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Simulation Savonius Wind Turbine with Multi-Deflector

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Abstract. This paper aims to study the windmill Savonius with multi-deflector. Multi-deflector placed around the windmill, which aims to reduced negative torque to the returning blade and directing the flow of wind to the advancing blade . CFD analysis with ANSYS software. The initial conditions with variation wind speeds 3, 4, 5 and 6 m / s. The result indicated by velocity distribution at positions 0^0, 45^0, 90^0 and 135^0. The largest static torque occurs at position 450 caused by the greater the Coand-like flow, dragging flow and overlap flow. The greater the static torque that occurs with increasing wind speeds.

Introduction

Savonius a vertical axis windmill that operates due to the drag force on the blades, but it also affects the lifting force of the mechanical power transmitted to the shaft. Savonius windmill has advantages such as simple design and construction, can receive wind from any direction, can work at low wind speeds, large static and dynamic torque but it has low efficiency [1].

Savonius windmill performance can be improved by additional deflector aimed at reducing the negative torque to the returning blades and directing the flow of the advancing blade [2,3,4]. However, Savonius with deflector performance is influenced by the tip clearance between the deflector, the greater the tip clearance so the greater losses that occur [4]. Single deflector has a weakness can only accept wind from the front, when there is a change in wind direction it is necessary to change the deflector position.

Multi-deflector overcome this so that the wind direction from anywhere is not a problem. In addition to the multi-deflector can reduce the vortex that occurs behind the windmill. The influence of tip clearance on the static torque and velocity distribution will be observed in the use of multi-deflector.

Methodology

Simulation using ANSYS software with geometry surface-plane, and the dimensions; in a blade radius (r) 103 mm, blade thickness (t) 5 mm, overlap (o) 31 mm or overlap ratio (o/2r) 0.15, windmill diameter (D) 391 mm. Multi-deflector with the number 8 has a long dimension of 1.5 r and thickness 5 mm. Tip clearance windmill to multi-deflector varied by 0.1 r 0.2 r and 0.3 r. Windmills and multi-deflector coaxial placed in the middle of a wind tunnel shown in Figure 1.

The solution using the Pressure-based, steady time, space 2D, Model k - epsilon, Standard Wall Functions, Velocity Pressure Control Coupling with Semi-Implicit Method for Pressure Linked Equation (SIMPLE), discretization Momentum Second Order Upwind and Pressure Standard [5,6,7]. Given boundary condition input variable wind speed are 3, 4, 5 and 6 m / s, and the output of outflow.

