Vertical axis wind turbine with collecting tide power as a complement generator

Li Haoran, Wang xuchen, Yu Tianning, Li Songqi

Northwestern Polytechnical University, Xi'an, P.R.China

1.background and meaning

With the development of science and technology, research and development about renewable resources has been done in advanced countries. China, as one of the world's biggest energy consuming country, is going to develop and utilize wind and tidal energy as well as other new energy sources.

The use of oil and coal to the global environment caused serious pollution. Today, the promotion of new energy and renewable energy development has been the world's attention and become a hot spot of the world governments and energy sector investment in research. Among them, the most representative one is tide power and wind power. Wind power is renewable with its sources from the earth and cannot be transformed to other substance by the procession of human. Wind power like hydropower, as there is no pollutant emissions, many countries in the power development plan, will use wind power as an alternative to conventional energy generation for one of the major energy sources. Therefore, the development and utilization of wind resources is to change the structure of China's energy needs, making it a rapid development of China's market economy needs for energy supply. Tidal energy contains huge amount of features that prove it to be a clean energy resource, people nowadays think highly about this generation and expect to promote it to a new level. Currently, governments are also adopting policies to encourage the development of renewable energy, combined with energy demand, research of vertical axis wind turbine with collecting tide power as a complement generator is necessary and eventually, this market generator is estimated to satisfy the contemporary energy requirements.

At present, domestic application of mature wind power. Since the technology is mature, normal operation there megawatt horizontal axis wind turbines. Such as

Germany 5MW horizontal axis wind turbine technology is mature just be used in many parts in China. However, in recent years, along with the theory of progress, verification, and the trend of large fan actual wind farm development, the advantages of vertical axis wind turbines are becoming evident. At the same time, domestic and international tidal power generation business also made important achievements. However, China lack the experience and research on tidal energy. So, there is still a long way to go. Our offshore tidal energy storage is very large, rational use of tidal energy in line with China's demand for new energy sources.

2 Design description

2.1 design chart and composition

Works model design and the actual design as shown in Figure 1 to 4

Wherein the design and model from the floor, turbines, fans, a generator and a circuit control components.

As tested, all parts work smoothly, the power generation performance model in line with requirements. When the model fan blades rotating at 360rpm, issued by intelligent power control. The circuit may give 3V battery. Turbine test also achieved the expected results. Both two machines with good performances.

