Horizontal axis wind turbine diagram

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In previous articles, you get to know about wind turbine and how it converts energy. We discussed important parts of a horizontal axis wind turbine. This article is intended to provide the function of each component in a wind turbine and the overall working of HAWT, control mechanism and control strategies, factors affecting the efficiency of the wind turbine.

The more the number of blades, the slower the rotor speed. So, turbines with 3 blades are relatively slower but will gain a high efficiency and a high torque. Wind turbines with a single blade are high-speed wind turbines.

As we discussed in a previous article, in upwind turbines rotor blades and nose face towards the wind. Wind vane detects the direction of air, while yaw mechanism is there to maintain the position of the rotor as the direction of wind changes.

As the wind strikes the blades, it tends to rotate them due to aerodynamic forces. Blade pitch control is an electronic control for blades. The power output of the turbine is monitored every second. As the power output reaches the rated limit, then controller immediately adjust (pitch) the blades a few degrees.

Stalling of turbine means increasing the angle of attack. As the angle of attack increases more surface area is available for aerodynamic forces.

Furling of turbine means decreasing the angle of attack. Blades are adjusted in a way that edges are facing towards the wind. It is applicable when there is strong wind and less wind energy is enough to drive the turbine.

We don’t want to get maximum wind energybecause wind turbines are designed to operate in particular wind speed (therated speed for most turbines are 5m/s to 25m/s). Strong winds may damage theturbine, so mechanical and electrical brakes are provided, to stop theturbines.

Braking system is there to limit over speed or it is used to stop turbine whenever it is needed.

Just think about it, wind speed never remainsconstant, so the output frequency changes whenever wind speed changes (Read electrical generator in the previous article). Of course, this is not going to happen. The electronic controller is there that keeps output within the limited range. The output frequency can be maintained by employing these ways.

It is a simpleand easy method, requires less complicated gearing mechanism. The block diagram of thefrequency converter is given below.

It is a generator that can deal withunpredicted weather conditions and hence variable and uneven wind energy. Itcan work with variable wind speed and produce constant output frequency.

You must know about Betz law. It is the law by which you can determine the amount of power you can generate, irrespective of the design. According to Betz law, maximum 59.3% of kinetic energy of wind, a wind turbine could capture. The factor 59.3% is called Betz coefficient. The output power of thewind turbine is:

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