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叶尖射流对风力机叶尖流场影响的数值研究

Numerical study on effects of blade tip air jet on the flow field of wind turbine blade tip

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英文关键词:air jet power growth rate aerodynamic performance of wind turbine power coefficient of wind blade tip vortex

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中文摘要：

为了设计出更加适合非并网系统的风力机，采用在叶尖加入射流的方法来改变叶尖流场分布.在风力机叶片顶端沿弦长布置3个喷口，采用CFD数值模拟方法，通过改变风力机转速获得原型和带喷口的风力机模型的气动特性以及流场分布.发现在转速低于1200r/min时，带有安装在不同位置的喷口的风力机功率增长率几乎都为零，射流在这一转速范围内对风力机的气动性能几乎没有影响.而转速高于1200r/min时，随着转速的增大，喷口位于叶尖中部的风力机的功率增长率快速地增大，射流影响了75%以上叶高的表面的压力分布，在大转速下吸力面低压区范围较大，其叶尖涡涡量低于其他方案中，并且在下游扩散得比其他方案快，改善了风力机下游流场，提高了风力机效率.喷口布置在叶尖前缘时其叶尖涡的局部涡量较原型叶片稍大，降低了风力机功率的输出.喷口布置在叶尖尾缘时基本和原型叶片相同.该结论为设计适用于非并网系统的定桨距变转速风力机提供了基础.

英文摘要：

In order to design a more suitable wind turbine for the non-grid-connected wind power system, the method of arranging air jet on the blade tip was adopted to change the flow field of blade tip. Orifices were arranged on the top of the blade tip at three chordwise positions. Using the CFD numerical simulation method, the aerodynamic performances and flow field distribution of a wind turbine based model and models with orifices were obtained under different rotating speeds. When the rotating speed was below 1200r/min, all the power growth rates of wind turbine with orifices were almost zero, indicating air jet had no effect on the aerodynamic performance of wind turbines at this range of rotating speed. When rotating speed was higher than 1200r/min, with the increase of rotating speed, the power growth rates of the wind turbine with air jet at middle of the chord raised fast. The air jet affected the pressure distribution on the blade surface of 75% blade height, and the low pressure area on the suction side was larger at high rotating speed. The vorticity of blade tip vortex of the blade with air jet at middle position was lower than the other model. Meanwhile, the dissipation of the blade tip vortex was faster than that of the other model, improving the downstream flow field and the efficiency of the wind turbine. There was no obvious change when the orifice was set at the trailing edge. But for the model with orifice at leading edge, the output power declined, and the wrticity of blade tip vortex is slightly larger than the based model. This conclusion provides the foundation for designing wind turbine applicable for non-grid-connected wind power system.

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