Impulse Turbine with Self-Pitch-Controlled Guide Vanes for Wave Power Conversion: Performance of Mono-Vane Type

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ABSTRACT

An impulse turbine with self-pitch-controlled guide vanes was proposed by the authors in a previous paper. The unsteady characteristics of this turbine have been investigated experimentally by the use of turbine test equipment in which the sinusoidally reciprocating flow conditions are simulated. The results have been compared with those of a Wells turbine. Furthermore, in order to clarify the usefulness of quasi-steady analysis of this turbine, they have been also compared with the analytical results calculated on the basis of the experimental data obtained by the model testing of a turbine rotor with fixed guide vanes under steady unidirectional flow conditions. As a result, it has been clarified that the impulse turbine presented here is superior to the Wells turbine in overall characteristics, and the quasi-steady analysis is available for this turbine.

NOMENCLATURE

a, a' : major radius (see Fig. 3)
b, b' : minor radius (see Fig. 3)
CA : input coefficient defined by Eq. 5
CT : torque coefficient defined by Eq. 4
f : frequency of wave motion
F : nondimensional output torque = T/(πρV^2/2)
h : blade height
I : moment of inertia
l : chord length
Q : flow rate
r : radius
S : blade space at mean radius (see Fig. 2)
Sf : nondimensional frequency = rF/Va
T : output torque
TL : loading torque
U : circumferential velocity
v : absolute flow velocity
Va : mean axial velocity
V : maximum value of w
w : relative flow velocity
Xf : nondimensional moment of inertia = I/(πρV^2/2)
Xf : nondimensional loading torque = TL/(πρV^2/2)
z : number of blades
α : incident angle of guide vane
γ : blade inlet angle
Δp : total pressure drop between settling chamber and atmosphere

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KEY WORDS: Fluid machinery, wave, guide vane, impulse turbine, wave energy, wave power generator.