

Device of Suppressing Abnormal Flow Phenomena in Turbomachinery (J-Groove Device)



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(1943)



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(1964)

1. Outline

In operating a turbo-machine at off-design conditions there occurs various abnormal flow phenomena which cause vibration and noise and sometimes lead to the damage of turbo-machine. Abnormal flow phenomena include surging, rotating stall, cavitation, abnormal axial thrust, impeller whirl and so on. To avoid these abnormal flow phenomena various devices characteristic to the phenomena have been developed, however this makes turbo-machine large-sized and causes the efficiency drop.

Here, paying attention to the mechanism that turbo-machine is the energy converter utilizing flow rotation, we have developed an innovative device of suppressing various abnormal flow phenomena commonly by controlling the flow rotation. The present device is the technique of controlling the angular momentum of main flow, and can suppress surge, rotating stall, impeller whirl perfectly in all flow range without dropping the maximum efficiency of the machine, and moreover it can improve cavitation performance and reduce axial thrust largely.

2. Explanation of Device

The present device is a very simple and clear technique of installing many shallow grooves on the casing wall of a turbo-machine in the direction of pressure rise. In the grooves is induced strong reverse jet due to the pressure gradient, which suppresses the rotation of main flow considerably. This device is able to suppress many abnormal flow phenomena commonly and conveniently with little drop of the maximum efficiency by installing no special equipment. The authors named this as "J-Groove", in which "J" means Juggling, Japan or Jun.

J-Groove shows variously different effects depending on the place of installation. When installed near the entrance of impeller, as shown in Fig. 1, J-Groove suppresses the whirl of inlet flow, which makes the performance curve instability, characterized by a rising head-discharge curve, very stable as shown in Fig. 2. Thus J-Groove can suppress surging without dropping the maximum efficiency (axial and mixed flow pump). Moreover, the reverse jet takes high pressure fluid to the low pressure region, and improves cavitation performance,

When J-Groove is installed at the entrance of diffuser(or impeller outlet), rotating stall of the vaned or the vaneless diffuser can be perfectly suppressed in all flow range and the pressure fluctuation disappears as shown in Fig. 3. On the other hand, when J-Groove is installed at the back of impeller shroud, it can reduce the axial thrust considerably as shown in Fig.4. Thus J-Groove can avoid abnormal transient axial thrust and vibration due to the axial thrust variation. In addition, J-Groove is also effective of suppressing draft whirl, when installed at the inlet of draft tube of water turbine.

3. Summary

The present device is the technique to suppress many abnormal flow phenomena in turbomachinery, to make the operation stable in all flow range and to promote the reliability of turbomachinery. This device can be easily applied to the existing machine and contributes to enlargement of operating range of turbomachinery. In Japan and abroad the research of developing the present device to various types is started, the spread of further application is expected.

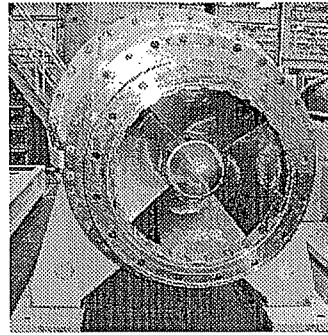


Fig.1 Installation of J-groove to the inlet of mixed flow pump

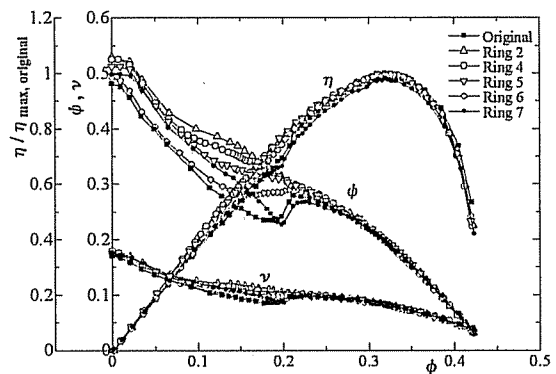


Fig. 2 Stabilized performance curve by J-groove in an axial pump

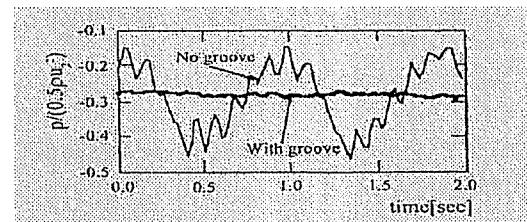


Fig. 3 Suppression of pressure fluctuation in vaneless diffuser

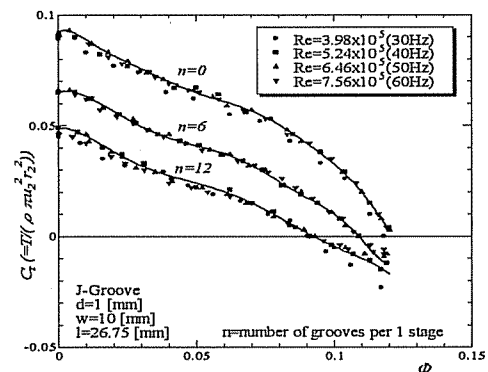


Fig. 4 Axial thrust reduction of centrifugal pump

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