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Development and validation of a CFD model used for vertical axis wind turbines simulations

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Abstract. This paper describes the design of a CFD model based on the finite element analysis, used for determining the performance of a vertical axis wind turbine. The validation of the proposed model is done by simulating a real rotor, chosen to be the 6 kW Quietrevolution wind turbine. The power curves of the real and the simulated rotors are considered as comparison criteria. The goal is to have close shapes of the two power curves.

1. Introduction

Simulations are an important tool in engineering that generally lead to cost reduction of product development and time. Finite element analysis is very important means in this sense and they serve as a base for the present work. Besides choosing the appropriate mathematical model behind physics of the simulated system, it is important to choose the right shape and size of the finite elements. It is also important that the elements are well adapted for the specific system to be analysed.

This work presents a CFD model created for determining the performances of a vertical axis wind turbine. The CFD model is made using ANSYS CFX software. The CFD model is used to determine the power curve of a real wind turbine namely Quietrevolution QR 6 produced by a British company. For this turbine the real power curve is known and is compared to the simulated one. This comparison is considered as validation variant of the CFD model.

2. Parameters of the analyzed wind turbine

The analyzed vertical axis wind turbine presented in the figure 1 has the constructive parameters presented in table 1. The parameters are taken from the technical specification document [1]. From the pictures of the QR6 turbine was determined the helical angle which is 120°. The chord length is not indicated in the specification so it was determined by measuring it from the pictures by taking the proportions between the known and measured dimension of the diameter and unknown and measured dimension of the chord. This was done by analyzing many images of the turbine so that the error is as small as possible. The chord length obtained is approximately 195 mm.

Another very important parameter of the wind rotor is the airfoil. This parameter is not specified either because most probable this is kept as a commercial secret by the company. As observed from the pictures, the airfoil used seems to be symmetric. We adopted NACA 0018 as it is among the most used symmetric airfoil for vertical axis wind turbines. The CAD model of the simulated rotor is presented in the figure 2. To be noticed that the simulated rotor does not have the axial shaft and the struts. This is done in order to simplify the simulation complexity and reduce simulation time.