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DESIGN &ANALYSIS OF HYBRID POWER GENERATION SYSTEM

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ABSTRACT

Electricity become a most essential need of human beings, from household to industrial work. So, the purpose of the project is to generate electricity without using non-renewable resources and pollution. Since, renewable standalone energy generation system have disadvantages, which need to be overcame by hybrid systems. Wind and solar energy have being popular ones owing to abundant, ease of availability and convertibility to the electric energy. This work covers realization of hybrid energy system for multiple applications, which runs under a designed circuitry to utilize the solar and wind power. And a designed circuitry for more efficient results, and inverters to convert the electrical energy as per demand. This thesis presents the design of hybrid solar wind turbine system for the power generation system by utilizing both solar and wind renewable energy to the domestic household in the remote area which is unable to connect to the grid.

In this project we have tried to develop hybrid solar and wind energy system also we will analyze different parameter to get maximum electricity.

KEYWORDS *Hybrid Solar and Wind mill power generation system, Solar tracking system, Vertical shaft design Solar panel PV.*

1. INTRODUCTION

Hybrid energy system is defined as the component combination of two or more types of power generation system. For this research, solar energy system is integrated with wind turbine system to form a hybrid renewable energy system. Since the power output of these renewable energy is ultimately depends on climatic conditions such as temperature, solar irradiance, wind speed and etc., the instability of the system output is compensated by adding a suitable energy storage system to the hybrid energy system. The power autonomy is greatly relied on the perfect balance exist between power demand and generated power.

Solar and wind can be categorized an intermittent source of energy since it is not continuous supply and does not meet electricity load demand in some time. For these two types of renewable energy, wind energy is the more affected source if compared to solar energy due to its inconstancy. Similarly, these two unpredictable energy sources standalone system will produce fluctuated output energy and thus cannot ensure the minimum level of power continuity required by the load. The photovoltaic system also depends on the weather conditions and only can operate during day-time. Wind power is basically electricity produced by a generator, which is driven by a turbine according to flowing air's aerodynamics, and is one of the fastest growing renewable energy technologies around the world. In the India, at different location due to different natural conditions and environment there is very much uncertainty is there in air flow velocity. There are many wind mill manufacturer are there, who manufacture the domestic wind mill according to there own standards. They will not select proper locations so that wind mill can develops maximum electrical energy.

2. PROPOSED WORK:

Design & analysis of hybrid solar and wind power system under different condition

2.1 Specification of proposed set up.

2.1.1 Testing conditions for wind mill

a) Varying blade quantity (such as 3 , 4 and 5 blades).
b) Varying blade angle with respect to vertical plane (Such as 0, 15 and 30 degree).
c) Varying wind mill blade shapes.
d) Applying different wind velocity through artificially through table fan.

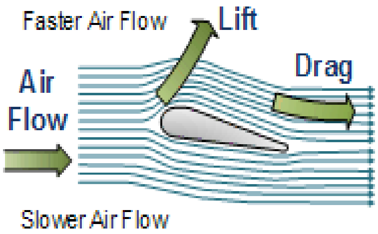
2.1.2 Testing conditions for Solar panel.

a. Regular Solar panel installation.
b. By using solar tracking system

3. THEROY OF DESIGN

3.1 Blade Design -

Rotor blade designs operate on either the principle of the lift or drag method for extracting energy from the flowing air masses. The lift blade design employs the same principle that enables aeroplanes, kites and birds to fly producing a lifting force which is perpendicular to the direction of motion. the air, a wind speed and pressure differential is created between the upper and lower surfaces of the blade.



The pressure at the lower surface is greater and thus acts to "lift" the blade upwards, so we want to make this force as big as possible. When the blades are attached to a central rotational axis, like a wind turbine rotor, this lift is translated into a rotational motion.

Drag designs are used more for vertical wind turbine designs which have large cup or curved shaped blades. The wind literally pushes the blades out of the way which are attached to a central shaft

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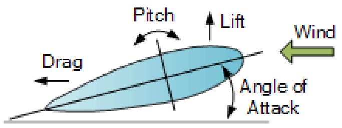
- **Angle Of Attack :**

The angle of attack of a turbine blade is the angle between the direction of the apparent or relative wind and the chord line of the blade. For an aircraft wing, it is the angle between the direction of motion of the wing and the chord line of the wing.

Above 15 degrees, the separation point moves right up to the leading edge of the aerofoil and laminar flow above the aerofoil is destroyed. The increased turbulence causes the rapid deterioration of the lift force while at the same time it dramatically increases the drag, resulting in a stall.



