

CONCEPTUAL DESIGN AND ANALYSIS OF A NOVEL
WAVE ENERGY HARVESTER FOR MALAYSIAN
SHORE

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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**CONCEPTUAL DESIGN AND ANALYSIS OF A NOVEL WAVE
ENERGY HARVESTER FOR MALAYSIAN SHORE**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for Bachelor's Degree in Engineering Technology
(Mechanical Technology) with (Hons.)

by

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Maintenance Technology) (Hons.). The member of the supervisory is as follow:

.....

(Project Supervisor)

ABSTRAK

Ombak merupakan salah satu sumber tenaga yang boleh diperbaharui yang boleh diubah menjadi sumber tenaga elektrik. Sumber asli menjadi penyumbang utama dalam sistem penjanaan elektrik dan sumber ini lama-kelamaan akan habis. Kajian projek ini adalah lebih kepada untuk menyelesaikan masalah ini. Malaysia dikelilingi oleh perairan yang menjadikan ia satu kelebihan jika terdapat alat untuk menjana elektrik bersumberkan kuasa ombak dibangunkan. Tetapi, kekuatan ombak yang terhasil di perairan Malaysia adalah tidak sekuat seperti yang ada di negara-negara yang mengkomersilkan penjanaan kuasa elektrik berasaskan tenaga ombak. Dalam projek ini, reka bentuk teknik baru dalam memanfaatkan tenaga ombak telah dibuat untuk mengoptimumkan penggunaan kuasa ombak. Hasil lakaran rekabentuk dilukis dengan lebih terperinci didalam perisian SOLIDWORK. Bahan untuk membuat alat ini dipilih mengikut kajian tentang bahan supaya ia dapat bertahan. Kimpalan arka digunakan untuk menyambung bahagian-bahagian semasa proses fabrikasi. Di akhir projek ini, alat penjanaan tenaga elektrik ini akan diuji menggunakan voltmeter untuk mengetahui nilai kuasa elektrik yang terhasil.

ABSTRACT

Wave is one of the renewable energy sources that can be harnessed to produce electricity. Fossil fuel is the main contributor to the electric power generation and this source eventually will extinct. This project research is more to solve this problem. Malaysia is surrounded by waters which make this fact as an advantage if there are electric power generations based on wave energy produced in Malaysia. But, the wave power generated in Malaysian waters is not powerful as wave power available in countries which used this type of renewable source to generate electric power commercially. In this project, new technique in taking advantages of wave energy was done to optimized use of wave power. The sketch of the design has been drawn more thorough using SOLIDWORK software. Materials to build this device were chosen based on the study of material to make sure it is reliable. Arc welding was used to join parts during the fabrication process. At the end of this project, wave electric generator was tested by using a voltmeter to measure the electric power produced from the device.

DEDICATION

I would like to dedicate my project to my beloved parents, my supervisor Mr Azrin Bin Ahmad and to all my friends for supporting me from the beginning till the completion of this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

UK	-	United Kingdom
OWEL	-	Ocean Wave Energy Ltd
USA	-	United States of America
MMS	-	Jabatan Meteorologi Malaysia
kW	-	Kilowatt
m	-	Meter
s	-	Second
P	-	Wave propagations
Hs	-	Significant wave height
Tz	-	The zero up crossing wave period
MATLAB	-	Matrix Laboratory
OCS	-	Outer Continental Shelf
HOQ	-	House of quality
SOLIDWORK-	-	Solid modelling CAD (computer aided design)
cm	-	Centimetre
GPa	-	Giga pascal
MPa	-	Mega pascal
°C	-	Centigrade
mm	-	millimetre
CNC	-	Computer numerical control
PC	-	Personal computer
FMEA	-	Failure mode and effect analysis

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Malaysia is among the fast developing nations within Asian countries. This particular development will increase to electrical power usage on the following 10 years need. Fossil fuels are actually a common source of energy for years. No doubt in the near future, Malaysia still continues to require fossil fuel due to the fact that almost all of the major present systems depend upon that. Fossil fuel burning such as gasoline and coal leads to environmental pollution by causing smog, acid rains and also affect to living things including human. Modern technological innovation gets risen up to answer this concern. Currently, newer research has been done like developing technology to harness solar energy and wind power. By looking forwards the technological innovation just like wave energy provides a greater chance of a long term energy generation in Malaysia, the particular search for clean, risk-free and also environmentally friendly electricity creation method demands hard work from modern society and also a paradigm move.

