Jet Wind Turbine

Dharmik U. Sheth, Ali Asgar S. Khokhar

ABSTRACT: Through the next several decades, renewable energy technologies, thanks to their continually improving performance and cost, and growing recognition of their Environmental, economic and social values, will grow increasingly competitive with Traditional energy technologies, so that by the middle of the 21st century, renewable Energy, in its various forms, should be supplying half of the world's energy needs." We have selected this so as to begin thinking towards power generation through clean sources such as wind. Power generation in our country is very low at present. Industrially developed states like, Maharashtra is suffering through major power shortages, and this is a signal of major crises. Even in cities like Mumbai peoples are suffering from power cuts. We knew that this project does not reflect any new discovery; but our intention is that residential societies should install such wind mills on the terrace to tackle with the power cuts and become independent unto certain amount. In this project wind turbine charges a 12 volt battery and runs various 12 volt appliances. We have fabricated the small scale wind turbine on the basis of design calculations and made changes in design to track it with manufacturing constraints.

KEYWORDS: Clean source of energy, No fuel costs, Renewable Energy, Small scale Wind Turbine, Wind mills.

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1. INTRO DUCTION

Many different methods of alternative energy are being evaluated in order to address the current crisis arising from the depletion of non-renewable resources. Wind energy represents a viable alternative, as it is a virtually endless resource. One of the more promising concepts in the wind energy field is the development of the Diffuser Augmented Wind Turbine (DAWT). These configurations use an additional diffuser to improve performance. The DAWT geometry concept has been analyzed using Clarkson's mRotor code with a focus on the Wind Tamer DAWT of Future Energy Solutions Inc of Livonia, NY. Preliminary calculations based on optimizing the original Wind Tamer geometries, indicate power coefficients peaking at Cp = 0.39, using commercial sizing. An optimization analysis in mRotor has indicated that power coefficients of nearly Cp = 0.5 for lower wind speeds, and even higher at faster wind speeds, can be achieved with minor design modifications. Full scale testing of this concept is underway at the Clarkson Wind Turbine Test site and will continue for several months.

I. **Introduction/ Background Information**

It is becoming necessary to fully understand how to improve wind turbine efficiency, as energy consumption and cost reaches record-breaking levels. The cost of oil and non-renewable resources is skyrocketing, and the depletion of these resources will require a sustainable and environmentally friendly energy source. An improvement to wind turbine efficiency will allow the limits of today to be surpassed, and someday be able to extract all of the energy from the wind with only a few improvements in technology. A greater number of these high-efficiency turbines would lower the cost of energy, powering the world for less.

2. PROBLEM DESCRIPTION

In this project the main aspect is how the wind energy is utilized in effective way for power development by running generator. For this a system is to be made which will convert the wind force in rotational motion of generator.

The system usually contains rotor blades on which wind strikes and which converts this force of the wind into rotational motion of the shaft which is connected to the shaft of the generator.

Also for holding this system a rigid structure is to be building which not only hold this system but also save it from damage. For holding this rigid structure a very strong base is to be developed which should be able to hold this complete system under various wind conditions.

3. JET TURBINE

The jet turbine design, which draws on technology developed for jet engines, circumvents a fundamental limit to conventional wind turbines. Typically, as wind approaches a turbine, almost half of the air is forced around the blades rather than through them, and the energy in that deflected wind is lost. At best, traditional wind turbines capture only 59.3 percent of the energy in wind, a value called the Betz limit.

Jet turbine surrounds its wind-turbine blades with a shroud that directs air through the blades and speeds it up, which increases power production. The new design generates as much power as a conventional wind turbine with blades twice as big in diameter. The smaller blade size and other factors allow the new turbines to be packed closer together than conventional turbines, increasing the amount of power that can be generated per acre of land.

The idea of enshrouding wind-turbine blades isn't new. But earlier designs were too big to be practical, or they didn't perform well, in part because the blades had to be very closely aligned to the direction of the wind--within three or four degrees. The new blades are smaller and can work at angles of up to 15 to 20 degrees away from the direction of the wind.

From the front, the wind turbine looks something like the air intake of a jet engine. As air approaches, it first encounters a set of fixed blades, called the stator, which redirect it onto a set of movable blades--the rotor. The air turns the rotor and emerges on the other side, moving more slowly now than the air flowing outside the turbine. The shroud is shaped so that it guides this relatively fast-moving outside air into the area just behind the rotors. The fast-moving air speeds up the slow-moving air, creating an area of low pressure behind the turbine blades that sucks more air through them.