The standard relationship between TSR ,C_p& angle of attack of small wind turbine system is shown in fig.
In our project we choose angle of attack is = $6^{0.}$

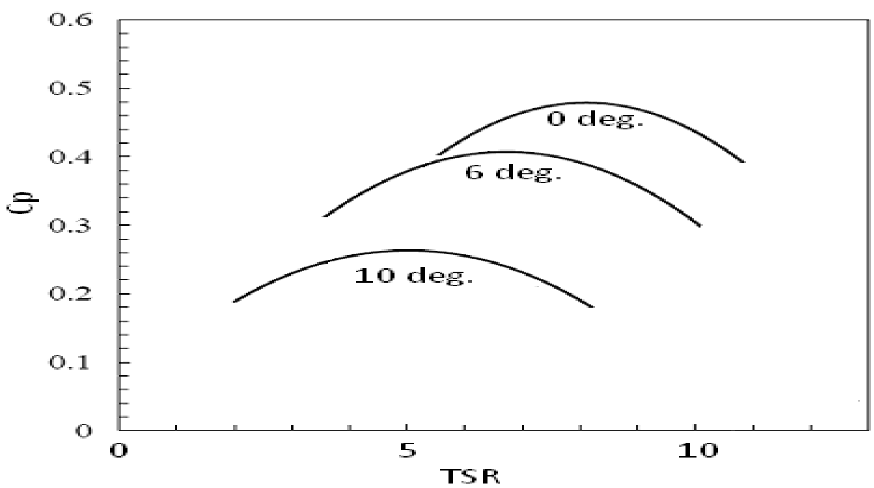


Fig.-Power coefficient Vs Tip Speed Ratio with Angle Of Attack.

4. DESIGN OF PARTS:-

a) Design of hub assembly which is suitable to increase or decrease number of blades as per test conditions / requirements.
b) Design of pole to suitable to carry all hub assembly.
c) Design of different blade shape.
d) Design of angle changing mechanism of wind blades with respect to vertical plane.
e) Solar tracking system.

4.1 MATERIALS AND METHODS

4.1.1 Rotor, blades:

- . In general, three blades are standard for the wind turbine.
- . Design towards lower peak operating speed which gives lower noise emission.

- Typical design rotor-tip speed to wind speed ratio is 5:1.
- . Rotor diameter is less than 10 m. Trend is towards larger rotors.

4.1.2 Tower:

- .Height is between 12 to 24 m, The trend is towards a taller tower, using a steel tubular structure.

4.1.3. Generator:

- . Synchronous permanent magnet generator
- . Use rare earth permanent magnet rather than ferrite magnet for superior magnetic properties.

4.1.4. Regulation control for gust events:

- . Use of yawing or furling - The rotor is turned out of the wind passively, by aerodynamic forces
- . Alternative method - mechanical brake, dynamic brake, stall control, pitch control.

4.2 SPECIFICATION :

i. Type : Domestic system

ii. Power:- 0 to 12 volts per hour.

iii. General Information :

a) The machine consists set up in which we can measure the rotor / hub speed.

b) Electrical battery and power measuring device.

c) Artificial arrangement to blow the air on proposed set up.

5. EXPERIMENTAL WORK

The fabricated mechanism will be tested for the suitability to the intended application. This experimental testing will include the testing of machine at actual site.

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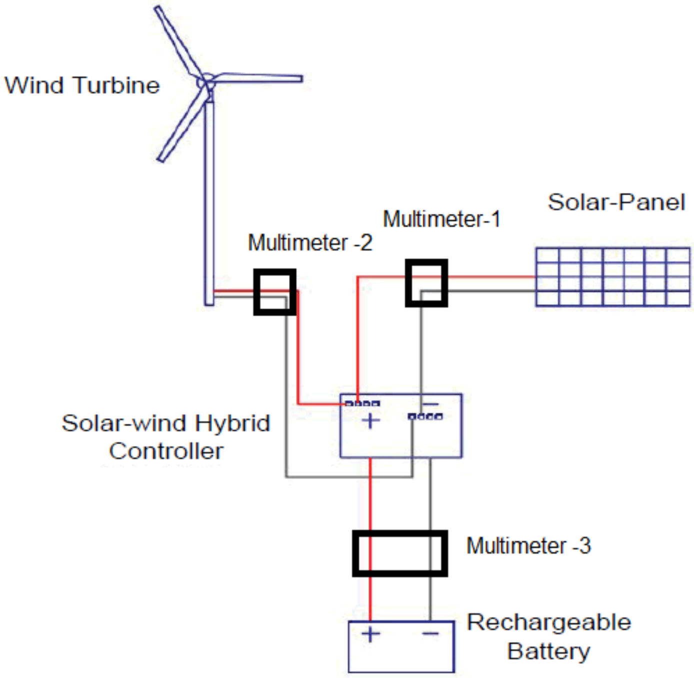
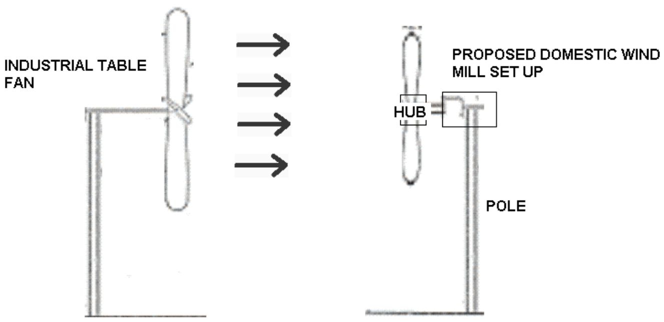


