

On the flushing effect and the likelihood of the environment friendly vertical breakwater consist of immersed water channel and water chamber as a wave energy extraction measure

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ABSTRACT

We numerically analyze the flushing effects and the likelihood of a vertical breakwater consist of immersed water channel and water chamber, originally proposed by Nakamura (1999, 2003, 2005) for the alleviation of reflected waves, as a wave energy extraction measure. As a wave driver, we use the Nerviier-Stokes equations and mass balance equation, and the numerical integration of which is carried out based on the smooth particle hydrodynamics with a Gaussian Kernel function. As a water level in front of curtain wall, where an anti-node of standing wave due to partial reflection is located, approaches its lowest level, a unidirectional flow in the water chamber formed by a preceding wave starts to move offshore. Once it exits water chamber, this energetic flow feeds necessary energy into the vortex in front of the water chamber to sustain long enough until next wave comes. Considering the facts that an intensity of the flow absorbed through the immersed water channel is strongly proportional with an extent and strength of the vortex formed on offshore side of front curtain wall and a curved path line of sucked water particles, we can deduce that aforementioned vortex is responsible for the flushing effects of the vertical breakwater consist of immersed water channel and water chamber. It is also shown that net flux through the immersed water channel increases as the mass inflow into a water chamber is getting larger ($T=1.4\text{sec}$, $L_c=6\text{cm}$), which also confirm our conclusion.

KEY WORDS: flushing effect of vertical breakwater with a water chamber and a immersed water channel; power generator using wave energy; smooth particle hydrodynamics (SPH); sponge layer

INTRODUCTION

Due to the sharp increase in crude oil price and exhaustion of fossil energy such that we have been merely 41 years, 67 years, 192 years away from running out of oil, natural gas, and coal, respectively, the development of alternative, renewable energy is emerged as an urgent task in South Korea, which heavily relies on the imported oil from overseas. Even though nuclear energy is generally regarded to be able

to replace oil, additional construction of nuclear power plant seems to be very unlikely in the near future, considering dysfunction like radioactive contamination and turmoil lately witnessed in the selection of new nuclear waste dump site.

Due to UNFCCC (United Nations Framework Convention on Climate Change) ratified on 21 March 1994 and Kyoto Protocol enforced on 16 February 2005, South Korea, 10th largest greenhouse gas emitting country, will begin the reduction of greenhouse gas emissions in 2013, which will further shake the Korean economy.

Even though it has been a while for tide and waves in the ocean to come into the spotlight as new endogenous renewable resource of humongous clean energy, it has not been fully utilized due to relatively expensive production cost. Lately, to enhance self sustaining of energy and stand up the challenge to reduce greenhouse gas emissions, South Korea teamed up with researchers from KORDI (Korea Ocean Research and Development Institute) commence the construction of pilot tidal power plant at Euldolmok, Garhorim bay along the west coast of Korean peninsula where a heavily indented coast provides tide activated power plant friendly water environment to accumulate necessitated technology and experience to commercialize tidal power plant.

For a case of wave activated power plant, less expensive than tidal power plant, U.S. Department of Energy (DOE) and State governments of Oregon, Washington, Maine, Hawaii, Massachusetts, and California launched E2I EPRI (Electric Power Research Institute) program to boost energy generation from renewables. E2I EPRI aiming to run pilot wave power plant of floating type of 1,500 MWh by 2006, and move on to build commercial floating type wave power plant of 300,000 MWh and now is encouraging main manufacturers of wave activated power plants to improve their facilities like Pelamis, Sea Dog, Wave dragon, Energetech, Aqua-energy to meet this criteria. Based on these facts, world wide renewable electricity market from ocean waves is already formed and will be in full blossom in coming years (Previsic et al., 2004).

In order of aforementioned floating type wave power plant to have a commercial competitiveness against conventional generation plant, 40-300m long swells should be prevailing few kilometers off the coast for