Thermal Performance Simulation of Liquid Metal Magnet Hydrodynamics Wave Energy Converter

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ABSTRACT

In this paper, we describe and provide a model of the heat dissipation inside the Liquid Metal Magnet Hydrodynamic Wave Energy Converter (LMMHD-WEC). There are two sources of heat: Joule heat losses in the LMMHD generator, and a little part of heat losses caused by friction in mechanical parts. Simulation results show that the temperature in the generator increases, but not significantly, and the converter external surface can be assumed as being perfectly cooled. So the LMMHD-WEC system temperature can be assumed safe during operation, according to the simulation, though not yet validated.

KEY WORDS: Heat transfer; LMMHD; Wave energy converter; Modeling.

INTRODUCTION

Ocean waves may become an unquestionable important clean energy sources in a near future. The possibility of converting wave energy into usable energy has inspired numerous inventors: more than one thousand patents has been registered by 1980 and the number has increased markedly since then (Falcão António F. de O., 2006). Difference converters use different working principles (oscillating bodies (Sá da Costa, J.,2003), oscillating water columns(Heath T,2000), overtopping devise(Kofoed JP,2006)) and are suited for different types of locations(off-shore, near-shore, on-shore).

This paper concentrates on a particular WEC, the prototype of the Liquid Metal Magnet Hydrodynamic Wave Energy Converter (LMMHD-WEC). Liquid metal allows a significant increase of electricity production, but, because of the liquid metal goes through the generation channel, energy losses under the form of heat is inevitable, so that the temperature of the system may rise to unacceptable values. This paper tries to study how high temperature rises are and to assess the hazardous to the system.

The paper is organized as follows: the first section briefly description the LMMHD-WEC system; then a dynamic function based on Newton’s Second Law is given, from which the heat transfer models based on the first law of thermodynamics of the system are described; the simulation results are given and that is followed by the conclusions.

THE LMMHD-WEC

The LMMHD-WEC is a semi-submerged WEC; it belongs to a category of WECs called point absorbers, because its diameter is negligible when compared to a typical wave length. It main consists a fixed LMMHD generator and a movable floater which heaves in wave (Fig. 1); when the wave moves from wave crest to wave trough, the ballast drives the floater moving down, then the liquid metal in the LMMHD generator moving down; when the wave moves from wave trough to wave crest, the floater drive the ballast and the liquid metal in the LMMHD generator moving up.

Fig. 1. LMMHD-WEC concept system

A demonstration LMMHD wave energy conversion device as shown in Fig.2, was set up in 2008 in Institute of Electrical Engineering, Chinese Academy of Science.