Fig:-Proposed ANALYSIS SET UP.



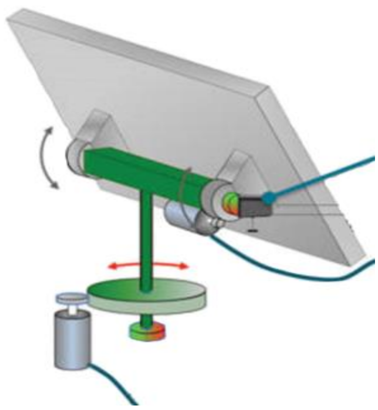


Fig. Proposed wind mill analysis set up

Fig. Proposed solar tracking set up

6. TESTING & CALCULATIONS

To test and confirm the working of developed mechanism for Wind mill set up and solar tracking system, we have taken practical demonstration at nearby location. Also we have collected the feedbacks and improvements points in developed model.

6.1 Sample Calculations

6.1.1 Power Available from Wind –

The following table shows the definition of various variables used in this model:

x = distance (m)

dE / dt =Energy Flow Rate (J/s)

t = time (s)

Under constant acceleration, the kinetic energy of an object having mass m and velocity v is equal to the work done W in displacing that object from rest to a distance s under a force F,

E=W=Fs

According to Newton's Law, we have:

F=ma

Hence,

E= mas … (1)

Using the third equation of motion

$v^2 = u^2 + 2as$

We get

$a = (v^2 – u^2)/2s$

Since the initial velocity of the object is zero, i.e. U=0

We get

$a = v^2/2s$

Substituting it in equation (1), we get that the kinetic energy of a mass in motions is

$E = (1/2)\ mv^2$

The power in the wind is given by the rate of change of energy:

P = dE/dt = (1/2) (v ^2) dm/dt

Mass flow rate is given by,

dm/dt =ρA dx/dt

and the rate of change of distance is given by:

dx/dt =v

We get:

$dm/dt = \rho A v^3$

Hence, from equation (3), the power can be defined as:

$P_a = 0.5 \rho A v^3 C_p$

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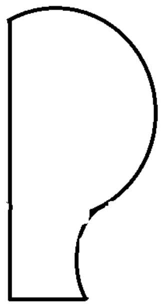
6.1.2 Vertical shaft design



As per our near by area the average wind speed is 4.5 to 7 m/s

The following are the basic equations that govern the calculation of moments.

The torque required to operate on the wind mill shaft

T = F x R

The projected area of wind mill we have considered 1000mm2

The wind load on each fan blade assumed p = 100N

Total torque on shaft = 100 x 100 = 10000N-mm

T = Max Torque generated to rotating Crank

Ϭ = 145 N/ mm2 considering factor of safety = 4

As per Design data book shaft material is selected Carbon steel C40

$$C40 \Rightarrow Sut = 580\ N/mm^2 \quad Yield = 435\ N/mm^2$$

σ = 145 N/mm2

As per ASME code

0.3 X Yield strength N/mm2

0.18 X ultimate strength N/mm2} whichever is smaller

0.3 x 330 = 99 N/mm2 ………………………………………….(a)

0.18 x 580 = 104 N/mm2 ……………………………………..(b)

From equation (a) & (b)

Allowable stress value will be 99 N/mm2

If key ways will provide to shaft then

τ = 99 x 0.75 = 74.25 N/mm2

Max torsional moment equation is given by

we know,

$$T_e = \frac{\pi}{16} d^3 \tau$$

Where T = 10000N-mm

By using above equation drive shaft dia d = 8.10mm ……………….A

Considering extra torque and load we have considered 20 mm dia.

