STAND-ALONE WIND TURBINE FOR DOMESTIC DC LOAD

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Abstract:
Energy is one of the most vital needs for human survival on earth .In today's era of technology and development, in almost every area the demand for energy is ever increasing while the supply is not sufficient to meet the energy requirement. So it has become necessary to find out alternatives sources of energy that are easily available such as solar, tidal, wind, biomass, etc. This paper relates to designing & installing a standalone wind turbine describes about the wind power and its potential that can be harnessed in the future to meet the current energy demand. The turbines rotates with the help of wind and then power generated through dynamo is given to the load otherwise it will stored in battery. If battery is fully charged then load is auto shifted to dynamo with the help of OP-AMP which provides constant voltage to battery.

Index terms: Micro wind turbine, battery energy storage system, dynamo, battery charging circuit.

I. Introduction:

Renewable Energy Sources are those energy sources which are not destroyed when their energy is harnessed. Human use of renewable energy requires technologies that harness natural phenomena, such as sunlight, wind, waves, water flow, and biological processes such as anaerobic digestion, biological hydrogen production and geothermal heat. Among the above mentioned sources of energy there has been a lot of development in the technology for harnessing energy from the wind.

Wind is the motion of air masses produced by the irregular heating of the earth's surface by sun. These differences consequently create forces that push air masses around for balancing the global temperature or, on a much smaller scale, the temperature between land and sea or between mountains. Wind energy is not a constant source of energy. It varies continuously and gives energy in sudden bursts. About 50% of the entire energy is given out in just 15% of the operating time. Wind strengths vary and thus cannot guarantee continuous power. It is best used in the context of a system that has significant reserve capacity such as hydro, or reserve load, such as a desalination plant, to mitigate the economic effects of resource variability.

II. Related Work:

Firstly decide a location for installing Wind Energy Conversion System. Readings of wind velocity at four different locations on collage terrace has been taken. By analyzing all these locations, finalized one location with better wind velocity than others.

Sr. No.	Locations	Wind velocity(m/s)
1	A	1.75
2	B	2.44
3	C	2.49
4	D	2.55

From above table, we have selected location D.

III. Wind Power Extraction with Batteries

The proposed micro-wind energy extraction from wind generator and battery energy storage with distributed network is configured on its operating principle and is based on the control strategy.

Lead-acid batteries are the most common type of batteries used in wind systems, due to their wide availability in many sizes, their low cost and performance characteristics. The lead-acid battery is an electrical storage device that uses a reversible chemical reaction to store energy. It uses a combination of lead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again.

IV. Micro-Wind Energy Converting System

The micro-wind generating system (μWECS) is connected with turbine, dynamo, pulley mechanism, and charging circuit to get power. The static characteristic of wind turbine can be described with the relationship in the wind as in

$P_{wind}=1/2$□□$R^2v^3_{wind}$

where ρ is air density (1.225 kg/m3),

R is the rotor radius in meters,

v_{wind} is the wind speed in m/s.

It is not possible to extract all kinetic energy of wind and is called C_P power coefficient. This power coefficient can be expressed as a function of tip speed ratio λ and pitch angle θ. The mechanical power can be

$P_{mech} = C_p * P_{wind}$

V. WIND TURBINE MODELING

As noted above, a wind energy conversion system is a complex system converting wind energy to rotational energy and then to electrical energy. The output power or torque of a wind turbine is determined by several factors like wind velocity, size and shape of the turbine, etc. A dynamic model of the wind turbine, involving these parameters, is needed to understand the behavior of a wind turbine over its region of operation. The control principles of the wind-

A. Inputs and Outputs of a Wind Turbine

The inputs and output variables of wind turbine can be broken into the following:

1. The independent input quantity *wind speed*, determines the energy input to the wind turbine.
2. Machine-specific input quantities, arising particularly from rotor geometry and arrangement (i.e, different configurations like horizontal axis or vertical axis turbines, area of the blades, etc.).
3. *Turbine speed*, *rotor blade tilt*, and *rotor blade pitch angle*, arising from the transmission system of the wind energy conversion system.
4. Turbine output quantities, namely *Power* or *Drive torque*, which may be controlled by varying the above three input quantities.

B. Power Extraction from the Air Stream

With the identification of the wind turbine's input and output variables, now it is possible to derive an expression relating these two values. The relation between the power and wind speed is derived as above :

The kinetic energy in air of mass m moving with speed V is given by the following:

Kinetic energy =½·m.V2 Joules

The power in moving air flow is the flow rate of kinetic energy per second.

