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A BRIEF REVIEW ON WIND ENERGY TURBINE BLADES

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Abstract

The element of a wind turbine that captures energy from the wind is the rotor. Efficiency will be depend on the number of blades on the rotor their shape, their length, and the speed at which the rotor turns. The total amount of energy available depends on the area swept out by the blades, the swept area.In this article we present a brief review on the various materials being used in the fabrication of wind turbine blades such glass fibres, epoxy matrix compositesetc. In addition a brief outline on the preparation of turbine blades are also reviewed. The pros and cons of different materials is discussed with reasonable explanations.

Introduction

Wind energy is produced with wind turbines, tubular towers with blades rotating at the top when the wind turns the blade. The blade turns a generator and create electricity. It works on the principle instead of using electricity to make wind like a fan. Wind turbines use wind to make electricity. Wind turns the propeller like blade of a turbine around a rotor, which spins a generatorand creates electricity.

Wind turbines can have horizontal and vertical axis the turbines do not actually produce wind energy. The blades turn,convert the enrgy of wind into rotational energy,a form of mechanical energy and wind energy is turn converted into electrical energy

APPLICATONS:

- The wind energy is used to propel the sailboats in river and seas to transport men and materials from one place to another
- Wind energy is used to run pumps to draw water from ground through wind mills
- Wind energy has also been used to run flourmills to grind the grains like wheat and corn into flour
- Now a days wind energy is being used to generate electricity. Wind energy may be considerd as the worlds fastest growing energy source
  By the way development of technology,wind power may become most economical and environmental friendly source of electricity in many countries in the coming 10 to 20 years.

WIND TURBINES

Wind turbines is a device that converts the wind kinetic energy into electrical energy

TYPES OF WIND TURBINES

1.Horizontal axis wind turbines:

Horizontal axis wind turbines are the most familiar type of electricity producing wind mill.most have three large blades that spins parallel to the towers where the main rotor and generator located.

They stand about 60 to 90 meters tall and the blades rotate at 10 to 20 rotations a minute.

ADVANTAGES:

Variable blade pitch,which gives the turbine blades the optimumangle of attack

The tall tower base allows access to stronger wind in sites with wind shear. In some wind shear sites ,every ten meters up the wind speed can increases by 20% and the power output 34%.

DISADVANTAGES:

- The tall towers and the blades upto 90 meters long are difficult to transport. Transportation can now cost 20% of equipment cost.
- Tall horizontal axis wind turbines are difficult to instal,needing vary tall and expensive cranes and skilled operators

VERTICAL AXIS WIND TURBINES:

- These have varied, unusually shaped blades that rotate in complete circle around the generator are located near the ground making maintainance easier and less expensive, VAWTs do not have to be upwind to generate electricity.
- VAWTs can be much smaller than their HAWTs. Standing only 5meters tall these VAWTs can be installed on the roofs of the building.

ADVANTAGES:

- A massive tower structure is less frequently used, as VAWTs are frequently mounted with lower bearing mounted near the ground.
- A VAWTs can be located nearer the ground, making it easier to maintain the moving parts.

DISADVANTES:

- Most VAWTs produce energy energy at only 50% of the efficiency of HAWTs in large part because of additional drag that they have as their blades rotate into the wind.

While VAWTs parts are located on the ground, they are also located under the weight of the structure above it.

CHALLENGES:

- Wind power must still complete with conventional generation source on a cost basis.
- Good land-based wind sites are often located in remote location far from cities where from the electricity is needed.
- Wind resource development might not be the most profitable use of the land.
- Turbines might cause noise and aerthetic pollution.
- Wind plants can impact local wild life.

ROTOR BLADES OF WIND TURBINE:

Blades are the main mechanical parts of a wind turbine. The bladesconvert wind energy into usuable mechanical energy. When the wind strikes on the blades, the blades rotates. This rotation transfers its mechanical energy to the shaft. We design the blades like aeroplane wings. The wind turbine blader can be 40meters to 90meters long. The blade should be mechanically strong enough to with stand strong wind even during the storm. At the same time, the wind blader should me made as light as possible to facilitate smooth rotation of the blades. For that, we make the blades with fibre glass and carbon fibre layers on synthetic reinforce.