6.2 Testing Results

6.2.1 Readings of A – type Vane

Sr. No	Vane type	Velocity of Air through fan	Generated Voltage in V	Generated Current in amp	Generated Current in watt
1		1 m/sec	4.5	0.145	0.6525
2		2 m/sec	4.5	0.24	1.08
3	A type	3 m/sec	5.2	0.295	1.534
4		4 m/sec	5.2	0.345	1.794
5		5 m/sec	6.2	0.545	3.379

6.2.2 Readings of B– type Vane

Sr No	Vane type	Velocity of Air through fan	Generated Voltage in V	Generated Current in amp	Generated Current in watt
1		1 m/sec	4.7	0.16	0.752
2		2 m/sec	4.9	0.32	1.568
3	B type	3 m/sec	5.5	0.35	1.925
4		4 m/sec	5.8	0.44	2.552

6.2.3 Readings of C– type Vane

Sr. No	Vane type	Velocity of Air through fan	Generated Voltage in V	Generated Current in amp	Generated Current in watt
1		1 m/sec	4.8	0.18	0.864
2		2 m/sec	5.2	0.32	1.664
3	C type	3 m/sec	5.9	0.38	2.242

6.2.4 Readings of of solar panel without solar tracking system

Sr No	Time	Angle of rotation in degree	Generated Voltage in V	Generated Current in amp	Generated Current in watt
1	9:00 AM	28	4.8	0.9	4.32
2	10:00 AM	28	5.1	1.1	5.61
3	11:00 AM	28	5.5	1.24	6.82
4	11:30 PM	28	6.2	1.28	7.936
5	12:00 PM	28	6.5	1.35	8.775
6	12:30 PM	28	6.8	1.6	10.88
7	1:00 PM	28	7	1.67	11.69
8	1:30 PM	28	6	1.68	10.08
9	2:00 PM	28	5.8	1.68	9.744
10	2:30 PM	28	5.8	1.67	9.686
11	3:00 PM	28	5.7	1.56	8.892
12	3:30 PM	28	5.6	1.46	8.176
13	4:00 PM	28	5	1.35	6.75

6.2.5 Readings of of solar panel without solar tracking system

Sr. No	Time	Angle of rotation in degree	Generated Voltage in V	Generated Current in amp	Generated Current in watt
1	9:00 AM	20	5	0.9	4.5
2	10:00 AM	30	5.2	1.1	5.72
3	11:00 AM	40	5.9	1.24	7.316
4	11:30 PM	50	6.2	1.28	7.936
5	12:00 PM	60	6.8	1.35	9.18
6	12:30 PM	70	6.8	1.6	10.88
7	1:00 PM	80	7	1.67	11.69
8	1:30 PM	90	7.8	2.2	11.928
9	2:00 PM	100	6.8	1.68	11.424
10	2:30 PM	110	6.3	1.67	10.521

11	3:00 PM	120	5.7	1.56	8.892
12	3:30 PM	130	5.6	1.46	8.176
13	4:00 PM	140	5	1.35	6.75
14	5:00 PM	150	5.1	1.2	6.12
15	5:30 PM	160	5	1.1	5.5

6.3 Testing points and concluded points as below:-

Sr. No	Points observed	Maximum Voltage in V	Maximum Current in amp	Maximum Power in watt
1	Wind mill Type A vane	6.2	0.54	3.348
2	Wind mill Type B vane	6.5	0.65	4.225
3	Wind mill Type C vane	6.8	0.75	5.1
4	Solar Panel :- Without Solar Tracking system	7	1.68	11.76
5	Solar Panel :- With Solar Tracking system	7.8	2.2	17.16

Remarks:-

From above reading it is seen that the Type C vane and solar tracking solar panel is effective and generate maximum power than other set up.

7. CONCLUSION

At the end of this project the concluded remark is, The set up analysis of hybrid system is very useful for domestic electricity purpose.

The main outputs and conclusions remarks are as below;-

1. The developed model operates successfully and It meets the all parameters of test rig.
2. From above reading it is seen that the Type C vane and solar tracking solar panel is effective and generate maximum power than other set up.
3. Test time required minimized and standard procedure adopted for testing.
4. Chances of equipment failures are less.

5. Test media can be reused and transferred to other place after testing.
6. Skilled and semi skilled personnel can carry out test.

8. ACKNOWLEDGEMENT

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