Proceedings of the Tenth (2012) ISOPE Pacific/Asia Offshore Mechanics Symposium
Vladivostok, Russia, October 3-5, 2012 www.isope.org

ISBN 978–1 880653 93-7: ISSN 1946-004X

The models of Sea Waves Energy Converters

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ABSTRACT

The models of some wave energy converters are considered. To study physical processes of hydrodynamics in wave power converters the numerical calculations for several variants of structures like OWEC and OWSC are performed. The results of model experiments on irregular wind waves for OWSC model are presented. The new variants of converters are proposed. To improve efficiency of wave converters the additional devices for receiving and converting wave's energy are offered.

KEY WORDS: Wave energy; converter; OWEC; OWSC; numerical calculation; model experiment.

INTRODUCTION

Power industry of Kamchatka and Kuril Islands uses mainly imported fuel. Price of energy here is higher to five times than in the world due to transport costs. On the other hand, here there are favorable climatic conditions for the development of sea wave power stations. The average potential of wave energy on the east coast is estimated at 40 kW/m. If we assume, that the efficiency of wave power converters is 50%, the technical potential of wave power on the coast of 10 km long can be 150 MW - this is existing energy consumption of entire Kamchatka.

Korobkov (1986), Sichkarev et. al (1989), Falnes et. al (1991) describe many patents of wave converters. Nevertheless, to achieve their practical efficiency, careful analysis and coordination of functional elements is required with taking into account real local conditions. It is known that sea waves have a wide frequency range. Power plant, designed only to large waves, will not work at weak waves, and the installation is designed only for weak waves, can be easily destroyed by storm waves. Therefore, at a designing of power plants need to lay a large reserve of strength. As a result, many well-known technical solutions are giving little return.

This paper considers some features of the two types of converters for waves in near shore and offshore waters: a) Overtopping Wave Energy Converter (OWEC) or Wave Energy Harnessing Breakwater (Kobayashi, 1989; Tjugen, 1993; Koutitas et. al, 2008; Zhen et. al, 2008), б) Oscillating wave surge converter (OWSC) (Whittaker et. al, 2005, 2011; Cameron et. al, 2010).

OWEC MODEL

Fig. 1 shows a diagram of OWEC cross-section. Working pressure Δh is created because of overtopping waves and filling the tank between the front and back walls. Underwater part of the back wall has openings (channels) with the hydro generators. Cross-sectional area of channels should be optimized to provide a suitable flow rate. To do this, should be maintained the maximum water level in the reservoir because flow velocity v in the channel depends on difference of water levels Δh in the reservoir and at sea:

$$v = \sqrt{2g\Delta h}$$

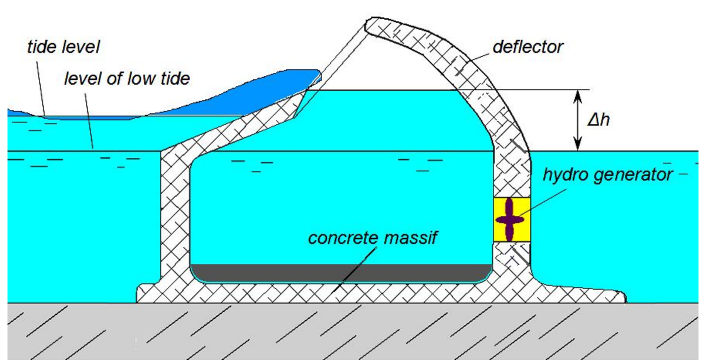

Fig. 1. Simple type of OWEC with low-pressure hydro turbines

Thus, statistical parameters of waves, cross-sectional area of channels, shape and size of the reservoir should be agreed with each other. When designing a system must take into account the following criteria:
- maximum flow of water through the water turbine;
- exception of the reflected waves overtopping back through the front wall;
- minimum wave reflection from the front wall;
- minimum loss of wave energy due to friction near the front wall;
- effective operation in a wide range of length and height of waves.