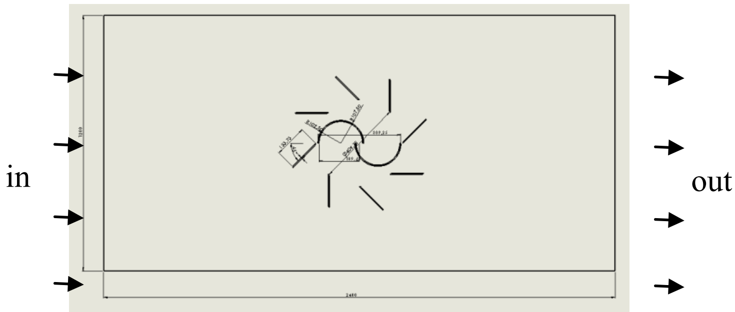
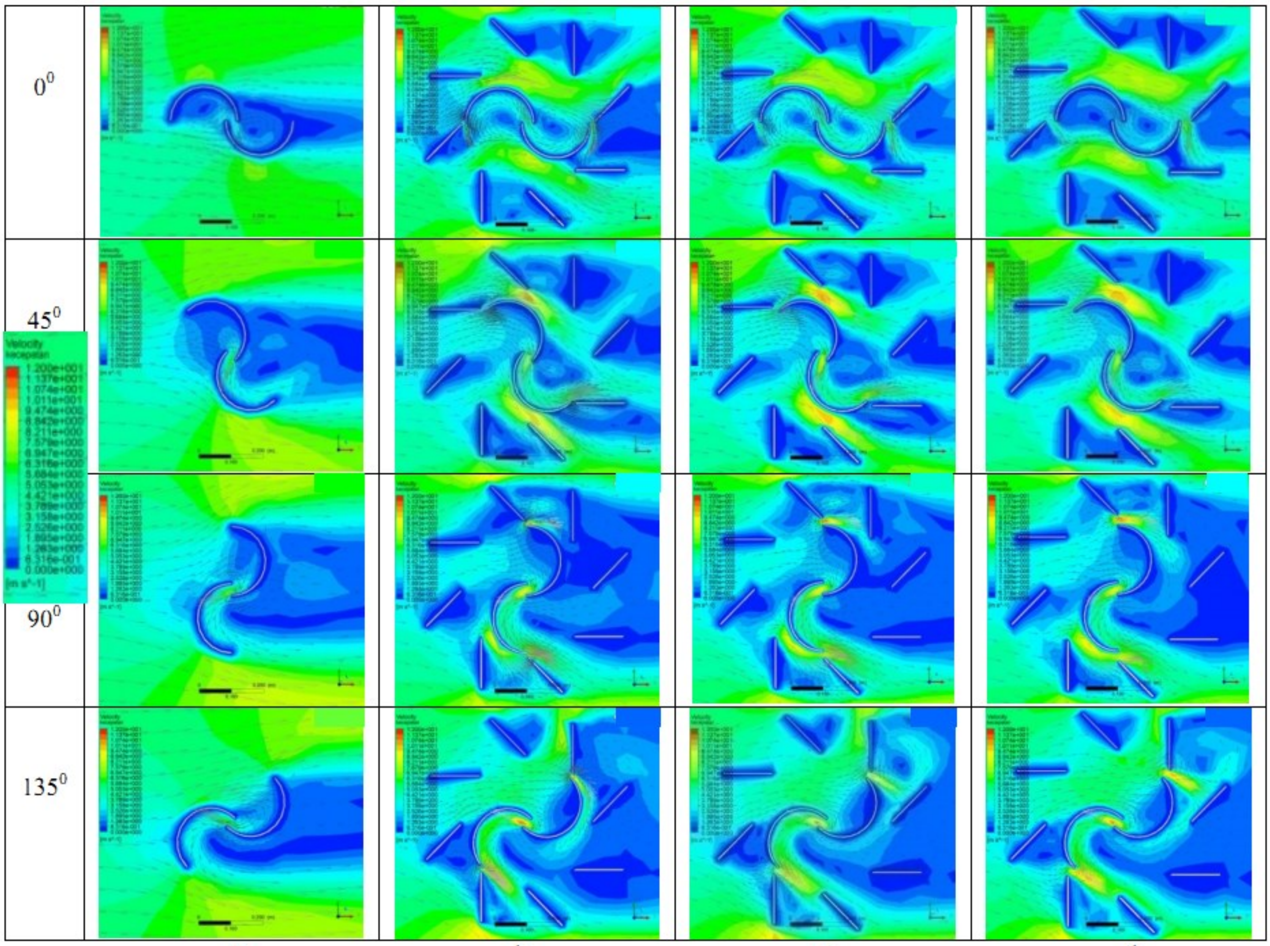


Figure 1. Physical model and boundary conditions

Result and Discussion

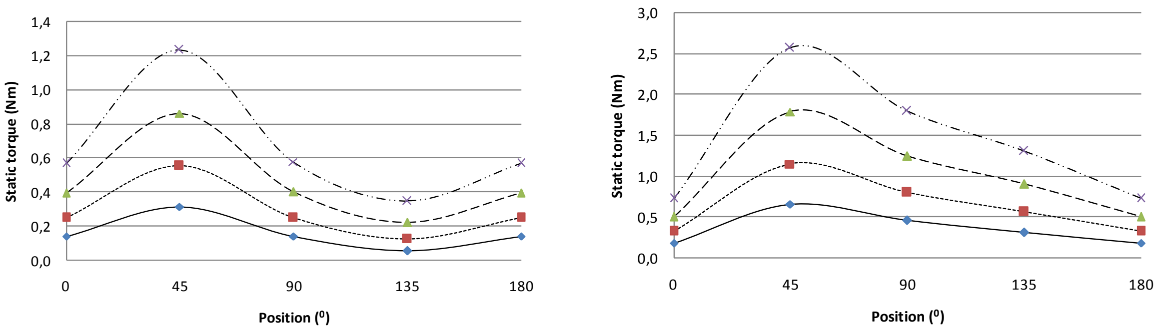
The result displayed in the form of the velocity distribution. Standard Savonius windmill placed on the left side then Savonius windmill with multi-deflector consecutive with tip clearance of 0.1 r, 0.2 r and 0.3 r. Velocity distribution with initial conditions the wind speed is of 5 m / s shown in Figure 2. Each velocity distribution and the speed limit are taken with the same scale. Figure 2 a - d shows the comparison of the velocity distribution at various windmill angles of θ = 0^0, 45^0, 90^0, 135^0. It presents the standard Savonius windmill (a), windmill with tip clearance multi-deflector 0.1 r (b), windmill with tip clearance multi-deflector 0.2 r (c) and windmill with tip clearance multi-deflector 0.3 r (d). Flow at standard Savonius windmill has six flow patterns that occur are Coand-like flow, dragging flow, overlap flow, stagnation flow, vortex from the tip of the advancing blade and vortex from the tip returning blade [1,8,9]. Coand-like flow, dragging flow and overlap flow produce positive power but three subsequent flow is reducing. Multi-deflector shown to increase Coand-like flow, dragging flow, overlap flow. The stagnation flow in windmill with multi-deflector shift closer to the axis windmill which makes a negative torque is reduced, while the vortex which occurs behind windmill has decreased. So multi-deflector increase the power that occurred on Savonius windmill. Coand-like flow, dragging flow and overlap flow have maximum velocity at positions 45^0.