COMPOSITES FOR WIND TURBINE BLADES

Wind turbines blades are primarly made composite materials that combine high-tensile-strength fibers with polymer resins to form glass or carbon-fiber-rein forced polymers(GFRP).

GLASS AND CARBON FIBERS:

Glass and carbon fibers. The stiffness of composites is determined by the stiffness of fibers and their volume content. Typically, E-glass fibers (i.e., borosilicate glass called "electric glass" or "E-glass" for its high electric resistance) are used as main reinforcement in the composites. With increasing the volume content of fibers in UD composites, the stiffness, tensile and compression strength increase proportionally, yet, at high volume content of fibers (after 65%), there might be dry areas without resin between fibers and the fatigue strength of the composite reduces .

Typically, the glass/epoxy composites for wind blades contain up to 75 weight % glass.Many investigations toward the development of fibers, which are stronger than the usual E-glass fibers, have been carried out. The high strength fibers (which are still used seldom in practice, but represent a promising source of the composite materials improvement) include glass fibers with modified compositions (S-glass, R-glass, etc.), carbon fibers, basalt and aramid fibers. S-glass (i.e., high strength glass, S means "Strength" here) developed in the 1960s, shows 40% higher tensile and flexural strengths, and 10-20% higher compressive strength and flexural modulus, as compared to E-glass.

The S-glass is much more expensive than E-glass. S2 glass was developed in the 1968 as a commercial version of S-glass. S glass and S2 glass fibers have the same composition (mag esiumalumino-silicate). The main differences are in sizing (fiber coating) and certification procedure. The price of S2-glass is around 10 times of that of E-glass. R-Glass fibers, introduced in 1968, are produced with a calcium aluminosilicate glass with less silica and added oxides. Some other special glasses developed by Owens Corning are ECRGLAS, Advantex and most recently WindStrandTM glass fibers. The WindStrandTM glass fibers show15 percent higher stiffness and up to 30 percent higher strength when compared to E-glass .

