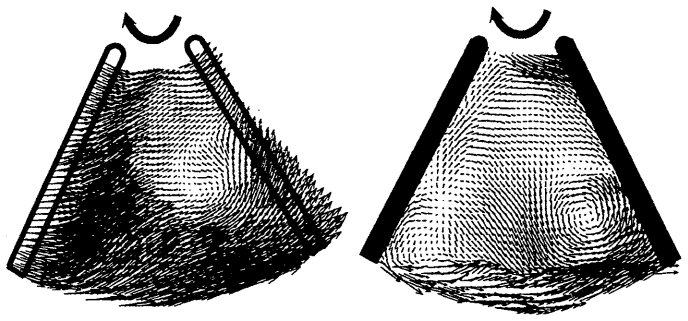
Recently, a turbo-pump of a very low specific-speed ($n_s \leqq 100$ [m,m^3/min,rpm]), which has very narrow impeller outlet width (about 1[mm] to 2[mm]), attracts attention in substitute for a positive-displacement pump because of not only vibration and noise problems but also a recent trend toward small size and high speed. However, it is still difficult to attain high efficiency by a conventional design in the range of very low n_s because the efficiency of a centrifugal pump decreases rapidly with the decrease of specific speed. With the need of developing new turbo-pump of high performance at the range of very low n_s, authors have made experimental studies and revealed that the performance characteristics of a very low n_s centrifugal pump are much different from those of an ordinary pump[1][2]. Therefore, there is strong demand of full understanding for the internal flow of a very low specific speed centrifugal pump in order to improve the pump performance. The purpose of this study is to make clear the internal flow characteristics and to obtain a basic knowledge of the pump performance by using PIV and PTV method.

The results show that vortex in an impeller passage and reverse flow at the impeller outlet decrease a tangential velocity remarkably at partial flow rate and cause a drop of theoretical head. Therefore, the performance instability at partial flow rate is caused by the large vortex and strong reverse flow. The reverse flow at an impeller outlet brings low angular momentum into an impeller and causes a sharp drop of absolute circumferential velocity ratio from the impeller radius ratio of about r/r_2=0.8, which results in a increase of slip factor in the case of β_2=30°impeller. Because of a leakage flow passing through tip clearance, the internal flow of an impeller passage becomes very complicated 3-dimensional flow field including strong secondary flow.



Absolute Circumferential Velocity Ratio
(Impeller A, Q/Q_0=1.0)



(Tip clearance, z/b=0.05) (Passage Width Center, z/b=0.5)
Phase Averaged Relative Velocity Vectors of Very Low Specific Speed Semi-Open Impeller (Impeller A, Q/Q_0=0.25)

References

[1] Kurokawa, J. et al., Turbomachinery (in Japanese), Vol.25, No.7, 337-345 (1997).

[2] Kurokawa, J. et al., Trans. of JSME (in Japanese), (B), Vol.66, No.644, 1132-1139 (2000).