It's plausible that such a design could double or triple a turbine's power output, Part of the increase comes simply from guiding the air to the turbine with the shroud. But we notes that it also helps to use the wind surrounding the turbine to speed up the airflow, because the power produced by a wind turbine increases with the cube of the wind speed. The key question is whether the new turbines can be built and maintained at a low-enough cost.

4. LITERATURE REVIEW

Windmills can be classified same like windmills they can be classified on the basis of axis of rotation they are: -

- Horizontal axis wind mill
- Vertical axis wind mill

Horizontal axis wind mill

Vertical axis wind mill

Fig.4.1 Horizontal axis wind mill [1]. Fig 4.2 Darrieus-design vawt [1].

Its design consist of a main rotor shaft which is driven by hydrofoil blades which rotate due to incoming air in turbine duct then this rotor shaft is coupled to generator in an coupling chamber .the generator is kept above air level in an machinery enclosure from there we can get the output the & utilize it for various purpose.

All existing HAWTs (or Horizontal Axis Wind Turbine) have the main rotor shaft and generator at the top of a tower, and must be pointed into the wind by some means. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servomotor. Most have a gearbox too, which turns the slow rotation of the blades into a quicker rotation that is more suitable for generating electricity. Since a tower produces turbulence behind it, the turbine is usually pointed upwind of the tower. Turbine blades are made stiff to prevent the blades from being pushed into the tower by high winds. Additionally, the blades are placed a considerable distance in front of the tower and are sometimes tilted up a small amount.

Downwind machines have been built, despite the problem of turbulence, because they don't need an additional mechanism for keeping them in line with the wind, and because in high winds, the blades can be allowed to bend which reduces their swept area and thus their wind resistance. Because turbulence leads to fatigue failures and reliability is so important, most HAWTs are upwind machines.

The vertical axis windmill consists of twin axial flow rotors of 15m to 20m in diameter, each driving a generator via a gearbox much like a hydroelectric turbine or a wind turbine. The twin power units of each system are mounted on wing-like extensions either side of a tubular steel monopile some 3m in diameter, which is set into a hole, drilled into the seabed.

Vertical axis turbines (or VAWTs) have the main rotor shaft running vertically. The main advantages of this arrangement are that the generator and/or gearbox can be placed at the bottom, on or near the ground, so the tower doesn't need to support it, and the fact that the turbine doesn't need to be pointed into the wind.

5. SCOPE OF PROJECT

(Methodology)

We will take the following steps...

1. Build a frame as as per blower swept area. Since the swept area of the blades is the most important factor for generating power, I want to start with a frame for the blades.
2. Find high quality bearings / shaft and mount them to the frame. This is important because the bearings can be one source of inefficeincy and reduce the power output.
3. Make the blade as per dwg and efficient as possible because this determines how much power we can steal from the wind. Also, choose a blade style that fits your needs; fast and scary
4. Then we put it all together and let it spin without an dynamo attached. Analyze the characteristics of the wind turbine in action. We need to know how many revolutions per minute (RPMs) the turbine will spin at for a given wind speed. The RPM value at an average wind speed gives us an idea of how to build the dynamo to fit the turbine. Figure out what the tip speed ratio (TSR) is so we can calculate the revolution per minute RPMs at any wind speed.

Build an dynamo that matches the RPM and TSR rating of the turbine. Make sure the cut-in speed is low enough that it will generate electricity at the right voltage. And, make sure the dynamo generates the most power at the RPM range that the wind in your area will spin it at.

6. CONCLUDING INTERFERENCES

(Objectives & Benefits)

6.1 Objectives:

Our main objective is the build a wind mill in such a way that cost of the wind mill is easily affordable by common people. So that common people get attracted towards such a clean source of energy which will give a source of business to the industries which works as the needs of common people. Due to this many companies will move towards manufacturing of such wind mill which will reduce cost of wind mill. Thus it will reduce cost of the power produced by the wind mill.