Matrix

Due to the low weight requirement to the wind blades, polymers are the main choice as the matrix material for the wind blade composites. As noted above, matrix of composite controls fracture toughness, delamination strength and out-of-plane strength and stiffness of the composite, and influences the fatigue life of the composites. Typically, thermosets (epoxies, polyesters, vinylesthers) or (more seldom) thermoplastics are used as matrixes in wind blade composites. Thermosets based composites represent around 80% of the market of reinforced polymers (Nijssen, 2007, Joncas, 2019). The advantages of thermosets are the possibility of room or low temperature cure, and lower viscosity (thus, allowing better impregnation and adhesion). Initially, polyester resins were used for composite blades. With the development of large and extra-large wind turbines, epoxy resins replaced polyester and are now used most often as matrixes of wind blade composites. While polyester is less expensive and easier to process (needs no post-curing), epoxy systems are stronger (high tensile and flexural strength) and more durable as compared with polyester resins. Epoxy matrixes ensure better fatigue properties of the composites. The production of epoxy based composites is more environmentally friendly. Still, recent studies (e.g., by Swiss company DSM Composite Resins) support arguments for the return to unsaturated polyester resins, among them, faster cycle time and improved energy efficiency in the production, stating that the newly developed polyesters meet all the strength and durability requirements for large wind blades. Thermoplastics represent an interesting alternative to the thermoset matrixes. The important advantage of thermoplastic composites is their recyclability. Their disadvantages are the necessity of high processing temperatures (causing the increased energy consumption and possibly influencing fiber properties) and, difficulties to manufacture large (over 2 m) and thick (over 5 mm) parts, due to the much higher viscosity. The melt viscosity of thermoplastic matrices is of the order 102 -103 Pax s, while that for thermosetting matrix is around 0.1-10 Pax s. Thermoplastics (as differed from thermosets) have melting temperatures lower than their decomposition temperatures, and, thus, can be reshaped upon melting. While the fracture toughness of thermoplastics is higher than that of thermosets, fatigue behavior of thermoplastics is generally not as good as thermosets, both with carbon or glass fibers (Nijjssen, 2007). Other advantages of thermoplastics include the larger elongation at fracture, possibility of automatic processing, and unlimited shell life of raw materials (Lystrup et al, 1998). Further, the development of matrix materials which cure faster and at lower temperatures is an important research area. Resins with faster cure and lower curing temperature allow reducing the processing time and automating the manufacturing. In some cases, thixotropic agents, like fumed silica and certain clays, are used to control viscosities of resins during manufacturing. In several works, the possibilities of improvement of composites properties by adding nanoreinforcement in matrix were demonstrated. Additions of small amount (at the level of 0.5 weight %) of nanoreinforcement (carbon nanotubes or nanoclay) in the polymer matrix of composites, fiber sizing or interlaminar layers can allow to increase the fatigue resistance, shear or compressive strength as well as fracture toughness of the composites by 30…80%. Graphite particles fiber coatings on glass fibers allow increasing the fatigue life up to 100 times e.g., (Bian, 1996). Summarizing the brief overview, one can state that apart from the basic solution (epoxy/E-glass composites) widely used for medium and large wind blades, there are several very promising directions of development of stronger, more reliable and economically producible composites, among them: • High strength fibers (strong glasses, carbon, aramid, other fibers) can ensure higher stiffness and sometimes better strength and damage resistance of composites; the disadvantages are higher costs and in some cases lower compressive strength (carbon fibers) and high sensitivity to local defects (e.g., misalignment). Hybrid composites with mixed E-glass and high strength fibers allow to achieve the combination of higher stiffness (due to carbon fibers) with limited cost increase • Thermoplastic resin matrixes, as opposed to the widely used epoxy matrix, are recyclable, can be reshaped upon melting and have higher fracture strain. Their disadvantages are high processing temperatures and higher viscosity, leading to the more expensive and difficult processing times. Resins with faster cure and lower curing temperature allow us to reduce the processing time and automate the manufacturing. Further, the nanomodified matrixes or sizing on fibers have a potential to increase the fatigue strength of the composites.

Manufacturing of Wind Turbine Blades:

During the first decades of the wind energy development, wind turbine blades were often produced using the wet hand lay-up technology, in open molds. The glass-fiber reinforcement was impregnated using paint brushes and rollers. The shells were adhesively bonded together/to the spars. This technology was used mainly to produce small and medium size blades (up to 35 and 55 m, respectively). For larger blades, the same technology was used, but the web were inserted and adhesively bonded between two sides, and the plies with more fiber content were used. The disadvantages of the open mold technology are high labor costs, relatively low quality of products and environmental problems. In 1970s, several companies and institutes explored the applicability of filament winding technology, seeking to improve the quality of turbine and to reduce labor costs [13].

The introduction of vacuum infusion and prepreg technologies allowed improving the quality of manufacturing [14]. The prepreg technology, adapted from the aircraft industry, is based on utilizing "pre-impregnated" composite fibers, which already contain an amount of the matrix material bonding them together. Prepreg (widely used, for instance, by the Danish wind turbine producer Vestas) allows the industrial impregnation of fibers, and then forming the impregnated fibers to complex shapes.

The most widely used technology to produce the wind blades, especially longer blades, is the resin infusion technology. In the resin infusion technology, fibers are placed in closed and sealed mold, and resin is injected into the mold cavity under pressure. After the resin fills all the volume between fibers, the component is cured with heat. The resin infusion technologies can be divided into two groups: Resin Transfer Molding (RTM) (resin injection under pressure higher than atmospheric one) and Vacuum

