DOUBLE ROTOR WIND TURBINE

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A drastic increase in energy demand and rising energy prices are forcing to seek new and better energy sources to meet people's demand for electricity. The ideal source should be cheap to use, and never exhaust its resources (be renewable!). In addition to conventional power plants in which electricity is produced from fossil fuels, in recent times renewable energy sources have become increasingly popular. Among others these include the wind energy.

Known types of wind turbines slowly reach its design maximum related to the maximum amount of electricity that are able to provide to the grid. The towers cannot be higher due to construction restrictions and due to economic calculation. Also used generators will not achieve a significant improvement in efficiency. The same applies to the shape of the rotor blade and the other component parts of the wind power plant. In this situation it is essential to propose innovative wind turbine construction that significantly improve the efficiency of energy production. Thesis on the double rotor wind turbine should allow the develop a new approach for designing the wind turbines.

The primary purpose which was realized in the course of research, it was to verify the theoretical considerations proving that the double rotor wind power plant generates more power, and thereby verifying substituted hypothesis:

The double rotor wind power plant can generate more power than wind power plant with a classic construction equipped with a rotor

In the new solution additional rotor, similar to the first, thanks to appropriate settings of the attack angle of blades and extra bearings added to generator stator, allows stator to rotate in opposite direction to generator rotor driven by first aerodynamic rotor. As a result the absolute speed of the generator, with the same wind conditions, are greater than in the traditional design with a single aerodynamic rotor.

As part of a research project funded by the National Science Centre, which part was this thesis, aerodynamic tunnel was built allowing tests of mini wind turbines. In terms of the work also the air stream uniformity in the measurement chamber of the aerodynamic tunnel was check and the approach to compensate was performed.

During the laboratory tests two constructs wind turbines were measured: classical equipped with one rotor and double rotor wind turbine equipped with two counter-rotating aerodynamic rotors. For both construction the operating parameters optimization was conducted. In the case of classical

construction, it boiled down to determine the optimum attack angle of the rotor blades. For double rotor construction optimum attack angle of the second rotor blades and the distance between the rotors has been additionally determined.

Based on the collected data mathematical model of double rotor wind turbine based on multi-layered one-way artificial neural network (ANN) was built. The network composed of the input layer, the output layer and a hidden layer where the number of neurons was changed in the range of 4 to 30. In the course of the simulations network with 27 neurons in the hidden layer showed a coefficient of determination at 0.9946. After confirming proper functioning of the ANN model using data from test set the re-optimization of operating parameters of double rotor wind turbine using ANN was carried out. This optimization allowed to clarify the optimal attack angle of the blades to the value of 125 ° for the first rotor blades and the range of 48 ° - 52 ° for the second rotor blades.

In the thesis also performance comparison of the single and double rotor wind turbines both were equipped with rotors of the same diameter was done. The comparison showed that the classic design generates more electrical energy in the entire operating range. The difference for the rated wind speed, ie 12 $m \cdot s^{-1}$, was 12% in favor of single rotor wind power plant, thereby thesis hypothesis has not been confirmed.

The research project contributed to the widening of the current state of knowledge on wind turbines. Used modeling method with ANN allows among other things to simulate the work of double rotor wind turbine and use the results to construct the controller based on the ANN the control blades attack angle in the two rotors, as well as the distance of two rotors. The results provide a basis for further work on the improvement of the double rotor wind power plant.

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