"Experimental Analysis of Vertical Axis Wind Turbine"

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Abstract - *Rapid increase in global energy requirement resulted in considerable attention towards renewable energy sources as there are shortages of fossil fuels. Wind energy is the most potential and clean renewable energy resource and available everywhere abundantly in free of cost. Vertical axis wind turbine is one of the important options to produce sufficient electricity for household's application at rural and urban area. Darrieus VAWT using NACA0018 airfoil as a blade profile to evaluate its performance. Darrieus VAWT with NACA0018 airfoil profile blade simulation model has been designed. Servomotor pitching mechanism is employed to increase efficiency.*

***Key Words*: Darrieus, VAWT, NACA0018, Servomotor, Pitching**

1. INTRODUCTION

Turbine is a machine for producing continuous power in which a wheel or rotor, typically fitted with vanes, is made to revolve by a fast-moving flow of water, steam, gas, air, or other fluid.

A vertical-axis wind turbines (VAWT) is a type of wind turbine. Where the main rotor shaft is set transverse to the wind (but not necessarily vertically) while the main components are located at the base of the turbine.
Savonius turbines represents a typical S shape and rotates by drag force and generate the electricity. It is self starting turbine and gives a very low efficiency.

Darrieus turbine is used to generate electricity by means of lift force. This type of turbine rotates at high rotation speed. Hybrid turbine-The suitable hybrid configuration of Darrieus lift-type and Savonius drag-type rotors for stand-alone wind turbine-generator systems is discussed using our dynamic simulation model.

1.1 METHODOLOGY

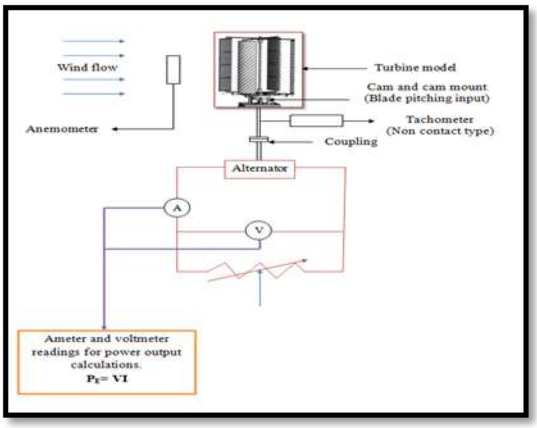
Design and fabrication of Darrieus vertical axis wind turbine.

Development of experimental setup to measure the various operating parameters and to conduct the test on fabricated model of the turbine.

Development of servomotor mechanism for obtaining efficient results.

2. DESIGN

Sr.No	Parameters	Value
1	Turbine Height (H)	0.6m
2	Turbine Diameter (D)	0.6m
3	Chord Length (C)	0.95m
4	Shaft Diameter	0.25m
5	Blade Airfoil Profile	NACA0018
6	No. of Blades	4



3. WORKING

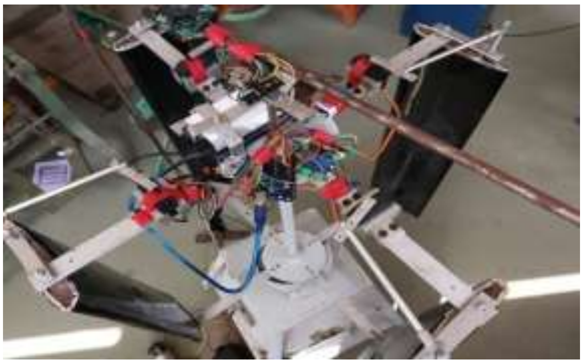
Servomechanism

A servo system mainly consists of three basic components,
a) A controlled device
b) an output sensor
c) a feedback system.

This is an automatic closed loop control system. Here instead of controlling a device by applying the variable input signal, the device is controlled by a feedback signal generated by comparing output signal and reference input signal. When reference input signal or command signal is applied to the system, it is compared with output reference signal of the system produced by output sensor, and a third signal produced by a feedback system. This third signal acts as an input signal of controlled device.

Principle of Servo Motor

A servo motor is basically a DC motor (in some special cases it is AC motor) along with some other special purpose components that make a DC motor a servo. In a servo unit, you will find a small DC motor, a potentiometer, gear arrangement and an intelligent circuitry. The intelligent circuitry along with the potentiometer makes the servo to rotate according to our wishes. This is where the gear system inside a servomechanism comes into the picture. The gear mechanism will take high input speed of the motor (fast) and at the output, we will get an output speed which is slower than original input speed but more practical and widely applicable.



Experimental setup with servomotor mechanism

4. CALCULATIONS

1) Wind Power (P_w) = $1/2\rho A(V_\infty)^3$
Where,
ρ= Density of air (Kg/m^3) =1.25Kg/m^3
A= Swept Area=0.36 m^2
V_∞= Wind Speed (m/s)

1) Wind Power for 6 m/s
$P_w = ½ \rho A(V_\infty)^3$
$P_w = ½*1.25*0.36*6^3$
P_w = 48.6 Watt

2) Wind Power for 8 m/s
$P_w = ½ \rho A(V_\infty)^3$
$P_w = ½*1.25*0.36*8^3$
P_w = 115.2 Watt

3) Wind Power for 10 m/s
$P_w = ½ \rho A(V_\infty)^3$
$P_w = ½*1.25*0.36*10^3$
P_w = 225 Watt

4) Wind Power for 12 m/s
$P_w = ½ \rho A(V_\infty)^3$
$P_w = ½*1.25*0.36*12^3$
P_w = 388.8 Watt

5) Wind Power for 14 m/s
$P_w = ½ \rho A(V_\infty)^3$
$P_w = ½*1.25*0.36*14^3$
P_w = 617.4 Watt

Power Test for fixed pitch turbine:

Wind Speed (m/s)	Turbine Speed (RPM)	Voltage (V)	Current (I)	Electric Power (P_e)
2	0	0	0	0
4	40	13.5	0.1	1.35
6	80	84.44	0.09	7.6
8	400	281.11	0.09	25.3
10	600	565.0	0.08	45.2
12	650	690.222	0.07	48.3
14	700	912.22	0.055	50.2
16	750	1307.5	0.04	52.3

Power Test for variable pitch turbine:

Wind Speed (m/s)	Turbine Speed (RPM)	Voltage (V)	Current (I)	Electric Power (P_e)
2	60	0.1	0.2	0.02
4	250	7.0588	0.17	1.2
6	450	47.6923	0.13	6.2
8	600	230.9090	0.11	25.4
10	750	355.0	0.1	35.5
12	800	447.7777	0.09	40.3
14	850	605.0	0.08	48.4
16	870	655	0.08	52.4

5. CONCLUSIONS

Maximum coefficient of power of the Darrieus turbine is 0.40.

Darrieus turbine is not self-started at low wind speed but it is more efficient as it operates at high speed ratio.

With using servomotor pitching mechanism we obtain the best outcomes.

Darrieus turbine is suitable and recommended for house hold application for power generation in rural and urban area.

For fixed Pitch mechanism at low wind speed turbine is not self starting, while for Variable Pitch mechanism at low wind speed turbine is self starting.

6. POSSIBLE OUTCOME

To develop the efficient turbine with maximum power coefficient by using variable pitching mechanism.

To develop new Vertical axis wind turbine.

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