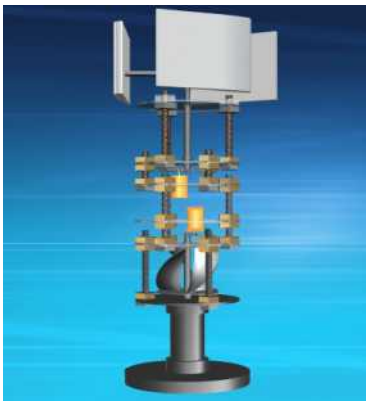

figure 1 the model of our generator

figure 2 design description

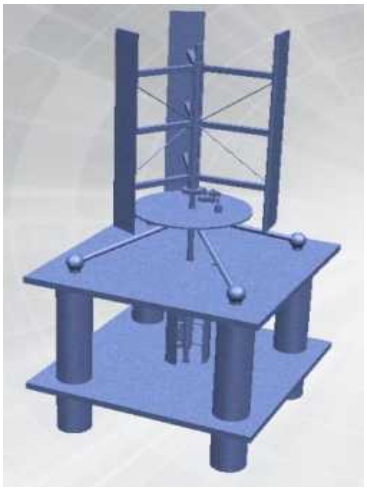

figure 3 perspective view of actual design **figure 4 another view**

2.2 describe of working principle

2.2.1 mechanical part

The overall shape of the blades

Darrieus wind turbine and wind turbine are used in the overall shape of H-type wheel vertical axis blades. It has many advantages, simple structure, drive load is small, high mechanical efficiency, reduce manufacturing costs and installation costs. Today vertical axis impeller type and lift resistance is generally divided into two kinds. Darrieus wind turbine belonging lift type wind wheel, wind turbines rely mainly on the lift to work, lift action makes the wind vane wheel peripheral speed be many times higher than the distal end of the wind speed, mainly used in wind genertator. Lift type Darrieus wind turbine wind wheel abbreviation "D impeller". Compared to all of the vertical axis wind turbine, its highest power coefficient can be the prominent feature. The lift-type Darrieus wind turbine impeller, the most common type are Φ-type and H-type wind turbines, H-type wind turbine manufacturing and installation more convenient, and judging from the swept area, the same diameter and height of the H-type wind turbine and Φ type wind turbine, windswept area of the former is the latter swept area of 1.5 times[3]. The machine uses H-type wind turbines.

To minimize flow separation because of the too large blade angle of attack , using

NACA0012 leaf type, and using a variable angle of attack techniques[4], the angle of attack controlled in 4 ° -13 ° in order to reduce and prevent flow separation.

The selected 1m NACA0012 chord (Re=2100000) blade for performance analysis. The use of transition SST Turbulence Model in transition SST (eqn 4) model, second order total differential scheme for solving, calculated using steady model in the ANSYS 12.0 fluent on the blade were 2D performance analysis, some useful results are obtained. Drag coefficient CD as performance ANSYS analysis the convergence condition, after 2000 steps of iterative convergence. we draw the following in line with the original intention of the design performance figure 5, 6, 7, and 8 following shown:

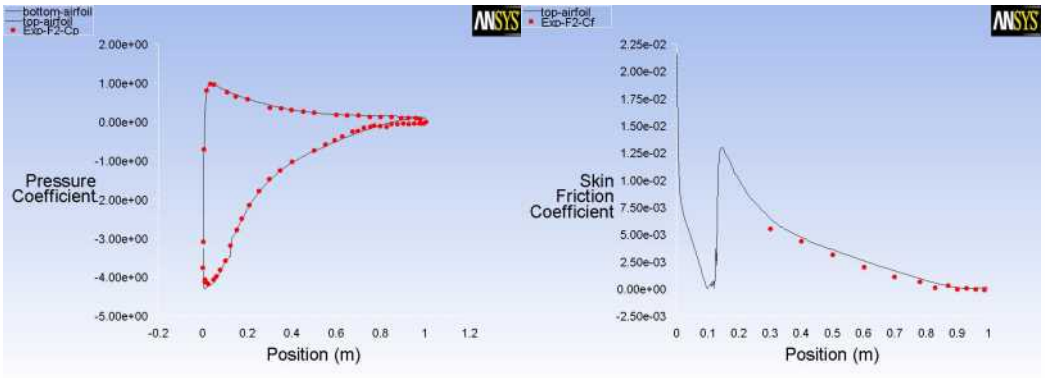

figure 5 the pressure coefficient

figure 6 The blade surface friction coefficient curve

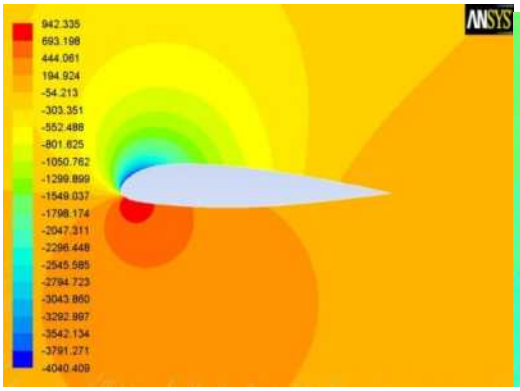

figure 7 Blade pressure nephogram

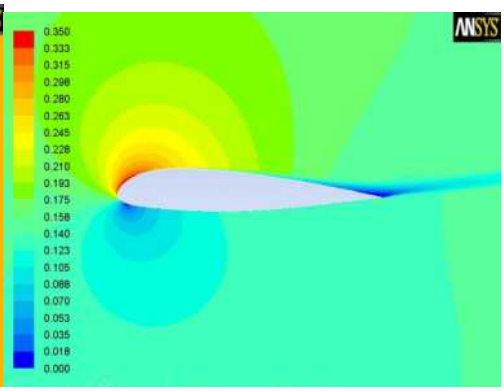

figure 8 Blade speed (Maher number) cloud

Combined with the knowledge of fluid mechanics, the performance figure shows the good performance of this blade.

