Numerical Modelling of Friction in Passively Pitching Blades for Tidal Turbines

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ABSTRACT

Tidal turbines experience unsteady and periodic loading due to, for example, the turbulence and the shear of the tidal stream, waves, and changes in the phase of the tidal cycle. Above a threshold tidal stream speed, namely rated speed, power generation is capped to avoid dimensioning the generator for short duration high load peaks. Power cap can be achieved by active systems, such as hydraulic pitch actuators. Recent theoretical [1], numerical [2][3] [4], and experimental [5] works on turbines whose blades are allowed to passively pitch by balancing the hydrodynamic pitching moments with a torsional spring mounted on the root of the blade, show that time-average power and thrust can be kept constant within a variable flow field. Numerical results further show that root-bending-moments can be reduced by at least 30%. This current work uses an experimentally validated model based on blade-element-momentum-theory, and aims to investigate the effects of friction present in the pitching mechanism on the load mitigation performance of a full-scale one megawatt tidal turbine equipped with passive pitch. The efficacy of passive pitch is shown to be constrained by friction, modelled as a function of bearing size and friction coefficients as found in literature for marine applications, with results identifying design limitations for the design of passively pitching blade systems.

References

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