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A PATH FOR HORIZING YOUR INNOVATIVE WORK

PORTABLE UNDERWATER MICRO TURBINE

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Abstract: Power generation using micro hydro turbine is a clean and renewable source of energy and also a pollution free system. Power produced from such a terrestrial system generally is in the range of kilowatts. A similar miniature turbine with power requirement in the range of 100 watts can be used for oceanographic applications involving small crafts, autonomous vehicles etc. This paper studies the possibilities of using such a portable turbine for such platforms used in oceanographic applications.

Keywords: Micro Hydro Turbine, Autonomous Vehicles, Hydro Power

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INTRODUCTION

The conversion of the potential energy of water into electrical energy is a clean technology. The use of hydropower can make significant saving in fossil fuels such as coal, hydrocarbons. The hydropower plant can be classified according to the size of electrical power it produce [1] as shown in Table I.

High electricity demand for industry and domestic purposes require the plant to produce as large power as possible to justify the capital investment. As a result most hydropower available around the world can be categorized as large hydro. These large reservoirs or dams displace human population and submerges virgin land that lead to environmental damages. While the capacity of micro power plants may be small compared to other higher power plants, they have made significant contribution in electrification program to remote and off-grid settlements. The system does not require dams, which is one of the biggest advantages

Table 1 classification of hydro power

Power	Class
>10MW	Large
<10MW	Small
<1MW	Mini
<100KW	Micro

I. types of turbines

There are two types of turbine to be considered, impulse turbine and reaction turbine [2]. Kaplan [3] turbine is an example of a reaction type turbine shown in Fig 1. Whereas Francis [4] turbine is a example of impulse type turbine. Francis turbine is used in medium head scheme. Generally impulse turbines are used for high water head site, and reaction turbines are used for low water head site. Impulse turbine is inserted in the fluid and power-driven from the stream of the flowing water across the blades of the turbine. Penton and Turgo[5] turbines are suitable for high head. Crossflow[6] turbine is suitable for medium and low head, which is less than 10 m. Reaction as shown in Figure 1 turbines operate with the flow of water [7,8], the flowing water hits the blades of turbine. It's like a jet of water stream falling on the blades of the turbine from a height.

The efficiencies for various types of turbines are shown in Fig. 2.

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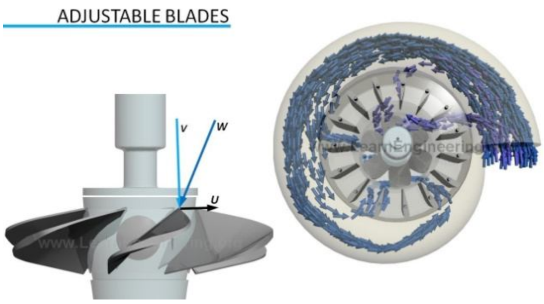

Fig. 1. Kaplan turbine

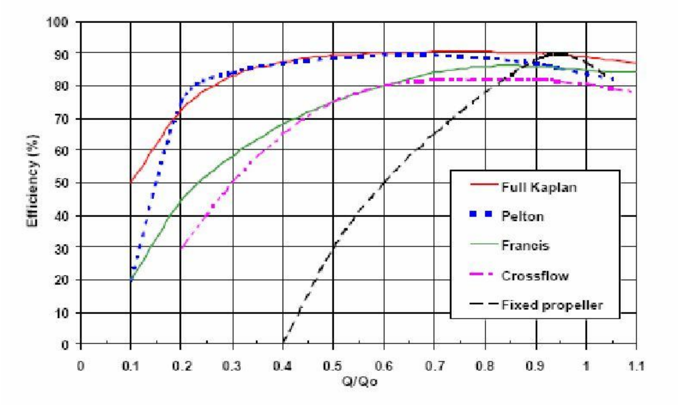

Fig. 2 Efficiency of typical hydro turbines

Crossflow turbine as shown in figure 3 can run with heads ranging from 5 and 200 m. It allows the water to pass through the runner twice before leaving the blades. This is a simple design and is easy to repair in case of breakdown of runner blades due to impact stress. The cross flow turbines have low efficiency compared to other types of turbines but can maintain its efficiency. The design is simple from maintenance point of view. This turbine is ideal for mini and micro hydro power production due to low cost and good regulation. Fig 4 shows various ranges of turbines based on flow rates