Renewable energy is the best alternative option since the resource does not have environmental effect like non renewable energy sources have and wave energy is regarded as the most dependable renewable energy. Renewable energy refers to the energy source that occur naturally and continuously in the environment and can be harnessed for human purpose. Winds would be the primary contributor of generating wave energy. The process of generating wind began with the differential

heating system from the earth surface and created wind gusts. As the wind gust going pass through open water, they exchange some of their power and creating oscillatory movement or vibrating motion on the water surface then come up with wave. Extraction of energy from waves is way more productive due to the fact that waves are more concentrated in form of energy compared to the wind energy.

For many years, researchers happen to be attempting wave power as a source of renewable energy. Professionals have developed a variety of mechanisms designed for collecting wave energy, this includes tapered channel systems that funnel wave into a turbine, underwater turbines powered by currents and float system that rise and fall on the water's surface and driving pistons that convert the motion into energy. According to the World Energy Council, which is an international consortium promoting renewable energy, ocean waves might produce two times more electrical power consume by global consumer. Wave energy through the ocean is the best option since the resource is actually free. However wave activity is so dispersed and hard to harvest this energy economically.

The purpose of the project would be to carry out an initial research to discover potential wave energy generation for use within Malaysia by looking from a few aspects and factors. Precisely why wave energy has been chosen, because it is more vast as well as more reliable than any other power sources. Even though some innovations tend to be ongoing, but still it is far from any power resource which adequately developed in Malaysia since the practicality as well as economics associated with harnessing wave energy is dependent on many aspects, especially geographic area and season that could trigger several issues towards the development of the electric power generator based on wave energy. All the research involved in the wave characteristic like wave height, wave period and wind speed are necessary in producing and developing a working and efficient electric generator based on wave power. The information regarding forecast of sea condition may be derived from the Malaysia Meteorological Department.

The development of renewable energy sources also an effort to reduce the emissions of greenhouse gases as prescribed by the Kyoto protocol. Among renewable energy sources, sea waves develop the highest amount of the energy density. Ocean wave energy has the potential to be commercially produced in rapidly than other green energy technologies, achieving the most effective progress level (Muzathik, 2010). However, wave energy has not yet been used to the substantial level within Malaysia, or elsewhere in the world. Wave energy conversion still remains a part of novel technologies for most countries although there are benefits from it. Table 1.1 show about existing wave energy device that can be found around the world.

Table 1.1: Examples of existing wave energy converter devices. (Wikipedia, 2014)

DEVICE	PROPONENT	COUNTRY OF ORIGIN	CAPTURE METHOD	YEAR BUILD
Anaconda Wave Energy Converter	Checkmate SeaEnergy	UK	Surface following attenuator	2008
AWS- iii	AWS Ocean Energy	UK (Scotland)	Surface following attenuator	2010
CETO Wave Power	Carnegie	Australia	Buoy	1999
Cycloidal Wave Energy Converter	Atargis Energy Corporation	USA	Fully Submerged Wave Termination Device	2006
OWEL	Ocean Wave Energy Ltd	UK	Wave Surge Converter	2013
Oyster Wave Energy Converter	Aquamarine Power	UK (Scotland-Ireland)	Oscillating Wave Surge Converter	2005

1.2 Problem Statement

Fossil fuels are non-renewable and will inevitably expire considering that it is used faster than it can be produced. Malaysia is among the fastest developing nations within Asian countries. This particular development will certainly increase the electrical power usage on the following 10 years. Fossil fuels are actually a common source of energy for years. But because of the fact that it will extinct in the future, search for another source of energy is necessary to prevent shortage of electricity.

Burning fossil fuels produces toxic waste such as photochemical pollution from nitrous oxides, and acid rain from sulfur dioxide. It also produces greenhouse gases, including large amounts of carbon dioxide that caused global warming phenomena which the earth is currently experiencing. This is a very serious problem because it not only affects our ecosystem, but the effect of the pollution from the toxic waste also can put human in danger. To prevent this problem before it becomes even worse, power generation which is not producing any chemical waste is needed.

Most of the power plant needs bigger area. In the future, land area will become limited because of several factors such as population growth and construction works. In the future, electricity consumption also limited and more power plants are needed. Fossil fuel power plant is not suitable to be built in the water area as it will become threats to water pollution and damaging ecosystem of the area. A solution is needed to prevent the problems in future.

1.3 Objectives

The general objective of this project is to contribute to the development of a wave energy converter system to the electrical power as well as to make sure it is suitable to use in Malaysian coastline. Understanding of wave character in the Malaysia region also includes to achieve the target of this research.