6.2 Benefits:

Following are the benefits of the wind mill

- Clean source of energy.
- No fuel costs
- Inexpensive
- Local transmission

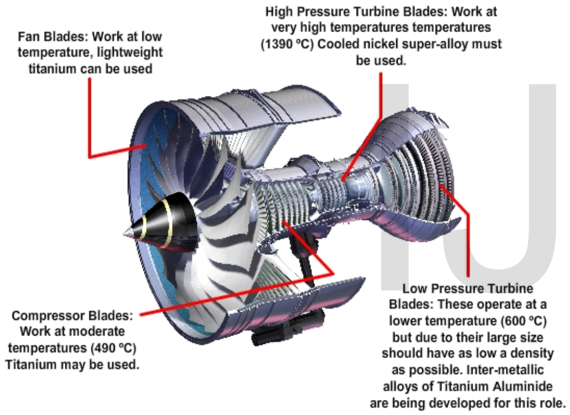
- Green pricing
- Using of small wind turbine will make residential societies independent from other sources of power.
- Running cost is low.

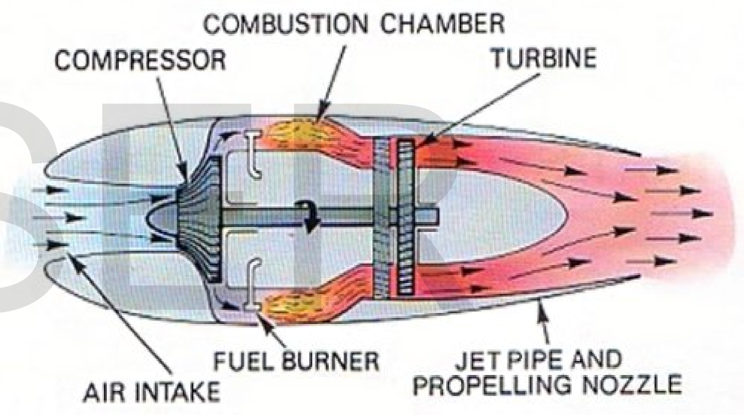
(*Left*) Pressure is equal in all directions in an inflated tied balloon. (*Right*) When untied the pressure on one side is unbalanced and can move the balloon.

From the front, the wind turbine looks something like the air intake of a jet engine. As air approaches, it first encounters a set of fixed blades, called the stator, which redirect it onto a set of movable blades--the rotor. The air turns the rotor and emerges on the other side, moving more slowly now than the air flowing outside the turbine. The shroud is shaped so that it guides this relatively fast-moving outside air into the area just behind the rotors. The fast-moving air speeds up the slow-moving air, creating an area of low pressure behind the turbine blades that sucks more air through them.

An engine that works by expelling a fluid jet backward so that the reaction to this exhaust propels the vehicle forward. Both the jet engine and the rocket engine are types of reaction engine, but whereas the rocket engine is self-contained and can work in a vacuum a jet engine can only function in the atmosphereThe principle by which all jet engines (and rockets) work is the third of Newton's laws of motions, namely that for every action (force in one direction) there is an equal and opposite reaction (force in the opposite direction). A toy balloon demonstrates this idea very simply.

If an inflated balloon is untied and released it flies across a room. It may be thought that the balloon is moving because the stream of escaping air is pushing against the atmosphere, rather as a row boat is propelled by the oars pushing back against the water. But this is not so. The balloon would fly just as well in a vacuum where there was nothing for the escaping air to push against; in fact it would fly better. The explanation lies in the fact that the pressure of the air in an inflated balloon is equal and constant in all directions. It were not, the balloon would be continually moving in the direction in which the pressure was greatest. When, however, the neck of the balloon is opened there is nothing for the compressed air to push against at that point and so is able to escape. But the pressure on the opposite side of the balloon is still there and, since there is no longer any counter pressure to balance it, it can move the balloon. Thus the balloon flies across the room in the opposite direction from the escaping air.





Air from the atmosphere is drawn into the front part of the engine and compressed by a compressor. This has numerous small blades and spins around rapidly. The compressed air flows into a combustion chamber, where fuel is injected, mixed with the air, and burned. In a typical jet engine, only about 1 kilogram of fuel is added for every 100 kg of air that enters the combustion chamber. Most of the hot exhaust comes from the surrounding air. Leaving the combustion chamber, the hot exhaust passes through a turbine. The flow of hot gas causes the turbine blades to spin around. A central shaft connects the turbine to the compressor, so that the compressor is turned by energy extracted from the hot exhaust. Plenty of energy is left over, however, to provide thrust to the jet engine by increasing the velocity through the exhaust nozzle. Because the exit velocity is greater than the free stream velocity, thrust is created.

7. DESIGN CALCULATIONS

7.1 Designing of wind mill

Before going to actual designing we must consider following points

- Suitable site
- Types of wind mill
- Aerodynamics design
- Overall design of wind mill

9. WIND JET TURBINE

In order to extract energy from a larger area of the approaching wind, smaller, sturdier, and faster blades can be used. We try to design a new idea about the shape of fin, cowl, lobed mixer, rotor and stator. There are some of important parts in this new design of wind turbine jet.

