

two types of impellers were tested, clarifying the problems relative to stall and choke which decide the flow range. Regarding choke, it is shown that the throat blockage is increased with the inlet relative Mach number due to the deceleration to the throat in the case of supersonic inflow. Regarding inducer stall, it is clarified that the camber of the inducer is an important parameter in addition to the inlet relative Mach number and the incidence angle.

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Compressor Performance Influenced by Distribution of Tip Clearance of Centrifugal Impeller

Yasutoshi SENOO *, *Hiroshi HAYAMI* *, *Mashiho ISHIDA* **, *Kohji NAKASHIMA* *** and *LI Fuzhong* **** The tip-clearance effects of centrifugal impellers are usually related to the clearance/bladewidth ratio at the impeller exit, and the relationship has been experimentally examined. In some cases the clearance was changed by the axial movement of the shroud casing relative to the impeller, and as a result the radial clearance in the inducer was hardly changed. If the tip clearance is changed uniformly along the shroud, the effects of tip clearance must be larger than predicted based on those experiments. In the case of centrifugal compressor with 6:1 pressure ratio, the decrement of impeller efficiency due to tip clearance is theoretically examined for five types of clearance-distribution along the shroud, and significant influences of the radial clearance in the inducer are demonstrated.

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Study of A Cross-Flow Turbine

for Tidal Power Generation (2nd Report. Effect of the changes of flow passage area on the Turbine with Symmetrical Nozzle Shapes)

Yoshiyuki NAKASE, *Junichiro FUKUTOMI* and *Yasushi FUKU* The previous report presented an elementary description of a cross-flow turbine for a tidal or a wave power plant. In order for the turbine to rotate in the same direction in reciprocating flows, this turbine performance is influenced by the symmetrical nozzle shapes around its axis. Then we investigate the relation between the turbine performance and the changes in the flow passage area. It is desirable that the changes in the flow passage area be smooth and the diffuser angle be small. Therefore, the separation in the diffuser become smaller and the turbine performance is improved.

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The Flow around a Rotating Cone in a Casing (For the Case When the Cone Vertex Angle is 60°)

Motoyuki ITOH *, *Yutaka YAMADA* * and *Hidetoshi HAYASHI* ** The velocity distribution around a rotating cone in a casing, and the pressure distribution on the casing wall are measured for a variety of combinations of the clearance ratio and the throughflowrate. The cone vertex angle, 2θ , used in the experiment, is 60°. The results of the velocity measurement for a large clearance ratio show the presence of a potential core in the flow field. The ratio of the angular speed of the potential core to that of the rotating cone, K , is almost the same as for the case of a rotating disk, if $C_q \cdot \sin \theta$ is kept constant (C_q is the dimensionless throughflow rate). The pressure distribution and the axial thrust coefficient are almost the same as those for a rotating disk and they are independent of the Reynolds number Re , when $C_q \cdot \sin \theta \cdot Re^{-0.8}$ is

kept constant.

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Fundamental Study on the Flattening of Temperature Distribution of a High Temperature Steel Slab (3rd Report, Heat Transfer Characteristics Due to a Confined Turbulent Impinging Jet Flow)

Koichi ICHIMIYA *, *Keiji KOBAYASHI* * and *Ryozo ECHIGO* **

Concerning the flattening of temperature distribution of a steel slab, the characteristics of local heat transfer due to impingement of a confined turbulent two-dimensional air jet on a heated surface have been conducted experimentally for a jet Reynolds number up to 20 000, for 6 heated surface-slot nozzle spacings and for 3 heated side surface-porous spacings. It was found that the spanwise heat transfer exhibits two or three local maxima. Nusselt number at the stagnation point was constant for the dimensionless spacing $1 < h/2d < 3$ and also increased with decreased in $h/2d (< 1)$.

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An Experimental Study on Natural Convective Heat Transfer from a Vertical Wavy Surface Heated at Convex/Concave Elements

Koki KISHINAMI, *Hakaru SAITO* and *Ikuo TOKURA*

Natural convective heat transfer from a vertical wavy surface with discontinuous heating has been studied experimentally by considering the effect of heat conduction in unheated elements. The wavy surface is constructed with concave and convex semicircular cylinders and has discontinuous heat sources on concave or convex surfaces. The behavior of the flow and the temperature distributions in the boundary layer of