

## Tidal Current Power Generation System Suitable for Boarding on a Floating Buoy

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### ABSTRACT

**This paper proposes a new type of machine for tidal current power generation using the floating buoy. The machine consists of the tandem runners and the generator with double rotors. The front and the rear runners counter-drive the inner and the outer rotors under the same rotational torque, respectively. The electric current goes down and the voltage goes up with the increase of the rotational speed, and the maximum output power is obtained at the same counter-rotational speeds as expected in the runner design.**

### INTRODUCTION

It may be suitable, for the tidal current power generation system, to apply the high specific speed hydraulic turbine such as the usual axial-flow types, cross-flow types (Toyokura et al., 1990) and/or Darrieus types (Furukawa et al., 1998). It is also desirable to make the machine of compact size and simple composition, but the usual generator may reject such desires. That is, it is necessary, for getting sufficient electric power, to make the rotor diam of the generator large or equip with the accelerator such as a gearbox, because the electric power is in proportion to the rotational speed in the magnetic field. Thus, the authors have developed a new type of generator with counter-rotating rotors instead of the usual mechanism, which can make the rotor diam small on account of relatively doubling the rotational speed. Moreover, the rotational torque is counter-balanced successfully in the double rotors (Kanemoto et al., 2000a), that is, the rotational moment hardly acts on the mounting bed. These advantages suggest that this generator is suitable for boarding on the floating buoy moored in a strait.

These rotors should be driven by the counter-rotating runners, which have scarcely been investigated as compared with ship propellers (Caricchi et al., 1994) and Wells turbine rotors (Gato, 1996; Raghunathan and Beattie, 1995). This paper proposes the counter-rotating type machine described above as a

tidal current power generation system, and discusses the results of the model tests.

### MODEL MACHINE OF COUNTER-ROTATING TYPE

The model machine is shown in Fig. 1. The front and rear runner shafts are directly connected to the inner and outer rotors of the generator, respectively. The model has no guide vanes for output power control and a draft tube by reason of germinal trial, which may not correspond with the future prototype machine.

The model generator is a 3-phase, 4-pole, permanent-magnet, synchronous AC generator with counter-rotating rotors. The characteristics were tested and are referred to by Kanemoto (2000b). The runners were designed to the following conception. The inlet flow (swirl-less condition) gives the rotational torque to the front runner, and swirls at the outlet. Its swirling flow again gives the counter-rotational torque to the rear runner, and runs out in the swirl-less condition. This means that the angular momentum change through the front runner is the same as that through the rear runner. Accordingly, the runners successfully counter-drive the inner and outer rotors of the generator. Fig. 2 shows the blade profiles realize the above flow conditions under the same counter-rotational speed, where  $R\theta$  and  $Z$  are the peripheral and meridian distances divided by the runner diam  $D$  ( $= 245$  mm). The symbol  $T$  is the blade thickness divided by  $D$ , exclusive of the section near the leading and trailing edges. The camber lines are single arcs, designed so as to give free vortex type flow at the front runner outlet and axial flow at the rear runner outlet. The front and rear blade numbers are 5 and 4, and both solidities are 1.1 irrespective of radius.

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