This general objective can be broken down to two specific objectives that would together achieve the overall goal of the project as follows:

- (i) Design and develop new electric generator based on renewable source (wave energy).
- (ii) To measure the energy produced from the wave.

1.4 Scopes

In order to make sure this project is on track and achieved as planned, several scopes were set as follows:

- (a) To design a wave electric generator for Malaysian coastline used.
- (b) To produce a low cost electric generator powered by wave energy.
- (c) To study various designs of wave energy harnessing technique
- (d) To develop a novel technique to convert wave energy to electrical power

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to the Wave Energy

The world is covered by almost 70 percent of water. There are possibilities that the resource can be harnessed and use to generate electric power. The wave holds some sort of large amounts of untrained power, and need only little from the power to generate electricity.

Certainly, just only 0.2 percent of the energy within ocean waves might provide power to the whole world (Drollette, 2006). With all this information, this may create a question why people are not paying more attention to invest in the development of wave energy. It is easy to do the research on an assumption of how much power does the wave can give us, but the difficult part is coming up with what approaches to convert this specific power directly into useful energy. In the following sub topic, there are several methods of innovations from inventors to manipulate this renewable source.

2.1.1 How Wave is Generating

The sun does not temperate our planet equally. Based on the Earth's natural formations along with the direction towards the sunlight, a few places obtain heat a lot more than others. Because a few air get heated, it might be much less dense and therefore the lighter air will float upwards. This particular simply leaves an area for denser and cooler air to rush in and fill the area.

Wind also a major contributor to the forming of big waves on the ocean. When the winds push right up to the ocean surface, the friction between them causes ripples. A larger wave created when the wind consistently continues to push against these ripples in a snowball effect. Basically, this phenomena is a result from the transferring energy from the sun to the wind and lastly generating the waves (Ren-Chieh Lien, 2013). There are a few factors to determine how a strong wave can be formed. These consist of:

- Wind speed : Faster wind will produce a bigger wave.
- Time of wind : Longer the time for wind to hit the wave, bigger it can be.
- Wind distance : The farther the wind travels against the wave (known as fetch), the bigger it will be.

Water operates as the medium for transferring kinetic energy. Water only moves in a circular motion and act like rollers in conveyor belt to transfer the energy. The particles rotate in order to move the belt upward, but they do not go in front in the process. The speed of the ocean waves will change whenever it moves to a various level of depth as shown in Figure 2.1. The direction of the ocean wave movement will change from the actual path when the speed is switching from slow to faster or otherwise. Ocean waves move quicker within deeper area compared to shallower area (Forget, 1996). Therefore refraction (bending) associated with ocean wave happens. The reduction in pace may also be along with a reduction in wavelength.

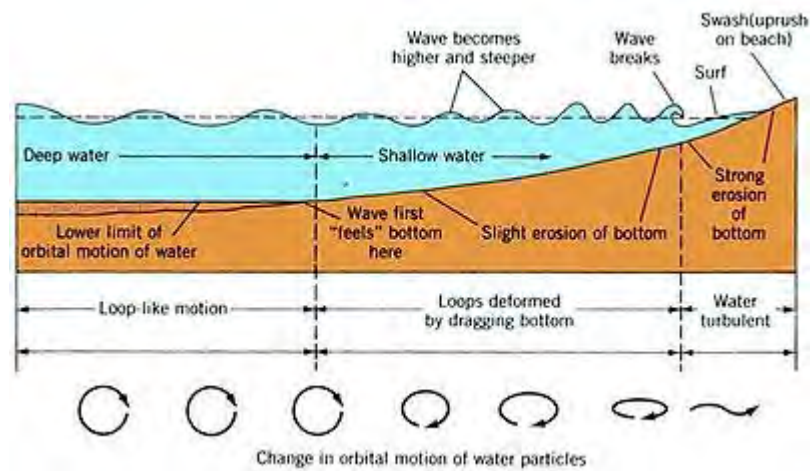


Figure 2.1 : Changes of wave pattern in different depths. (Akbar, 2011)

2.1.2 Relations between Wave Characteristic

2.1.2.1 Wavelength and Speed.

Wavelength depends on how fast the wave is moving. In deep water, faster wave speeds will produce a longer wave. The waves become shorter when the speed is decreasing in a shallower area. A group of wave must be used to measure the estimated time it takes for the waves to travel between two locations.

2.1.2.2 Energy and Height.

When wave height increase, wave energy also will increases. This connection is very important in predicting wave height. Predictions of wave heights must be placed around a narrow range as error in height are increased dramatically for wave energy and the potential of breakdown.