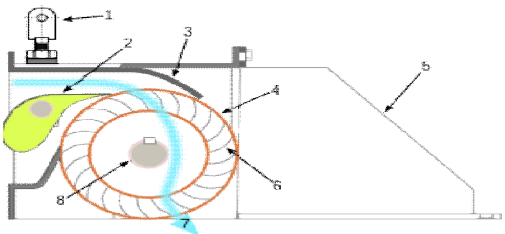

Fig3. Crossflow turbine

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Table 2 various turbines

Turbine	Medium	Rating	Size
Kaplan	Water	Megawatts	Large
Cross flow	Water	kW	Small
Francis	Water	Megawatts	Large
Wind turbine	Wind	Kilowatts	Medium
Wave	Water	kW	Medium

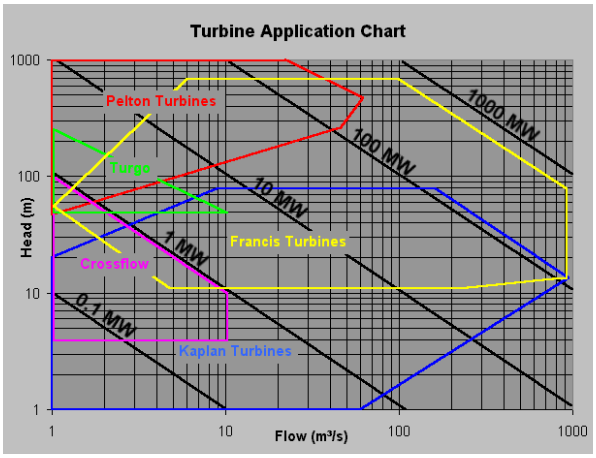

Fig 4. Head and flow ranges of turbines

II. the micro hydro turbine

The micro hydro turbine can be adapted from one of the large scale turbines shown in Fig 5. The turbine specifications are given below.

Fig. 5 Portable turbine

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It is desired that for a system required to generate power in the order of 10 to 100 watt range, the turbines described above need changes in dimensions. The portable turbine ratings are

- Max power 200W @ 3.2m/sec
- Min current speed 1.3m/sec
- Alternator -low rpm PMA
- Voltage:14V @800 rpm
- impeller- 250mm diameter
- Size: -D300mm x470mm
- Weight - 3kg

The system shown in fig 5 can be used for micro underwater power generation, possibly to shallow depths only and not to deep depths due to pressure restriction. If needed, the micro turbine needs to be made to required pressure rating. Therefore such a plant needs to be adapted for power generation underwater in oceans by making modifications in the assembly of the system. This is a horizontal axis type turbine. The important parameters to be considered while modifying/ designing such a small scale turbine involves redesigning blades, motor and alternators, and the mounting mechanism. Depending on the platform to be used for mounting, these modifications would be in the horizontal axial or in the vertical axis. Further modifications need to address loads on turbine, materials etc. Another very important aspect in such a design could be power management vis a vis the power generated. Storage systems will be required to offload the power and controls to synchronize power generation with respect to load will be essential. Such a system can offer several advantages like

- No fuel and limited maintenance
- low running cost during operation
- Long lasting and robust technology
- Green energy source
- power is obtainable within seconds,
- capacity to accumulate energy

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III. Simulation results

A small exercise was undertaken to understand the effect on power generation against the velocity of the medium. The plant was considered as having a circular face with an area A. Water flow with velocity V and standard density was considered. Using the standard equation [9] of power output for a turbine with varying medium velocity the power output was calculated and is shown in figure 6.

Power (W) = $1/2A \times \rho \times V^3 \times C_p$

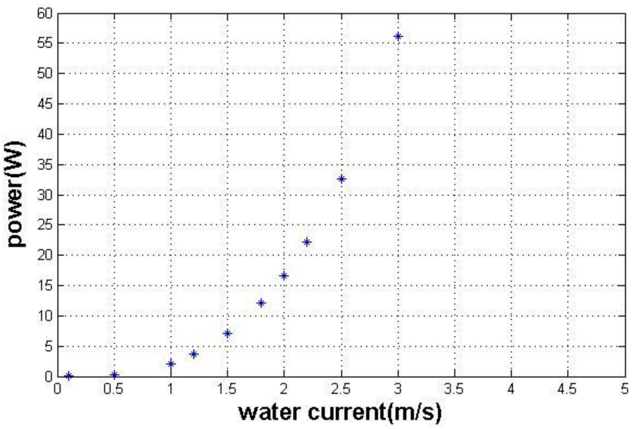

Fig. 6 Output of turbine

IV. CONCLUSION

This paper wants to bring out the possibility of using terrestrial turbine in ocean applications with suitable modifications. Literature has been studied for the various turbines available; a possible turbine is suggested. From the output results it is inferred that with increase in velocity of the medium, pretty good output power is possible to be obtained.

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