Power =½ · (mass flow rate per second).V2

C. Typical Wind Turbine Operating Systems

There are mainly two kinds of wind energy conversion systems in operation; *fixed-speed* or *constant speed wind turbines* which operate at a nearly constant speed, predetermined by the generator design and gearbox ratio, and *variable speed wind turbines*.

	Constant Speed	Variable Speed
Advantages	1. Simple and robust. 2. Inexpensive electrical system. 3. Electrically efficient. 4. Fewer parts ,hence higher reliability. 5. No frequency conversion hence, no current harmonics. 6. Lower capital cost .	1. Less mechanical stress. 2. Higher energy capture . 3. Aerodynamically efficient. 4. Low transient torque . 5. Mechanical damping system not needed ,the electrical system could

		provide the damping. 6. No synchronization problems stiff electrical control can reduce voltage sags.
Disadvantages	1. Aerodynamically less efficient. 2. Mechanical stress 3. Noisy	1. Electrically less efficient . 2. Expensive 3. Some times involves complex control strategies.

TABLE 1.COMPARISON OF FIXED AND VARIABLE SPEED WINDTURBINE SYSTEMS.

VI.Wind Generator:

As the wind generator we use GI metal's six horizontal axis wind turbine of 125-115 mm and a length of 480 mm. This blades are fixed on a circular GI metal plate of diameter 230-325 mm with the shaft of 10 mm of diameter and 250 mm in length. On this shaft four bearings are mounted with the inner diameter of 10 mm and outer diameter 35 mm. To avoid the friction in gear box we use pulley mechanism . Thus ,two pulley with the different diameter in which large pulley is connected to the turbine shaft having diameter of 120 mm and width of 10mm and the second small pulley of diameter 45mm and width of 10 mm connected to dynamo shaft. The 22 turns and 34 gauge of dynamo attached to its shaft allows to harvest significant power even at low wind speed .

VII. Charging circuit :

Constant voltage charging is one of the most common charging methods for lead acid batteries. The idea behind this approach is to keep a constant voltage across the terminals of the battery at all times. Initially, a large current will be drawn from the voltage source, but as the battery charges and increases its internal voltage, the current will slowly fold and decays exponentially.

When the battery is brought up to a potential full charge, which is usually considered around 13.8V, the charging voltage is dropped down to a lower value that will provide a trickle charge to maintain the battery as long as it is plugged into the charger. The best characteristic of this method is that it provides a way to return a large bulk of the charge into the battery very fast.

The drawback is that to complete a full charge would take a much longer time since the current is exponentially decreased as the battery charges. A prolonged charging time must be considered as one of the issues to this design.

Wind is one of our main portable power sources. Inherently, they provide a constant current which is dependent on wind speed and other uncontrollable variability in the environment. This characteristic fits well with a constant voltage charge design, which does not depend on the current provided by the input source, which in turn eliminates the dependence of the charger on external variations like the time of day, weather conditions or temperature. The effects of the changing voltage are also minimized since the voltage is being regulated.

VI. Experimental Result:

After assembling the wind energy conversion system, readings of voltage and current with respect to wind velocities has been taken and tabulated as below:

TIME (pm)	WIND VELOCITY (m/s)	VOLTAGE (V)	CURRENT (A)	TEMP (^{0}C)
3:30	2	11	0.5	35.6
3:31	2.3	12	0.5	37.7
3:32	3.6	15	0.6	38.2
3:33	2.5	10	0.3	38.4
3:34	0	0	0	39
3:35	0	0	0	39.3

3:36	3.1	17	0.8	39.3
3:37	2.9	12	0.5	39.5
3:38	0	0	0	39.3
3:39	1.6	4	0	39
3:40	4	12	0.5	39.2
3:41	4	11	0.5	39.1
3:42	5	17	0.8	39.2
3:43	5.3	18	0.8	39.4
3:44	6.9	18	0.8	38
3:45	4.8	16	0.8	38

TABLE

2.EXPERIMENTAL RESULT

VII. a lculation:

P_{wind} = 1/2□□$R^2v^3_{wind}$

where ρ is air density (1.225 kg/m3),
R is the rotor radius in meters,
v_{wind} is the wind speed in m/s.
P_{wind}= ½*1.225*3.14*0.585^2*4^3
=42.12 Watt
From above table ,
V_{avg} =10.8125
I_{avg} = 0.4625
P =V*I
=5 W

This is the power calculated or about 1 hour which is based on availability of wind at decide location .

VIII. Conclusion :

From experimental results, the data available for wind at different location is taken which compare the maximum wind speed for location where the installation of wind turbine has to be done. The wind speed for the location D is max which gives the power 5W for about 1 hour in one day .For 24 hour the power is about 120 Watt.The power for 1 month is 3600 W.

IX. References :

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