The design of vertical axis wind Tidal generators complementary, according to the analysis of NACA0012 leaf type, the angle of attack at 4 DEG -13 deg. It can rotate 4 DEG -13 DEG space between blades and even blade supported plate. So that the wind utilization coefficient increased significantly, reducing the flow boundary layer separation caused by the negative impact, and ultimately improve the wind energy utilization coefficient.

In the design of wind turbine, considering the hub structure design and materials and the structure design of angle of attack, a speed increasing box structure design and material selection. The cabin structure design and material selection of the tower design are based on mature technology. Especially the study of [5] control technology of wind wheel in variable torsion force. Fan drive system is composed of three driving gears, the rotating speed of the wind wheel and the generator speed matching. The structure shows in figure 9 and figure 10.

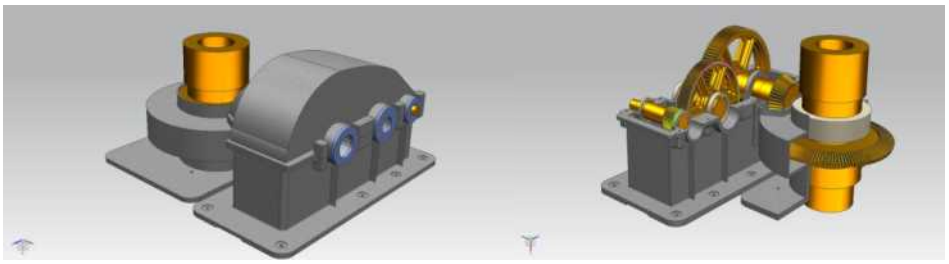

figure 9 The overall effect of wind turbine **figure 10 Fan gear renderings**

Owing to the complementary vertical axis wind tidal generator used in the shallow water area in China, especially along the less than 20 nautical miles of the coast line of wind energy rich region, the tower design need special means and methods. Basic design method, in the sea level design of triangular truss, the three sets of vertical axis wind tidal complementary generator in the three points are arranged, which can greatly keep vertical axis wind tidal a complementary position with stability. Connect a plurality of triangular truss, forming a vertical axis wind Tidal generators complementary group. Tidal power generator by piling and using the special shape of the chassis shape, when the tidal flow out of date, chassis pressure

surface and suction surface force makes the chassis received downward pulling force, and the chassis is fixed, the vertical axis wind Tidal generators complementary work in a stable position.

2.2.2 Circuit and a control section

In the power generation process, issued by the energy of different frequency and amplitude of electricity with varies by adaptive control circuit, using a phase adjustment prediction method based on wind power automatic control circuitry, it can be good for the generator to integrate and transport the power[6].

Two different energy generators will gather together, through the phase-frequency processing is stored in a battery or incorporated in a total of wires, with high availability.

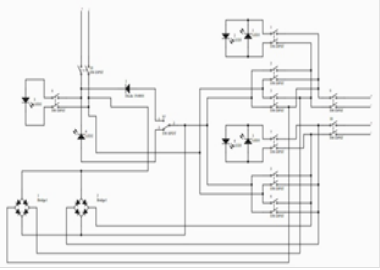

figure 11 control circuit diagram

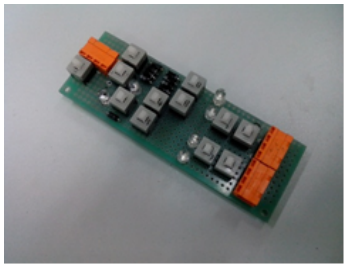

figure 12 Circuit part of the model physical map

Vertical axis wind turbine tidal complementary ways of combining three kinds of braking.

Fan and turbine brake way:

① electromagnetic soft brakes;

② electric brake brakes;

③ mechanical brake.

