directly correlated to the vorticity and pressure distribution around the blade. The effect of the LEV physical size on the total circulation over the suction surfaces explains the difference between rigid and flexible blades. Fig.11 (a) and (b) represent the variation of the mean power coefficient C_P and the input power required to deform the blades for the aforementioned cases. It can be seen that the higher C_P values are recorded at a0/c=0.2.

8. CONCLUSION

Blade shape for a VATT has a large effect on the turbine efficiency, which is primarily attributed to the nature of the interaction between the blade and the detached LEV vortex. The control and the manipulation of this expected interaction is the solution for an efficient model of VATT. As the turbine rotates, the blade can interact with the vortices generated by the blade itself or by previous blades. The ability of the blade to change its shape and therefore the flow structure interaction during the turbine rotation can produce significant improvements. The change in the blade camber line gives rise to a typical larger horizontal surface where the LEV is expected to act on. Moreover, this correction is able also to alter the flow angle of attacks and therefore the leading edge vortex time of formation, which results in an improved lift and power extraction. Computational results indicate that this strategy of control indeed enhance the VATT performance. For a tip speed ratio λ=3.5, a frequency zi=4, and a camber amplitude a0/c=0.2; the power coefficient (CP) rises about 20 % relative to the original turbine.

REFERENCES

[1] Amet E, Maître T, Pellone C, Achard JL. (2009). 2D numerical simulations of blade–vortex interaction in a Darrieus turbine. J. Fluids Eng. 131(11): 111103. https://doi.org/10.1115/1.4000258

[2] Anderson JM, Streitlien K, Barrett DS, Triantafyllou MS. (1998). Oscillating foils of high propulsive efficiency. J Fluid Mech. 360: 41-72.

[3] Beem HR, Rival DE, Triantafyllou MS. (2012). On the stabilization of leading-edge vortices with span wise flow. Exp. Fluids 52: 511-7.

[4] Bouzaher MT, Hadid M, Derfouf S.E (2017). Flow control for the vertical axis wind turbine by means of Flapping Flexible foils. J Braz. Soc. Mech. Sci. Eng. 39: 457.

[5] Bouzaher MT, Hadid M. (2017). Numerical investigation of a vertical axis tidal turbine with deforming blades. Arab J Sci Eng 42: 2167.

[6] Campanile LF. (2007). Modal synthesis of flexible mechanisms for airfoil shape control. J Int Mater Syst Struct 19: 7: 779-789.

[7] Heathcote S, Wang Z, Gursul I. (2008). Effect of spanwise flexibility on flapping wing propulsion. J. Fluids Struct 24: 183-99.

[8] Hoke CM, Young J. Lai JCS. (2015). Effects of time-varying camber deformation on flapping foil propulsion and power extraction. Journal of Fluids and Structures 56: 152–176.

[9] Hoogedoorn E, Jacobs GB, Beyene A. (2010). Aero-elastic behavior of a flexible blade for wind turbine application: A 2D computational study. Energy 35(2): 778–85.

[10] Jie W, Chen L, Yang SC, Zhao N. (2015). Influence of a flexible tail on the performance of a foil hovering near the ground: Numerical investigation. European Journal of Mechanics B/Fluids 52: 85–96.

[11] Liu W, Xiao Q, Cheng F. (2013). A bio-inspired study on tidal energy extraction with Flexible lapping wings. Bioinspir.Biomim. 2013Sep; 8(3): 036011.

[12] Lee AT, Flay RGJ. (1999). Compliant blades for wind turbines. Trans Inst Prof Eng NZ: Electr/Mech/Chem Eng. Sect 26(1): 7.

[13] Liu WY, Zhang X, Liu XF, Gong JX. (2010). Bionic design and performance study for flexible blades of wind turbine. J Mach Des 5: 7–10

[14] Liu W, Xiao Q. (2015). Investigation on Darrieus type straight blade vertical axis wind turbine with flexible blade. Ocean Engineering 110: 339–356

[15] Miao JM, Ho MH. (2006). Effect of flexure on aerodynamic propulsive efficiency of flapping flexible airfoil. Journal of Fluids and Structures 22: 401-419.

[16] Maître T, Amet E, Pellone C. (2013). Modeling of the low in a Darrieus water turbine: wall grid reinement analysis and comparison with experiments. Renew Energy 51: 497-512

[17] Nabavi Y. (2008). Numerical study of the duct shape effect on the performance of a ducted vertical axis tidal turbine. PhD thesis, University of British Columbia, Vancouver, Canada.

[18] Read DA, Hover FS, Triantafyllou MS. (2003). Forces on oscillating foils for propulsion and maneuvering. J Fluids Struct 17: 163-83.

[19] Tuyen QL, Jin HK. (2015). Effect of hydrofoil flexibility on the power extraction of a flapping tidal generator via two- and three-dimensional flow simulations. Renewable Energy 80: 275-285

[20] Wang Y, Sun XJ, Dong XH, Zhu B, Huang DG, Zheng ZQ. (2016). Numerical investigation on aerodynamic performance of a novel vertical axis wind turbine with adaptive blades. Energy Conversion and Management 108: 275–286.