The new design of our wind turbine can be smaller than conventional turbine but can generate more power. Based on the concept of the jet engine's turbine, our wind turbine's component can be divided into:

1. Rotor
2. Cowl
3. Lobed Mixer
4. Blades
5. Stator

jet engine shaped wind turbine is designed to be an amazingly 3 to 4 times more efficient than standard wind turbines. Present day wind turbines only capture 50% of the air flow, cannot stand high winds, have high building standards, require many trucks to deliver parts for 1 turbine and have to be built tall and away from habitable areas. Due to their large size, the large turbines force air around it instead of through it and during high winds they are usually turned off or break due to their huge slow spinning blades.

wind jet turbine is designed to be made simple and small, giving it the ability to handle high wind velocities due to its effectiveness to handle off axis flow and turbulence. Slow air on the inside flares out while the fast air on the outside is deflected in. When the two flows meet at different angles they create a rapid mixing vortex. A “fin” placed on top of the wind jet turbine has the ability to automatically align to wind direction. In addition, it can be disassembled to fit in one truck vs the traditional wind turbines which will need several trucks to just deliver parts to 1. With the costs estimated to be 25-35% less and the added ability to place these turbines closer together.

10. JET WIND TURBINE SAMPLE POWER CALCULATION

New invented JET wind turbines are both types – horizontal axis and vertical axis.

Power output calculation of horizontal axis jet machines follows same basic formulas as for conventional wind turbines.

Power output calculation of horizontal axis non jet machines is presented below:

11. NON JET WIND TURBINE POWER CALCULATION

Because air has mass and it moves to form wind, it has kinetic energy. We know from physics class that:

Kinetic energy (joules) = 0.5 x m x V2

Where:

m = mass(kg) (1 kg = 2.2 pounds)

v = velocity (meters/second) (meter = 3.281 feet = 39.37 inches)

Usually, we're more interested in power (which changes moment to moment) than energy. Since energy = power x time and density is a more convenient way to express the mass of flowing air, the kinetic energy equation can be converted into a flow equation:

Power in the area swept by the wind turbine rotor:

P = 0.5 x rho x A x V3

Where :

p = power in watts (746 watts = 1 hp) (1,000 watts = 1 kilowatt)

rho = air density (about 1.225 kg/m3 at sea level, less higher up)

A = rotor swept area, exposed to the wind (m^2)

v = wind speed in meters/sec (20mph = 9m/s) (mph/2.24 = m/s)

This yields the power in a free flowing stream of wind. Of course, it is impossible to extract all the power from the wind because some flow must be maintained through the rotor (otherwise a brick wall would be a 100% efficient wind power extractor). So, we need to include some additional terms to get a practical equation for a wind turbine.

Wind Turbine Power:

$P = 0.5 \times rho \times A \times Cp \times V^3 \times Ng \times Nb$

Where:

p = power in watts (746watts = 1 hp) (1,000 watts = 1 kilowatt)

rho = air density (about 1.225 kg/m3 at sea level, less higher up)

A = rotor swept area, exposed to the wind (m2)

Cp = Coefficient of performance (.59 [Betz limit] is the maximum theoretically possible, .35 for a good design)

V = wind speed in meters/sec (20mph = 9m/s)

Ng = generator efficiency (50% for car alternator, 80% or possibly more for a modern permanent magnet generator or grid-connected induction generator)

Nb = gearbox/bearings efficiency (depends, could be as high as 95% if good)

12. JET WIND TURBINE POWER CALCULATION

Basically, above described calculation is used for JET turbine, as well.

Two basic differences have to be made: Cp = Coefficient of performance have to be about .45 because of better JET blade performance (0.35 for conventional design) - see the calculation below.

Ng = generator efficiency instead 80% for a modern permanent magnet generator is above 90% because of higher rpm of JET rotors based on smaller rotor diameter for the same power output (see the calculation below).

Overall efficiency increasing of single rotor jet wind turbine is calculated as follow: [0.45 x 0.9] / [0.35 x 0.8] = 1.45 times more efficient The power calculation of SINGLE ROTOR JET axial turbines is based on above approach.