Among them, the electromagnetic brake release soft tip spoiler via solenoid valves, electric brakes with brake mechanical brake combination. Three brake ways that wind turbines and tidal power generation in a vicious wind conditions (such as wind speed less than 3.5m / s or greater than 50m / s, or requires emergency braking) makes wind turbine safety brake, to exclude security risks.

Above the capabilities of existing technology is mature, it can be directly applied in combination, and can get good results.

In addition, the fan and turbine power adjustment in two ways.

① External unloading continuously viable;

② excitation sub-regulation;

This can make power generation more stable, conducive to vertical axis wind turbine tidal complementary high life for a long time to work. So that the goal of working life of the generator reaches 20--30-year objectives can be achieved.

2.3 vertical axis wind turbine tidal complement the actual design parameters

chart 1 vertical axis wind turbine tidal complement the actual design parameters

unit	SATWT-1001
power(MW)	4
Height（*m*)	125
Fan power (MW)	3
Fan Height（m)	80
Fan diameter（m)	58
Fan Rated speed：（rpm）	25
Fan blade length m：	70
Turbine rated wind speed（m/s)	25
Fan power coefficient Cp	0.43
Fan mechanical overall efficiency	0.90
mechanical energy into electrical energy efficiency Ne	0.72
Fan blades：	3
Ye turbine power (MW)	1
Turbine leaf height（m)	45
Ye turbine diameter（m)	17
Turbine work flow velocity（m/s)	1.0-10
Rated speed turbine Leaf (r/min)	20
Turbine blade height (m)	30
Ye turbine efficiency：	0.85

3. innovation

1) binding

Today the community wind turbines and tidal energy generators are each run as a separate system to generate electricity. The vertical axis wind generator will complement tidal wind and tidal power as two sub-treat, and ultimately the two

subsystems combine organic, as a collection system to collect energy to provide electricity. So that more energy can be collected in the same place, the final form of electrical energy output.

2) Economy

Compared with traditional horizontal axis wind power system, wind power utilization system of vertical axis wind up to 5 times higher than conventional systems, vertical axis wind power systems with no noise, no-cut advantages out, breaking the traditional system. " Wind hour turn, when the wind stopped, "the inefficient mode, making use of the width of the wind speed increased significantly.

Design of vertical axis wind turbine tidal complementary when, for NACA0012 airfoil analysis, the attack angle control at 4 ° -13 ° to that line. Even you have to have 4 ° -13 ° rotatable space between the blade and install the blade support plate. This makes wind energy utilization coefficient is significantly improved, reducing the negative impact caused by the airflow boundary layer separation, and ultimately increase the power coefficient. Cost fan blades of the horizontal axis is the ratio of the entire unit to occupy a very large part of the cost of wind turbine blades increased, along with the blade length, that increase wind wheel radius was three power growth; at the same time , wind turbine swept area, namely wind turbine power output with the blade length, that increase was the wind wheel radius squared growth. The corresponding values such as Formula 1- relation formula 3.

$$y_1 = k_1 \times r^3 \quad (1)$$

$$S_1 = k_2 \times r^2 \quad (2)$$

$$P_1 = k_3 \times r^2 \quad (3)$$

Wherein y_1 is a horizontal axis wind turbine blades cost increases, S_1 is the rotor swept area, P is the corresponding power output; and k_1, k_2, k_3 for the corresponding constant.

This makes fan blades cost growth rate is far greater than the rate of output growth, with the increase in the length of the blades, the rapid growth of investment costs, while output grew more slowly, therefore, will soon reach the limits to growth.

The vertical axis wind turbines can contribute to the horizontal direction, that is, arm length and number of blades increases linearly support the blade, you can reach the rotor swept area increases, it will increase the cost of the wind turbine with the wind wheel linearly increase the radius increased, while the output power of growth with the growth of the wind round the square of the radius was growth; the growth rate of output power is far greater than the cost of the investment growth rate, can be seen, vertical axis wind turbine with large-scale development, investment costs per unit of generated power is rapidly decreased. Corresponding numerical relationship as formula 4, formula 5.

$$y_3 = k_5 \times r^3 \quad (4)$$

$$y_4 = k_6 \times r \quad (5)$$

Y_3 vertical axis wind turbine blades which cost growth, y_4 corresponding power output, k_5 and k_6 corresponding constant.

