Advances in Environmental Biology, 8(22) November 2014, Pages: 116-119

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Study of Tidal Current Power Generation by Vertical Axis Underwater Turbine with Diffuser in Costal Peninsular Malaysia

Azman Idris, Azim Arshad, Shahrani Anuar, Ahmmad Shukrie and Rosdi Hussin

Energy Sustainability Focus Group, Faculty of Mechanical Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

ARTICLE INFO

Article history:
Received 25 September 2014
Received in revised form
26 October 2014
Accepted 25 November 2014
Available online 31 December 2014

Keywords:

ABSTRACT

Tidal water current in Malaysia can be used as a resource to generated electricity by using turbine, however the velocity of water is very low and the installation of diffuser can accelerate the water velocity. This study purpose is to study the effect on velocity when a diffuser is installed in a turbine and the potential power generation of a turbine produce. The study was analyzed by using 2 dimensional computational fluid dynamic (CFD). The simulation was done with the same size of diffuser but different kind of velocity. The velocity range for this study is from 0.3 m/s – 2 m/s. This velocity was selected because is this study the area selected for this installation of turbine is at Pulau Pangkor where the average minimum velocity is around 0.3 m/s and the average maximum velocity is 2 m/s.

To Cite This Article: Azman Idris, Azim Arshad, Shahrani Anuar, Ahmmad Shukrie and Rosdi Hussin., Study of Tidal Current Power Generation by Vertical Axis Underwater Turbine with Diffuser in Costal Peninsular Malaysia. ***Adv. Environ. Biol., 8(22),*** *116-119, 2014*

INTRODUCTION

Malaysia is one of the countries that depend in oil industry and coal production for electrical energy generation. However the fossil fuel is depleting year by year. Therefore it is vital for Malaysia to find and alternative source to cope with the problem. As a tropical country it is a good step taken by the government to find alternative source using renewable energy. A huge potential can be seen for Malaysia in harnessing tidal energy to meet energy requirement contribution.

The average velocity of tidal range in peninsular Malaysia is around 2 m / s. Therefore a setup of diffuser is a good way to increase the velocity of tidal. The article means to study the effect of velocity flow through the diffuser and power potential generated from velocity produce.

2. Material:

2.1. Type of channelling device:

Geometry hydrodynamic profile of the pontoons is related to channelling device. There are three main part of internal channelling that is nozzle, straight channel and diffuser. Nozzle help the velocity of water inside the neighbourhood rotor accelerate more than the current speed. For straight channel the function is to maintain the flow uniformly in the rotor zone. Diffuser act to adjust the flow passing through the rotor zone to the outlet condition. At projected upstream zone of the bow the device flow into two parts between pontoons and outside the pontoons.

To analysis the external flow we need to add two other parts that is bow and deflector. Bow function to smooth the development of flow upstream of the nozzle inlet. Deflector act for transferring internal and external flow ones by creating a suction zone downstream which accelerated the internal flow and compensates the energy extracted by the rotor [1]. Figure below the design of a diffuser use to be analyse.

2.2. Types of Turbine selected:

Nowadays there is a lot of turbine is been develop. The style may be different from rotor design, number of blades and shapes [2]. For this study the turbine selected is from the company new energy corporation inc. This turbine was selected based on the characteristic which is suitable to be installed in peninsular Malaysia.

Corresponding Author: Azman Idris, Energy Sustainability Focus Group, Faculty of Mechanical Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
E-mail: azman_cowt@yahoo.com

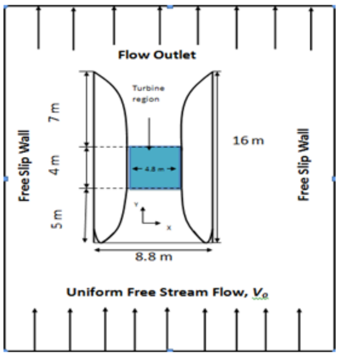

Fig. 1: Diffuser.

Table 1: Characteristic of turbine.

Characteristic	ENC-025-R5
Max. Power	25 kW
Water velocity at Max.power	3 m/s
Rotor speed at Max. power	40 RPM
Overall system Mass	1760 kg
Overall system height	4.24 m
Rotor diameter	3.40 m
Rotor height	1.7 m
Efficiency	30 %

Fig. 2: Turbine Selected. (source//http.www. New Energy Corporation inc).

2.3. Site selection:

There are three sides in peninsular of Malaysia which have the highest tidal current [3]. (a) Pulau Pangkor (b) Melaka (c) Perlabuhan Kelang. This side was identifying by using the software TPXO where they use satellite imaging data to predict the tidal height and tidal current.

Table 2: Tidal Current.

Location	Avg.Min velocity (m/s)	Avg.Max velocity (m/s)
Pulau Pangkor	0.3	2
Melaka	0.2	1.5
Perlabuhan Kelang	0.1	1.2

3. Methodology:

3.1. Computational fluid dynamic:

The problem that involves fluid flow can be solve by using CFD.CFD uses numerical method and algorithms to perform the calculation involve the interaction of liquids or gases with surface defined as boundary condition[4]. The inlet boundary is set as the uniform flow velocity and the outlet boundary is set as outflow. The flow is set to be an axisymmetric steady flow whereas the turbulence model is RNG k-Ɛ model. Based on figure 1 the design model was based on profile A0A1 by ponta et.al.[1]. The inlet velocity was set from 0.3 m/s to 2 m/s and the corresponding shroud turbine velocity,*V* were obtain. The coefficient of velocity *Cv* where obtain by using *Vo* where *Cv* is *V / Vo*.

