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The Perspective of Hydropower as Renewable Energy

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ABSTRACT

According to environmental impact of fossil fuel, growth population and demand for energy, it is compulsory to replace the fossil fuel with renewable energy. Hydropower as a renewable energy possesses a lot of potential to provide energy and it is essential to improve the kinetic energy devices to harness the energy of water.

KEY WORDS: *Energy Demand; Hydropower; Turbine.*

NOMENCLATURE

C_T	torque coefficient
C_P	Power coefficient
T	Torque
P	Power
R	Radius
$V0$	Velocity
ρ	Density
A_{ref}	Cross section
λ	Tip speed ratio

1.0 INTRODUCTION

With the increase in awareness about the importance of a sustainable environment, it has been recognized that traditional dependence on fossil fuel extracts a heavy cost from the environment.

Hence keeping in mind that currently, the world is heavily dependent on fossil fuels which are rapidly diminishing, the role of renewable energy has been recognized as great significant for the global environmental. Also, majority of remote area that place beside current water are very poor, with low living condition and limited access to media and information.

It is proof that utilization of electricity energy is key of economic growth and improvement of people's living standards so to improve and development living level of remote area residents, providing of electricity is essential.

There are different kinds of renewable technologies, such as biomass, wind, solar, hydro and geo thermal, which are clean and reliable to reduce greenhouse gas emission that leads to global warming, while saving money and creating jobs. Among different renewable energy technologies, hydro power generation (large and small scale) is the prime choice in term of contribution to the world's electricity generation due to hight density and continuse avaibility [1, 2].

There are two main types of kinetic energy conversion rotor, horizontal axis (axial-flow) and vertical axis where the turbine blades would turn the generator by capture the energy of the water flow to produce electricity [3-7].

2.0 DEMANDS FOR RENEWABLE ENERGY

The constraint from global warming and high oil price lead to the worldwide concerns to intercept the serious impacts on both the economic growth [8-10] and the environmental pollution [11-13]. Population growth has significant effect on the demand for energy that still the much of energy supply is fossil-based resources which the consumption of fossil fuels caused to serious environmental problems especially CO_2 emission. According to International EnergyAgency (IEA), nearly 68% of the worldwide electricity was generated from the fossil fuels, nuclear (13.4%), hydro (15.3%) and others (3.3%) [14]. Therefore, the renewable and cleaner sources of energy are essential to safe the future electricity supply for the developing countries including Malaysia.

3.0 ENERGY SUPPLY IN MALAYSIA.

At present time, the electricity generation by using the gas turbines through gas-fired combined cycle plants is the main source of electricity power in Malaysia and followed by the steam stations [15]. The supply and demand of electricity increased owing to the population growth. By 2030, the predicted demand of Malaysia may be more than 150,000 GW h (1.5 times of the demand in 2010) [16]. But use of fossil fuel for power generation release greenhouse gasses (GHG) to cause the environmental effects. As a result, a clean energy source is essential to protect the environment and generate electricity. According the geographical location of Malaysia, it has a high rainfall rate around 250cm per year. Also, this country has a long coastline such as straits of Malacca and many rivers with great potential to generate electricity from current water as renewable technology especially for remote areas [17]. Malaysia is offering the renewable energy to reduce the high dependency on fossil fuel. The usage of renewable resources is providing 1% of the annual electricity generation in 2011,the influence of renewable energy can reach 16.5 GW h or 13% of the total power generation by 2030 [18].Thus, to harness more energy of current and more contribution of hydro to provide electricity, it is necessary to improve and development kinetic energy devices

4.0 HYDROKINETIC TECHNOLOGY

Hydrokinetic energy can be generated from ocean, river or any water stream. Hydrokinetic or water current turbines, produce electricity directly from the flowing water in a river or a stream. The turbine blades would turn the generator and capture the energy of the water flow [19].

Conventional hydropower generation is done by building dams and the energy of falling water, running the turbine to generate electricity. Hydropower generation has negative environmental effect and is costly, but the new category of hydro power energy uses kinetic energy of stream instead of potential energy.

It is considerable that hydrokinetic turbine has a lot of similarities with wind turbine in terms of the physical principles of operation, electrical hardware, and variable speed capability for optimal energy extraction [20]. However, water is almost 800 times denser than air, therefore hydrokinetic turbines are more efficient than wind turbine even at low speed [21], [22].

4.1 Turbines

According to alignment of rotor axes with respect to the water flow, there are two main category of turbine to harness kinetic energy of water to generate electricity, horizontal axis (axial axis) and cross flow (vertical axis turbine)[3-7] as shown in figure 1 and 2. Which both types depend on condition and size can be used for river or marine. Inclined axis more used in river application and other axial-flow turbines are mainly used for the extraction of ocean energy. In the vertical axis domain, Darrieus turbines are the most prominent options that use of H-Darrieus or Squirrel-cage Darrieus (straight bladed) turbine is very common.

There is no consensus yet on whether horizontal-axis or vertical axis will be the best option for using current water energy but the vertical axis turbine appears to be advantageous to the horizontal axis turbine in several aspects [23].