3) adaptability

Adaptive control can be seen as a characteristic can regulate their own feedback control system according to changes in the environment so that the system can be intelligent according to some set of standards to work in the best condition. In order to adapt to the complex marine environment, reduce staff workload, one large vertical axis generator using adaptive intelligent control. According to theoretical and experimental, in the vertical axis of rotation of the impeller, the wind velocity by influencing the boundary layer and the trailing edge flow separation and so to affect the power generation efficiency of the blade. By varying the air flow in the impeller blades during the rotation angle of attack can effectively improve the air flow conditions, guarantee blade efficiency. It can be said by a powerful database support, integration of adaptive control of the whole machine to provide maximum security for the vertical axis wind turbine tidal complementary work environment, as well as provide convenient.

4) Extension

Making the entire device is simple and easy to install. Because this device designed in the marine environment, the maintenance of a relatively large degree of difficulty, use a global modular composition. Conceptual design stage, the use of the unit body that is modular structure facilitates the initial design work, the designer simply list the modules to be added according to the actual application requirements, rather than for the module is described in detail, later worked just the various departments of the different modules carried out by the rough to detailed design can gradually. Secondly, because this design means in the marine environment, the maintenance of the relative difficulty of a large, global modular constitute a single module to facilitate repair and maintenance or replacement without changing the rest of the module, a great saving product maintenance costs. Even in module upgrade process, we simply solve incompatibility between the modules without redesigning the entire system replacement; thirdly, to facilitate the design process for the first time, multiple modules can be performed simultaneously, whenever the modules designed according to the plan table, it does not appear the problem of convergence of each module, thereby improving the work efficiency, but also saves a lot of time; and finally, at the experimental stage, can be taken strictly based on the theory of a single module to experiment, to achieve the objectives and requirements after reassembling, whole experiment, you can easily identify the problems, blindness and also reduces the waste of resources experiments. Easy repair and maintenance or replacement of individual modules without changing the rest of the module, a great saving product maintenance costs.

5) a complete set of system design software.

Machine blade aerodynamic design software and material structure design software has been designed. Fan blade design, simply enter valid parameters, the program will be given in accordance with the design requirements of the relevant design parameters and associated performance analysis, the optimum blade shape, gear design, enter the necessary power parameters, according to the mechanical design principle instead of doing the design process design. Related theme design software is shown in Figure 13.

Nowadays, in less than 20 miles of the costline, there is much engergy stored in the tidal power as well as the wind power. So it is expected that our project has a bright future.

4 expected application prospects

According to the survey, the offshore a height of 10 m wind energy economy can develop capacity of 7.6 million kilowatts, and China's mainland coastline up to more than 18000 kilometers, also accompanied by a huge tidal energy to be developed, according to the census and statistics can be the development of tidal energy in total power generation amounted to 600 billion kw • h, the total installed capacity of up to 20GW. There are a lot of high energy density along the southeast coast, the average tidal range is 4-5m, the maximum tidal range in 7-8m [7]. But in China, especially the development of wind energy and tidal energy offshore wind energy is still in the initial stage, there are abundant tidal energy and wind energy resources that are not used, according to the national "Twelfth Five" plan to invest 2 trillion yuan for energy-saving and emission reduction projects, one of which is the use of clean energy, and with the China's energy demand increasing, more and more energy is needed to maintain and consolidate the stable development of economy, so countries in the development of new energy and renewable resources offer policy incentives,

such as for the development of wind and solar energy, the country has given financial support to promote the development of these areas, so the tidal wind power will get the support of the government. Also, the aforementioned countries in energy demand rising stage, so countries in the limited fossil energy has to supply in the future, then the remaining vacancies will need to clean energy to replenish, so the potential market, tidal wind power in the domestic market prospects very well. Moreover, tidal wind power generation in the near coastal, greatly easing the coastal cities of the shortage of energy, and can reduce the consumption of fossil fuels, and is beneficial to environmental protection.

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