Energy conversion performance of a triplet BBDB device model under regular wave conditions

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ABSTRACT

In order to study energy conversion performance of the triplet Backward Bend Duct Buoy (BBDB) wave energy device, which is made up of three parallel connection novel BBDB devices, a single BBDB device and a triplet BBDB device in parallel are tested under regular waves in a wave-making pool. In these experiments, the distance between two buoys is set 0.5 m and the airflow direction in chamber is bidirectional in the triplet wave energy device. The total energy conversions of every air chamber are estimated from wave to chamber when wave heights or periods changed. Results show that the total energy conversion efficiency of every chamber of the triplet BBDB device has a narrow unimodal response width to wave period and decreases with the increase of wave height. Under the wave with suitable wave height and response period, many of the total energy conversion efficiencies of every chamber can reach more than 100%, and the optimal conversion efficiency of them is 136.1%. Each chamber of the triplet device has the similar energy conversion properties to that of the single BBDB device, and their energy conversion efficiencies are also very similar.

KEY WORDS: Backward Bent Duct Buoy; wave energy device; air chamber; total energy conversion efficiency; triplet BBDB device; regular wave; optimal conversion efficiency.

INTRODUCTION

At present, there are many kinds of wave energy utilization technologies in the world, most of which are used in the way of a single device or device group to generate electricity. Parallel devices to generate power is a relatively new type of utilization mode, which has some remarkable advantages, such as saving sea area, reducing submarine cables, decreasing offshore construction cost and so on.

The existing wave energy devices mainly belong to the floating oscillating buoy technology, in which the Sharp Eagle Device developed by Guangzhou Institute of Energy Conversion (Sheng, Wang and You, 2013), Chinese Academy of Sciences, the Wave Star ENERGY Device by Denmark (WAVESTAR, 2020) and the Combined Oscillating Buoy Device by Ocean University of China (Correspondent of Guanhai Tingtao Website, 2014) all have the characteristics of parallel connection wave energy devices, but are not really multi-connected device. The multi-connected wave energy device is a wave energy conversion device formed by connecting two or more identical single devices in parallel in the wave incident direction. Few wave energy devices can form a multi-connected device for their shapes and structures, but the single floating BBDB device (Masuda, 1986) is one of the few ones.

Up to now, there is little research on multi-connected wave energy devices in the world (Xia and Kang, 2014; Han, 2015; Astariz, Iglesias, 2015), mainly concentrated in China. Liang and Sun (2003) did some experiments to test the energy conversion performance of multi-connected BBDB devices under regular waves. In these experiments, the BBDB device was composed of the rectangular air chamber in the head, the neighboring buoyancy tank, which had rectangular head and round tail, and the flat duct connected with the air chamber in the bottom. And such several devices are connected in parallel to form a multi-connected device. The wave energy conversion performances were investigated for the single, the double and the triplet BBDB device fixed by various anchoring methods and their optimal chamber conversion efficiencies are 108.9%, 108.3% and 104.5% respectively. Chen (2019) improved the above BBDB device, which had a triangular buoyancy tank tail and a medium height duct, to form the triplet device