3.2. Power Generated:

Tidal stream power density working principle is by extracting kinetic energy of fluid from a current flow. The cube of the flow velocity is related to the tidal hydraulic power density[5].

Advances in Environmental Biology, 8(22) November 2014, Pages: 116-119

$$P = \frac{1}{2} \times l \times Ao \times U^3 \times \Pi \quad (1)$$

ℓ = Density of fluid
Ao = Cross-sectional area of turbine
U= Current speed (m/s).
Π= Turbine efficiency

Placed can effect he potential power of tidal in stream device because the calculation is based on tidal-current velocity. Buy summing up the harmonic constituent wave we automatically can predict the tide level which corresponds to a particular astronomical influence. The predicted of tidal current can be more difficult by their sensitivity to bathymetry and landmasses.

4. Result:

Figure 4 show the coefficient of velocity *Cv*, data against the point inside the diffuser *(Xo)* over the distance between the 2 diffuser (*D*). Figure 3 showed what the measurement of *Xo* is and also *D*.

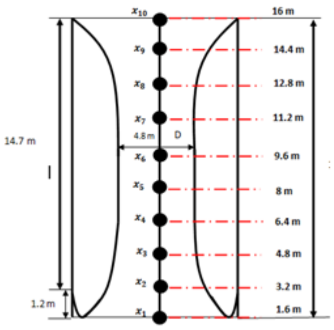

Fig. 3: Distance Xo and D.

Table 3: Cv and (Xo/D).

Coefficient of Velocity, Cv						Distance Xo over D
0.3	0.64	0.98	1.32	1.66	2	
1.17	1.15	1.14	1.14	1.44	1.15	0.33
1.38	1.35	1.33	1.33	1.33	1.33	0.67
1.55	1.53	1.53	1.52	1.52	1.52	1
1.63	1.63	1.62	1.62	1.62	1.62	1.33
1.63	1.63	1.63	1.63	1.64	1.64	1.67
1.61	1.61	1.61	1.62	1.62	1.62	2
1.53	1.54	1.54	1.55	1.56	1.56	2.33
1.38	1.39	1.40	1.40	1.41	1.41	2.67
1.20	1.21	1.22	1.23	1.23	1.23	3
1.05	1.07	1.08	1.09	1.09	1.09	3.33

Figure 5 showed the result of potential power generated by the turbine by using mathematic calculation and the actual power generated.

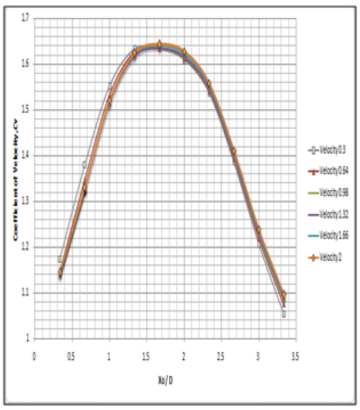

Fig. 4: Cv against (Xo/ D).

Advances in Environmental Biology, 8(22) November 2014, Pages: 116-119

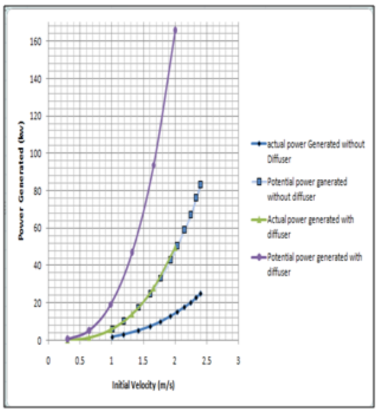

Fig. 5: Actual Power Generated and Potential Power Generated.

Table 4: Power Generated without Diffuser.

Actual Power generated (kw)	Potential Power generated (kw)	Initial Velocity (m/s)
1.82	6.07	1.01
3.09	10.31	1.19
5.26	17.53	1.42
7.50	25.01	1.61
9.94	33.14	1.77
12.92	43.06	1.93
15.17	50.57	2.03
17.79	59.28	2.15
20.13	67.09	2.25
22.83	76.09	2.33
25.00	83.32	2.40

Table 5: Power generated using Diffuser.

Actual Power generated (kw)	Potential Power generated (kw)	Initial Velocity (m/s)
0.16	0.55	0.3
1.57	5.23	0.64
5.72	19.06	0.98
14.07	46.90	1.32
28.09	93.65	1.66
49.71	165.72	2

Conclusion:

From this study we know that diffuser helps to increase the velocity of water thus the power generated by the turbine will increase too. However further research has to be done to understand the flow condition around the diffuser and the characteristic of the diffuser

REFERENCE

[1] Ponta, F.L. and P.M. Jacovkis, 2008. "Marine-current power generation by diffuser-augmented floating hydro-turbines," Renew . Energy, 33(4): 665-673.
[2] Megan DeGraaf and Jason Mather, 2010. " The Potential of Tidal In-Stream Energy Conversion Turbines".
[3] Lim, Y.S., S.L. Koh, 2010. "Analytical assessments on the potential of harnessing tidal currents for electricity generation in Malaysia" , Renewable Energy, 35: 1024-1032.
[4] Khunthongjan, P. and A. Janyalertadun, 2012. "A Study of diffuser angle Effect on Ducted water current performance using CFD."Songklanakarin J.Sci,Technol., 34(1): 61-67.
[5] Jack Hardisty, 2009. "The Analysis of Tidal Stream Power" John Wiley& sons inc.
[6] Sustainable hydropower, 2009. New energy corp.com.http// www.new energy corporation.com