Assisted Resin Transfer Molding (VARTM) (or Vacuum Infusion Process) (when resin is injected under vacuum or pressure lower than atmospheric, typically, under a vacuum bag) [15]. A variation of VARTM called SCRIMP™ (i.e., Seemann Composite Resin Infusion Process) was developed in late 1980s and is quite efficient for producing large and thick parts. Currently, vacuum assisted resin transfer molding (VARTM) is the most common manufacturing method for manufacturing of wind turbine rotor blades. With his method, layers of fabrics of dry fibers, with nearly all unidirectional fibers, aligned in the direction along the length of the blade, are position on mold parts along with polymer foams or balsa wood for sandwich structures (for the aeroshells). In order to form a laminate that is thick by the root and gradually becomes thinner towards the tip, most plies run from the root only partly toward the tip; the termination of a ply is called ply-drop. The fabrics and subsequently covered by a vacuum bag and made air-tight. After the application of vacuum, low-viscosity resin flows in and wets the fibers. After infusion, the resin cures at room temperature. In most cases, wind turbine rotor blades are made in large parts, e.g., as two aeroshells with a load-carrying box (spar) or internal webs that are then bonded together. Sometimes, the composite structure is post cured at elevated temperature. In principle, this manufacturing method is well suited for upscaling, since the number of resin inlets and vacuum suction points can be increased. A challenge with upscaling is however, than quite many layer of dry fabrics must be kept in place and should not slip relative to each other. The composite is quite thick by the root section, typically exceeding 50–60 mm in the consolidated state. In practice, it can be a challenge to avoid the formation of wrinkles at double-curved areas and areas with un-wetted fibers and air bubbles can be entrapped in the bondlines. After manufacturing, the blades are subjected to quality control and manufacturing defects are repaired. Since a large blade represents a large value in materials, increasing sizes means that it becomes less and less attractive to discard blades with manufacturing defects. Thus, with increasing size the requirements towards materials go towards easier processing and materials should preferably be more damage tolerant so that larger manufacturing defects can be tolerated. shows the schematics of the manufacturing of a wind turbine rotor blade by assemblage and bonding of two aeroshells and two shear webs.

The infusion process is usually cheaper that the prepreg process. However, the prepreg composites have more stable, better and less variable mechanical properties than the composites produced by resin infusion. This technology is relatively environmental friendly, and makes it possible to achieve higher volume content of fibers, and to control the materials properties. Further, the prepreg technology allows higher level of automation and better choice of resins.

Lately, the automated tape lay-up, automated fiber placement, two-pieces or segment wind blades, enhanced finishing technologies are expected to come into use to improve quality and reduce costs of the composite blade manufacturing [14]. A big challenge, in comparison with e.g., automatization of composite structures for aerospace, is the much larger thicknesses and the much larger amount of materials to be places in the molds for wind turbine rotor blades. For some parts of the blades, 3D woven composites represent a promising alternative to producing fiber reinforced laminates. Mohamed and Wetzel [16] suggested producing spar caps from 3D woven carbon/glass hybrid composites. It was demonstrated that this technology allows producing spar caps with higher stiffness and lower weight, than the commonly used technologies.

Wind energy pros and cons:

There are advantages and disadvantages to any type of energy source, and wind energy is no different. In this article, we'll review some of the top pros and cons of generating electricity from wind turbines.

