Preliminary Concept Study on Converting Wave Energy by a Low Frequency Large Amplitude Oscillating Floater

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ABSTRACT
Wave energy, as a kind of clean and renewable energy, is more and more paid attention to in ocean engineering field recently, as CO2 emission becomes a serious concern around the world. Most popular wave energy converters are designed to extract wave energy by wave frequency movements. However, it is well known a single point moored floater will perform wave frequency small amplitude motions while travelling with low frequency large amplitude in horizontal plane. A concept of point type floater wave energy converter is proposed to collect wave energy by not only wave frequency motions but also large amplitude low frequency oscillations. Two kinds of power take-off devices coupled with Wave Energy Converter (WEC) oscillating at low frequency are investigated by both theory and numerical simulation. One is to convert energy by the velocity of low frequency oscillation, which is not as significant as the other --by the amplitude of low frequency oscillation of the system comprising a semi-stiffness spring.

KEY WORDS: Wave energy converter, low frequency oscillation, semi-stiffness Power Take-Off

INTRODUCTION
Harvesting wave energy becomes a hot topic around world (Clement et al., 2002; Hughes and Heap, 2010; Daughdrill, 2009; Previsic, 2009; Smith, et al., 2009; Chen, et al, 2011), as CO2 emission is recognized as a cause of Greenhouse effect. Many kinds of point type Wave Energy Converters (WECs) are developed since last century, such as Oscillating Water Column (OWC) (Evans, 1976) and Archimedes Wave Swing (AWS) (Cruz and Sarmento, 2007). Usually, wave energy conversion can be divided into two steps (Falnes, 2007): primary conversion – wave energy transferred from sea to oscillating system, and second conversion – captured mechanical energy converted into other form, such as electric. Since the sea surface varies in wave frequency domain and power consumed in the damping resistance is referred as “active power”(Falnes, 2002). it is not surprising that many floating point type WECs adopt damping type Power Take-Off (PTO) devices to couple the velocity of wave frequency (WF) motion.

However, A WEC in sea will suffer not only WF first order wave loads, but also second order wave loads, especially the Low Frequency (LF) component, which could lead to Large Amplitude (LA) oscillations when coupling with mooring system. As shown in Fig.1, a sample of time registrations of displacements of a Single-Point-Moored (SPM) tanker in irregular head waves is plotted.

It can be seen although LFLA motion velocity is relatively low; its stroke is very large compared with wave frequency motions. The energy generated by force times its distance, may be also significant. Based on above idea, a concept design of a point type floater WEC single point moored in sea is proposed to collect wave energy by both above-mentioned parts. The SPM floater will perform wave frequency heave motion while oscillate in surge with low frequency and large amplitude. The classical theory of energy conversion by WF heave...