a. b. c. d.

Figure 2. Comparison Velocity Distribution, a. Standard Windmill, b. with tip clearance 0.1 r, c. with tip clearance 0.2 r and d. with tip clearance 0.3 r

Figure 3 shows a graph of static torque with position windmill at wind speeds of 3, 4, 5 and 6 m / s. Of each figure shows the largest static torque that occurs at position 45^0. For standard Savonius windmill has a value that is small enough static torque at position 135^0. Savonius windmill with multi-deflector has about 2 times the static torque of the standard windmill that is of 1.2 Nm to 2.6 Nm at a wind speed of 6 m / s. The greater the wind velocity create static torque generated greater. At position 0^0 windmill with multi-deflector that uses the tip clearance of 0.2 r have the best static torque value.



a. b.

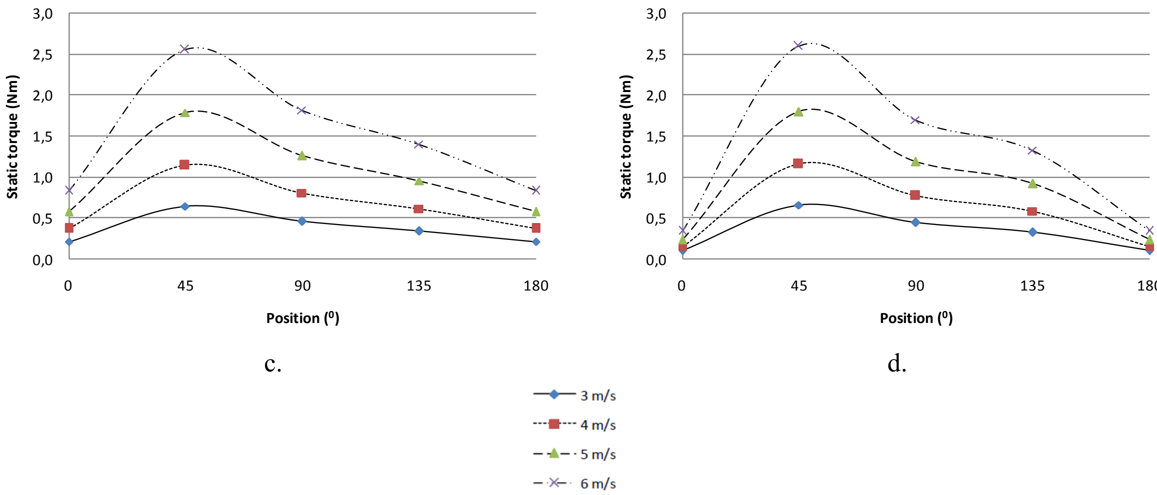


Figure 3. Graph of static torque vs position, , a. Standard Windmill, b. with tip clearance 0.1 r, c. with tip clearance 0.2 r and d. with tip clearance 0.3 r

Conclusions

From the analysis it can be concluded that:

- Multi-deflector improves the Savonius windmill performance by increasing the Coand-like flow, dragging flow and overlap flow, and reduce of three other streams.
- The maximum static torque occurs at position 45^0
- Savonius windmill standard has the lowest static torque at position 135^0
- Multi-deflector with a tip clearance of 0.2 r has the best performance, especially at the position 0^0
- Increase the static torque that occurs with increasing wind speeds.

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