12.1 Power capacity

Calculation of Wind Energy and Power

Force = mass x acceleration F = ma (Typical Unit -Newton’s)

Energy = Work (W) = Force (F) x Distance (d) (Typical unit – Joules)

Power = P = W / time (t) (Typical unit –Watts)

Power = Torque (Q) x Rotational Speed (Ω)

Kinetic Energy in the Wind

Kinetic Energy = Work = $\frac{1}{2}MV^2$

Where:

M= mass of moving object

V = velocity of moving object

Mass of moving air

M = density (ϱ) x volume (Area x distance)

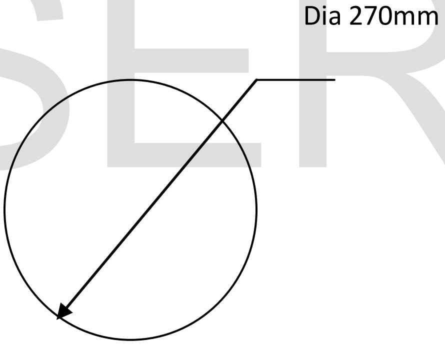
= ϱ x A x d

= $(kg/m^3)\ (m^2)\ (m)$

= kg

= 1 x 0.196x 0.5

= 0.098 kg



Data

Air Velocity v = 20 m/s

Tip speed ratio = 4

Dia of turbine = 270 mm (on the basis of blower out let size)

$P = 0.5 \times A \times \varrho \times v^3$

$\mathbf{P = 0.5 \times 3.14/4 \times 0.27^2 \times 1.2 \times 20^3}$

P = 274 watt / hrs

Tsr = tip velocity / air velocity

4 = tip velocity/ 20

$V \text{ tip} = 80 \text{ m /s}$

$V \text{ tip} = w \times 2 \times 3.14 \times r /60$

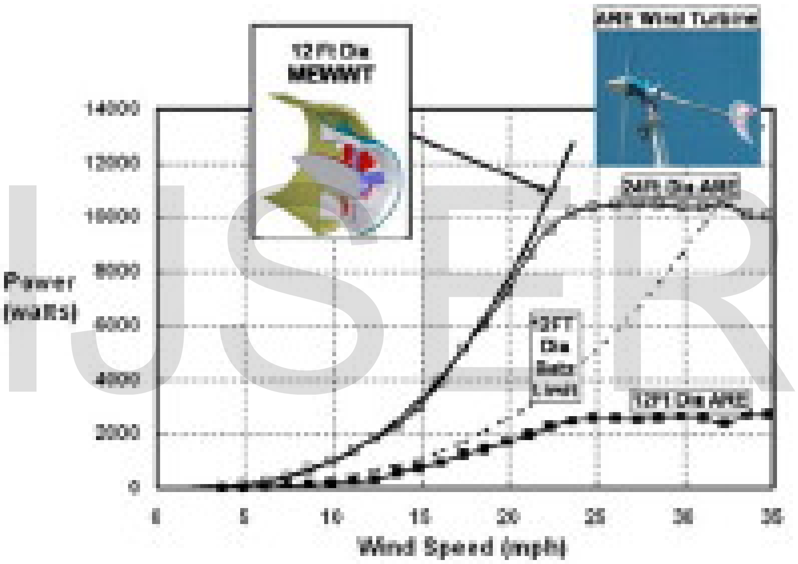
$80 = w \times 2 \times 3.14 \times 0.135 /60$

Angular velocity in rpm = 5661 rpm

Wind turbine speed = 5661 rpm

On the basis of tip speed ratio and turbine speed we select standard generator for wind mill

SUMMARY



During working on this project we came to know about the various renewable sources of energy and there importance in power production in the world. We came to know that importance of the power through wind mills. In future, further development in the direction of wind energy will make the power cheaper. India stands fifth in rank of power produced by wind energy.

The building of this project has helped us to develop good amount of confidence as we were able to tackle very interesting problems like,

1. Transmission system for converting the wind force in to rotational speed of shaft.
2. Mechanism to rotate the head assembly so as to access the use of wind from any direction, which increases the efficiency of the system.

It also gave us opportunity to realize ourselves as we were subjected to different problems and were compelled to take self decisions which really develops our problem tackling skills.

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First Author: Dharmik U. Sheth**,** Graduate, Department of Mechanical Engineering, Vidyavardhini College of Engineering and Technology, Email: dharmiksheth99@gmail.com

Second Author: Ali Asgar S. Khokhar, Graduate, Department of Mechanical Engineering, K.J.Somaiya College of Engineering, Email: khokharali5252@gmail.com