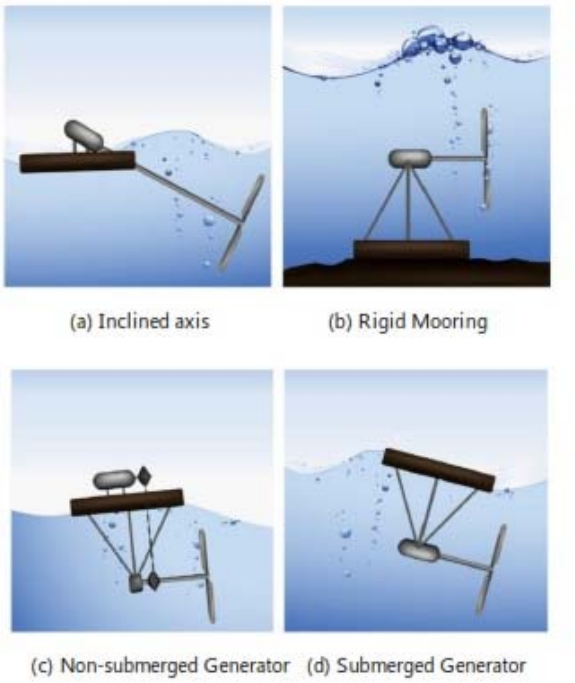
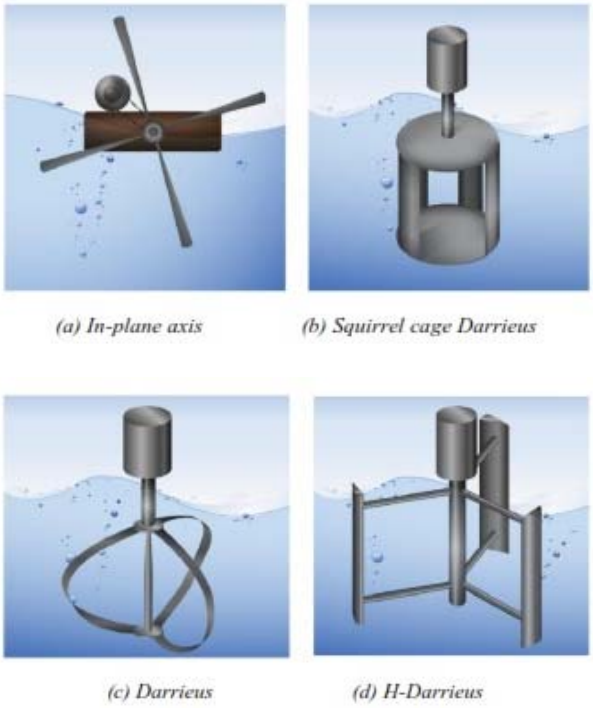
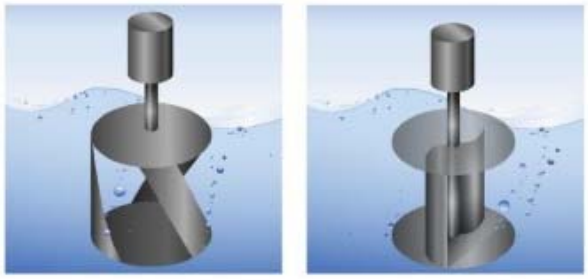


Figure 1: horizontal axis turbine





(e) Gorlov (f) Savonius

Figure 2: vertical axis turbine

4.2 Operational Principles

Most of the principals of this type of turbine are based on wind turbines, as they work in a similar way. The following parameter can show operation of turbines:

Tip speed ratio:

$$\lambda = Rw/v_0 \quad (1)$$

Torque coefficient:

$$C_T = T/ (1/2)\, v_0^2 \rho\, R\, A_{ref}, \quad (2)$$

Power coefficient:

$$C_P = P/ (1/2)\, v_0^3 \rho\, R\, A_{ref} \quad (3)$$

Power output:

$$P = T.w \quad (4)$$

R is the maximum radius of the rotor, V_0 is the velocity, ρ is the water specific weight, $A_{ref}$is cross section (2RH in VACT and Π R^2in HACT), P is power, T is torque and w is angular velocity.

The equation (3) showed that the power increase in a cubed of velocity of current past from turbines, thus velocity of water flow has effect on power output. [24] mentioned two main parameter for performance of turbines are torque and tip speed ratio (TRS) that torque output of the turbine has a significant effect on the total power output. [25] mentioned according to Beltz law the maximum power coefficient can be 0.59 (theatrical maximum power coefficient). But [26] showed the maximum C_P for river was around 0.25 that the river turbine can produce power in range 1-10kw [27] and minimum workable velocity for river is 0.8-1 m/s and [28] mentioned for marine C_P was around 0.35-0.5 that the high value of efficiency usually related to HACT and turbine operate in velocity above 1.5m/s for marine application. In ocean currents it has been estimated to be about 5000 GW [29].

5.0 IMPROVEMENTS OF TURBINES

Efficiency and power output of turbines are important factors to choose them for electricity generation in water. Up to now some researchers focus on improvement, development and offer new ideas to increase efficiency of turbines.

There are two methods to obtain more energy from water and find high value of output power: one of them is increase incoming water speed of turbines using ventury duct or flow nozzle, manmade channel and place turbines after slop land another method is directly development of turbines system to increase Cp or present new concept of turbine to increase efficiency of them such as such as using deflector [30,31], using new material [32], new design blade [33], effect of number of stator and rotor blades [34],use of separator and scoop[35], using hybrid turbine, new VAT that use wind, solar and rain to produce power[36],new concept desigen[37] and so on.

6.0 CONCLUSION

In conclusion, According to world‘s demand for energy and negetive effect of fossil fuel, it is compolsary to placment fossil fuel with renewable energy and development the hydrokinetic devices to harness the hydro power is emergency.

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