Concentrated Wind Energy Power Plant

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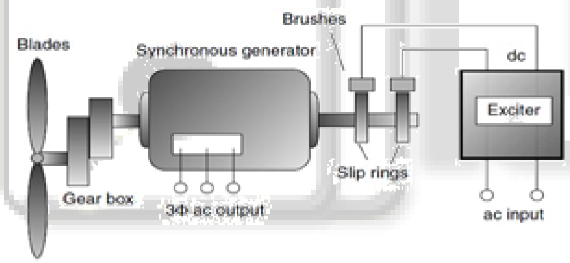
Abstract— This Technical Application Paper is intended to define the basic concepts & idea about the quality improvement in wind energy power generation which characterize this application and to designing a concentrated wind power plant and this is just an imagination which is set up to present towards the dignitaries who are the experts in their field. Although many operational aspects affect wind power plant operation, this paper focuses on power quality improvement of energy generation by introducing some new concept, which will lead to meet the requirement of shortage of power for consumers. Because a wind power plant is connected to the grid, it is very important to understand the sources of disturbances that affect the power quality. The advantages, disadvantages and importance over the current existing structure are also provided in this paper. Since, it is just an imagination it requires various researches, planning and management to set up and further improvement in this structure can also be made. Whether it should be adopted or not depends on the feasibility, cost and requirement of power generation.

Key words: Wind Energy, Wind Turbine Generators

I. BLOCK DIAGRAM OF WIND TURBINE GENERATORS:



The function of the blades is to convert kinetic energy in the wind into rotating shaft power to spin a generator that produces electric power. Generators can create the needed magnetic field with a permanent magnet rotor, almost all wind turbines that use synchronous generators create the field by running direct current through windings around the rotor core. Exciter is needed to convert ac from the grid into dc for the rotor. Second, this dc current needs to make it onto the spinning rotor, which means that slip rings on the rotor shaft are needed, along with brushes that press against them. Replacing brushes and cleaning up slip rings adds to the maintenance needed by these synchronous generators.

II. IDEAL POWER CHARACTERISTICS:

A. Cut-in Wind speed:

Low-speed winds may not have enough power to overcome friction in the drive train of the turbine and, even if it does and the generator is rotating, the electrical power generated may not be enough to offset the power required by the generator field windings. The cut-in wind speed VC is the minimum needed to generate net power. Since no power is generated at wind speeds below VC, that portion of the wind's energy is wasted. Fortunately, there isn't much energy in those low-speed winds anyway, so usually not much is lost. Rotating, the electrical power generated may not be enough to offset the power required by the generator field windings. The cut-in wind speed VC is the minimum needed to generate net power. Since no power is generated at wind speeds below VC that portion of the wind's energy is wasted. Fortunately, there isn't much energy in those low-speed winds anyway, so usually not much is lost.

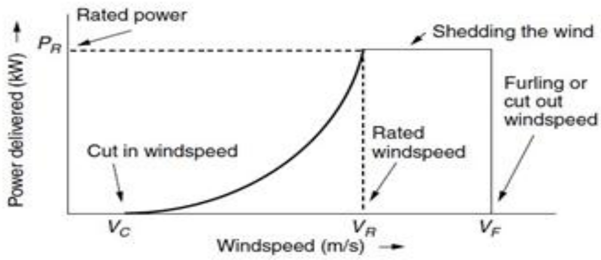


Fig.: wind speed vs. power delivered characteristics

B. Rated Wind Speed:

As velocity increases above the cut-in wind speed, the power delivered by the generator tends to rise as the cube of wind speed. When winds reach the rated wind speed VR, the generator is delivering as much power as it is designed for. Above VR, there must be some way to shed some of the wind's power or else the generator may be damaged. Three approaches are common on large machines: an active pitch-control system, a passive stall-control design, and a combination of the two.

C. Cut-out or Furling Wind speed:

At some point the wind is so strong that there is real danger to the wind turbine. At this windspeed VF , called the cutout windspeed or the furling windspeed ("furling" is the term used in sailing to describe the practice of folding up the sails when winds are too strong), the machine must be shut down. Above VF, output power obviously is zero.

III. BETZ LIMIT (MAXIMUM ROTOR EFFICIENCY)

The upwind velocity of the undisturbed wind is v, the velocity of the wind through the plane of the rotor blades is vb, and the downwind velocity is vd. The mass flow rate of air within the stream tube is everywhere the same, call it ˙m. The power extracted by the blades Pb is equal to the difference in kinetic energy between the upwind and downwind air flows: The mass flow rate is thus ˙m= ρAvb

$$\text{Maximum rotor efficiency} = \frac{1}{2}\left(1+\frac{1}{3}\right)\left(1-\frac{1}{3^2}\right) = \frac{16}{27} = 0.593 = 59.3\%$$

$$P_b = \frac{1}{2}\rho A\left(\frac{v+v_d}{2}\right)(v^2 - v_d^2)$$

$$P_b = \frac{1}{2}\dot{m}(v^2 - v_d^2)$$

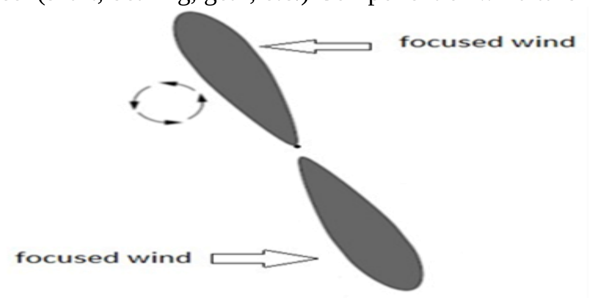
$$P_b = \frac{1}{2}\rho A\left(\frac{v+\lambda v}{2}\right)(v^2-\lambda^2 v^2) = \underbrace{\frac{1}{2}\rho A v^3}_{\text{Power in the wind}} \cdot \underbrace{\left[\frac{1}{2}(1+\lambda)(1-\lambda^2)\right]}_{\text{Fraction extracted}}$$

$$\text{Rotor efficiency} = C_P = \frac{1}{2}(1+\lambda)(1-\lambda^2)$$

IV. LIMITATIONS OF THE EXISTING WIND POWER PLANT:

The above shown typically used wind turbine characteristics can be modified by using concept called concentrated wind power plant .The limitation of typical wind turbine is that the motor has to be stopped in case of extremely heavy wind condition or excessive wind velocity.

This is because as power generated by wind turbine is directly proportional to cubic value of velocity .This indicates that as the wind speed increases to very high velocity, it will try to develop excess power than the rated value of power rating of machine .Which is actually not possible and this will lead to the failure of machine and nacel (shaft, bearing, gear, etc.) Component of wind turbine.



A further problem arises in this structure is that constant power output can’t be generated every time,Which will actually decides the rating of generator used in wind power plant. This is because as the wind velocity varies every time therefore the output power never remains constant and generator of a particular fixed rating cannot be used and in case of excessive speed the machine will have to stop because of the limited rating of machine, otherwise the machine will lead to failure or damage.