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Engineering Guidelines for Airborne Wind Energy Tethers with HMPE Fibers⁽¹⁾

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Airborne Wind Energy tethers are a critical component in many AWE systems. The challenge in designing an AWE tether is finding the optimal balance between system performance and lifetime of the tether. Both aspects are crucial in determining the economic feasibility (generated energy price) of the whole system. The presentation will elaborate on the different parameters responsible for the performance and for the service life of the HMPE tether.

There are many diverse systems that are currently under development, this presentation focusses on tethers for the so called pumping yo-yo system. In these systems, the tether is the critical component for transfer of the kinetic energy from kite to ground station. Given the desired hardware (sheaves and winches) and performance expectations (over one year continuous use) this presentation will give insights on a first estimation of the tether design and dimensions.

As a starting point an overview will be given on fibers available to system developers in the industry, but soon it will be concluded that for this application the base material of

choice is HMPE fibers. The presentation will explain some of the fundamentals of different HMPE materials involved and elaborate on possible failure mechanisms that may occur in the pumping yo-yo system. Especially creep lifetime and bending fatigue insights are described for long term lifetime performance checks. Other conditions like sand ingress, system fleet angles, that may influence the longevity of the tether are briefly mentioned, but since firm testing data is lacking, it is recommended to perform these checks on case by case basis.

An engineering method will be proposed to come to a first design of the tether. As an illustration a real life example pumping yo-yo tether (Kite Power) will be worked out. For static use of the tether (no bending fatigue) only the creep lifetime consideration can be taken into account.

(1) The presentation is based on the chapter that has been submitted for publication in the accompanying Airborne Wind Energy book to be presented at the AWEC2013 in Berlin.