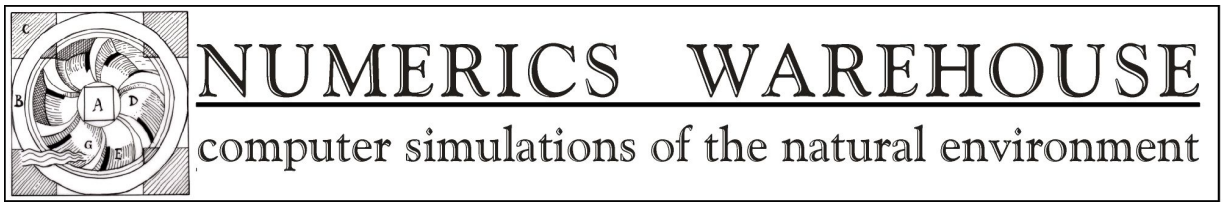

Report Title

Preliminary Appraisal of the Balkee Wave Energy Converter

By Marcel Curé

Report Date

3rd September 2011

Report: Balkee Wave Energy Converter

Numerics Warehouse Report: NW_Balkee_2011_01

Technical Lead: Marcel Curé (Ph.D. M.Sc.)

Report Revisions

Revision Number	Date	Note	Author
1	03/09/11		Marcel Curé

Contents

1. Introduction

Based in in Ireland, Numerics Warehouse Ltd. are specialists in supercomputer based renewable energy resource evaluation using numerical models. Our customers include some of the companies with some of the most promising upcoming ocean energy technologies such as OpenHydro (Tidal turbines), Tonn Energy (Wave Energy), energy utilities like the Swedish giant Vattenfall and ESBi, and government agencies like Sustainable Energy Authority of Ireland and the Irish Marine Institute.

We came across the Balkee Wave Energy Converter during a business visit to Mauritius. We were struck by how extraordinarily simple the concept of this wave energy converter was, with two simple levers employed to convert linear vertical motion into rotary motion suitable to turn a permanent Magnet Alternator or a pump. We observed the device functioning in a test tank at the inventors laboratory. The simple prototype was coupled to a alternator which generated electricity – sufficient to power a light bulb in very small waves.

The efficiency of the WEC and its performance under a uni-modal wave spectrum have not been previously evaluated, but using the simple wave energy flux equation for deep water linear waves it is possible to make a rough estimate of the percentage efficiency of the device as configured – including wave response of the float, energy losses due to friction in the levers, ratchets etc. and the alternator .

This brief report is intended to make an appraisal of the technology *at its current state of development* and to recommend further appropriate studies. We feel that the inventor Rajendraneth Balkee has shown himself to be extraordinarily resourceful to turn his simple but elegant idea into a basic prototype, to test it from a small craft at sea, and to apply for and be granted a UK patent. Clearly this WEC has a very motivated product champion behind it and deserves further study. This brief report is the first stage in this process.

Figure 1 photograph of the device undergoing tests in a harbour.

2.0 The Balkee WEC Concept and its relationship to other types

The basic difference between the Balkee converter and other types is that it uses a system of mechanical levers to create rotary motion from the movement of a surface following float. Most other WEC's use waves to either compress air or a fluid, which is then used to drive a turbine. The use of a turbine will itself cause a loss of efficiency – especially when it is considered that turbines have a narrow range of speeds over which they work well without further complicating them with adaptive controls for the angle of attack of the turbine blades. Turbines also need to run at a moderate or high speed (not a good idea in the marine environment) and they are expensive to produce.

The Balkee converter uses 'Lazy Tongs' (see fig. 1), which means that there are very few moving parts and very few frictional bearings. In fact the device has only 6 simple hinges and two ratchets before the rotational motion is applied to the alternator. This means it should be possible to create (using suitable materials) a highly efficient power train. The simplicity of the components also means that the device should be inexpensive to produce.

3.0 Basic power calculation

Out of curiosity an attempt was made to enumerate the efficiency of the prototype.

The power flux attributable to linear deep water waves is given by :-

$$P = \rho g^2 H^2 \frac{T}{64\pi}$$

where P is the power in W/m, ρ is the density of water (1025 kg/m^3), g is the accelaration due to gravity (9.81 m/s^2), H is the wave height in m, T is the wave period in s.

During a simple test using the configuration shown in fig. 1 it was reported to us by Mr Balkee that H = 0.15 m, T = 4 s. This gives a power in the waves of 40 W/m. The float has an exposure of 0.3 m to the wave front so the power available to the device is 12 W. The device was reported to generate sufficient electricity to power a light bulb of between 5 and 10 W. This implies an efficiency of between 42 to 83 %

Clearly this calculation was made using some figures which need to be measured properly, but the very high efficiency found encourages us to do the tests under wave tank conditions with proper transducers, waves with known characteristics and over a wide range of waves.

The device itself needs to be built to a higher specification, including more attention to the bearings and the float. It is expected that even simple improvements will increase the efficiency.

4.0 Conclusion and recommendations

Based on the promise of the innovative concept itself and of the rudimentary power calculation performed, it is recommended that the WEC be considered a suitable candidate for proper testing in a wave tank. The device needs to be built to a much higher specification for these tests. The tests should cover a range of wave heights and periods. The float should be altered systematically to see how the shape and size affects the power transmission.

We commend the inventor and wish him well in developing his innovative wave energy converter.