**Blade’s materials**

Reference 1: Recycling of thermosetting composites for wind blade application

It is thus evident that P increases with the cube of the wind speed, and it is thus clear that the annual distribution of the wind speed (and its direction) in a certain location is probably the most significant project parameter [5]. However, the amount of wind energy that can be converted in usable energy is considerably lower. Theoretically speaking, the maximum efficiency of a wind turbine rotor exploiting the lift force (i.e. perpendicular to the direction of the wind) is 59.3%, and it represents the ‘Betz limit’. Wind plants based on the drag force (i.e. parallel to the direction of the wind) have an even lower theoretical efficiency (about 29.6%).

HAWTs are nowadays the preferred turbine design, especially for big size wind projects, but small scale VAWTs have been also recently installed in urban areas, as they are characterized by lower noise levels and allow the production of energy also in locations with discontinuous and turbulent winds. In Figure 1(a-b) is reported a representative scheme of HAWT and VAWT wind generators.

Composite materials are widely applied in WT blades for their better mechanical performances and easy manufacturing [15-25], coupled with the possibility to tailor/modify both the stiffness and the strength changing the orientation of the reinforcing fibers.

From the data reported in Table 2 it is evident that polymer composites are characterized by a superior specific strength, but the most interesting advantage in their use is probably the superior fatigue resistance.

GFRPs are generally produced by using an epoxy or polyester (or less commonly vinylester) thermosetting matrix, while for the manufacturing of CFRPs Only epoxy resin is utilized.

**Referência:** DORIGATO, Andrea. Recycling of thermosetting composites for wind blade application. **Advanced Industrial And Engineering Polymer Research.** Trento, Italy, p. 2-48. fev. 2021.

**Citação com autor incluído no texto:** Dorigato (2021)

**Citação com autor não incluído no texto:** (DORIGATO, 2021)

Reference 2: Finite Element Analysis of a Composite VAWT Blade

The modern wind turbine materials are composites made up of fiberglass reinforcements. For turbine blade design, they are composed of E-glass with epoxy, polyester or vinyl ester and normally hand-layup fabrication techniques are used (Sutherland, 2000). The glass-epoxy composite material is recommended for the design of wind turbine blades due to its useful characteristics (National Research Council (NRC), 1991).

The comparative study of Aluminium and Glass-Epoxy shows that Aluminium has been extensively used as VAWT blade material but Glass-Epoxy has been used for HAWT blade only and its application on VAWT blades has not been utilized yet by manufacturers (Islam et al., 2008). However, Glass-Epoxy is considered as one of the prospective materials for the construction of straight bladed VAWT blades (CANMET Energy Technology Centre (CETC), 2001), because they are economically attractive and have a good combination of material properties e.g. high strength, moderate density and stiffness.

**Referência:** HAMEED, M. Saqib et al. Finite Element Analysis of a Composite VAWT Blade. **Ocean Engineering.** Sahiwal, Pakistan, p. 669-676. out. 2015.

**Citação com autor incluído no texto:** Hameed et al. (2015)

**Citação com autor não incluído no texto:** (HAMEED et al., 2015)