Mechanical Engineering Master's Defense

Numerical simulation of environmental flow over buildings for renewable energy application

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abstract

For the increasing concerns of influence on environment by fossil-electricity generation, application of renewable energy becomes one of the most focused issues in society. Based on the limitation on urban environment, wind turbines, which can be mounted on rooftop or between buildings, are regarded as a feasible way for wind energy generation. This study presents wind flow simulations in a large-scale environment with certain dimension buildings. Different inlet velocity boundary conditions are tested firstly, and the non-uniform inlet boundary condition shows better agreement with realistic situation. Turbulence intensity is set to be 10% for comparison consistency. The k-epsilon turbulence model is regarded as a better simulation for this certain condition. After that, three different structures, which include single building, pristine double building and modified circular gap double building systems, are tested in this environment condition. The result shows 18.8% velocity increasing on the top of single building system. Pristine double building systems are tested with 4 different gap distances, and building with 10 meters gap achieved the best velocity condition, which 32.8% velocity increasing and 11.8% improvement comparing to single building system, respectively. But the location of maximum velocity moves to the gap and the maximum velocity on the rooftop of double building system is approximately 5.1% lower than single building system. Based on previous study, modified circular gap double building system is created with 10 meters gap. Comparing result with single building system, modified circular gap system achieves higher improvement for wind flow, whose improvement of velocity increasing in the gap and on the rooftop of building are 47.1% and 3.0%, respectively. As a result, the modified circular gap double building can be regarded as a high efficiency system of environmental wind flow over buildings for renewable energy system.

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