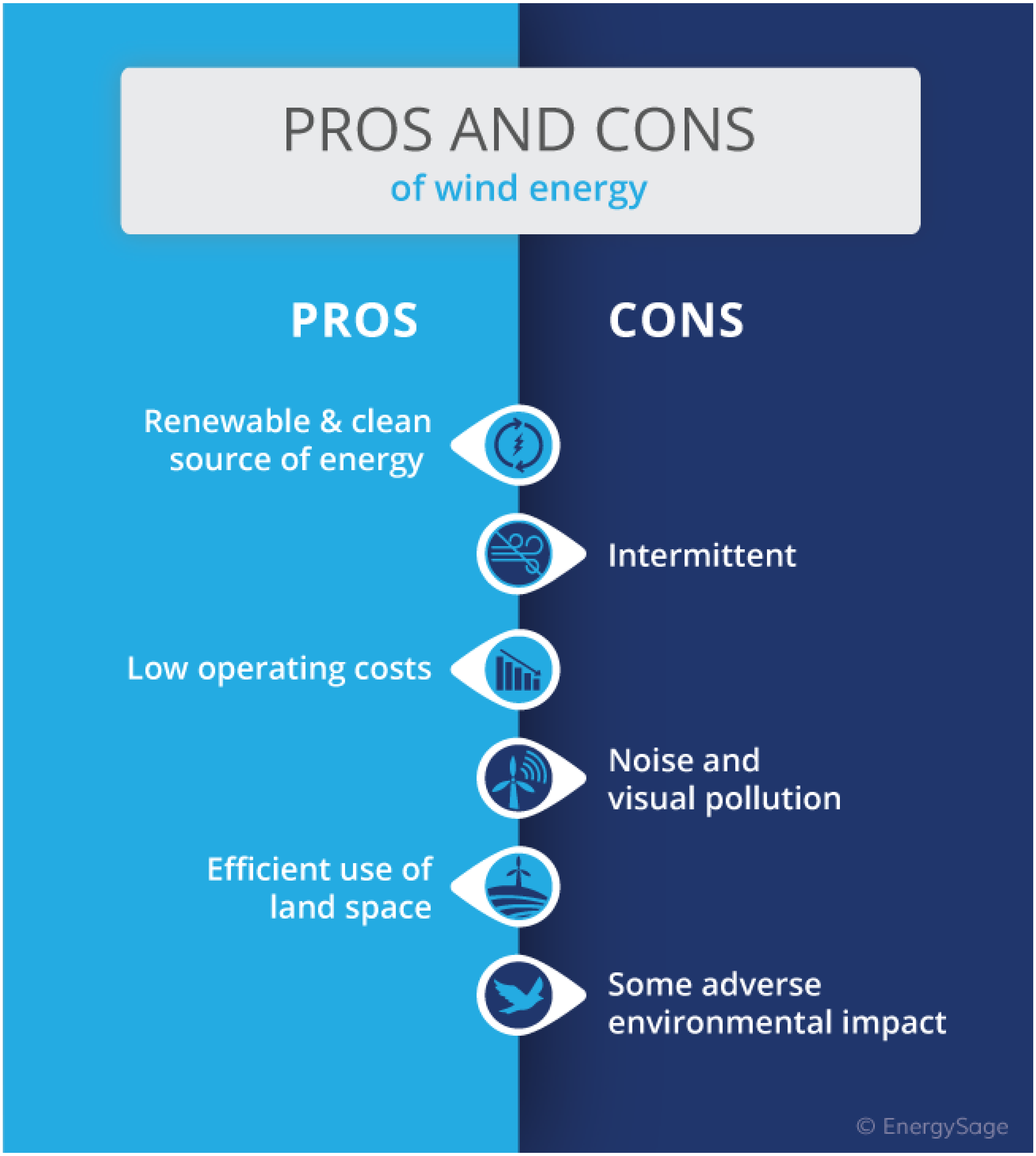
Top pros and cons of wind energy:

Wind energy is one of the most commonly used types of renewable energy in the U.S. today, and also happens to be one of our fastest-growing sources of electricity. However, while there are a number of environmental benefits to using wind energy, there are some downsides. Here are a few of the top pros and cons:

Pros and cons of wind energy

Pros of wind energy	Cons of wind energy
Renewable & clean source of energy	Intermittent
Low operating costs	Noise and visual pollution
Efficient use of land space	Some adverse environmental impact

On the pros side, wind is a clean, renewable energy source, and is one of the most cost-effective sources for electricity. On the cons side, wind turbines can be noisy and unappealing aesthetically, and can sometimes adversely impact the physical environment around them. Similar to solar power, wind power is also intermittent, meaning that turbines are reliant on weather and therefore aren't capable of generating electricity 24/7.


PROS AND CONS
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CONCLUSION

Finally, I want to say the advantages of wind energy are more than the disadvantages so my opinion that wind energy which has many benefits, such as it is less expensive than factories, less space, are easily available all over the world and non-polluting to the environment. So wind energy is also more useful than traditional methods to create energy. Meaning that it is getting cheaper and cheaper to produce wind energy.

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