

Experimental power and thrust coefficients of a shrouded horizontal axis hydrokinetic turbine

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Abstract

Dataset includes power and thrust coefficients of a 19.8 cm diameter horizontal axis hydrokinetic model turbine measured experimentally in a water tunnel. Tests are done at 0.7, 0.9, and 1.1 m/s water speeds for three turbine configurations: turbine blade alone and then with two shrouds. Output power of the turbine and its thrust force are measured experimentally. Results are corrected using a theoretical model that accounts for free surface proximity and blockage effects of the water tunnel.

Keywords: Hydrokinetic turbine, shroud, performance, thrust coefficient

1 Water tunnel

Tests are carried out in the recirculating water tunnel facility at the University of Manitoba. The tunnel has a 61 cm wide by 183 cm long test section and allows maximum of 60 cm water height. A propeller pump provides water flow up to speed 1.1 m/s at the test section for the full water height. Turbulence intensity of the flow at the test section is less than 3% for the maximum speed.

2 The model turbine

The model turbine has a rotor blade and allows use of shrouds. The rotor blade is a 19.8 cm diameter three bladed H0127 wind turbine blade of KidWind Project Inc. with a solidity of 0.13. Two shrouds are designed, manufactured, and used in the experiments. One is a duct of convergent-divergent profile referred to as the *shroud*. The other is a straight wall duct referred to as the *diffuser*. Schematics of profile and photos of the shroud and the diffuser are depicted in Figure 1 and the geometric characteristics are summarized in Table 1. Thickness of the diffuser wall is 9 mm.

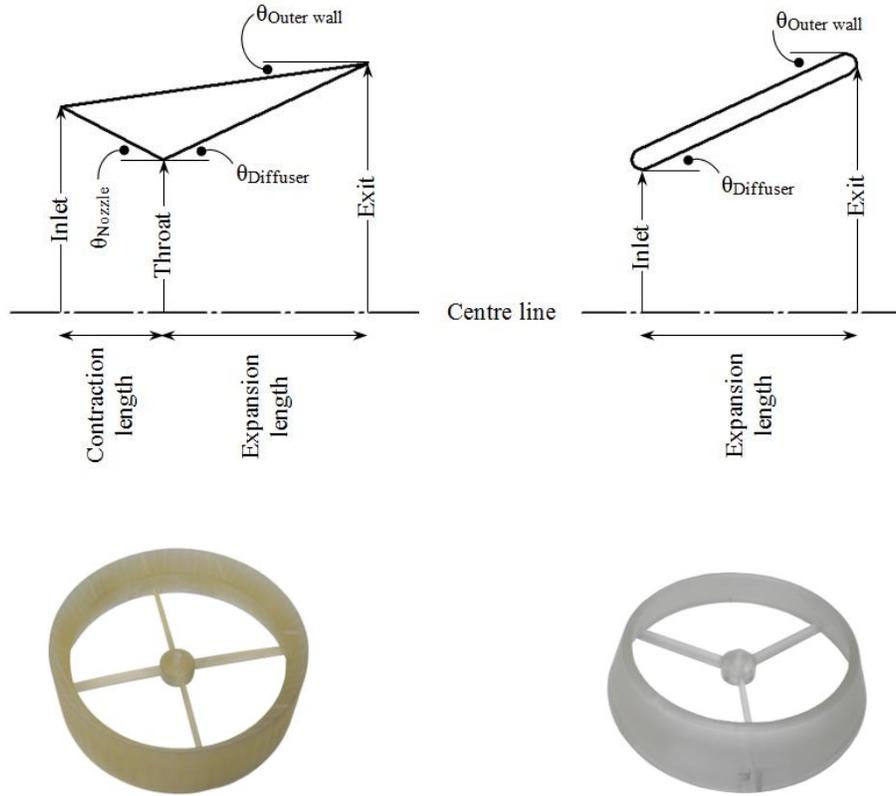


Figure 1: Schematic profile and photo of the shroud (left) and the diffuser (right)

Table 1: Dimensions of the shroud and the diffuser

Dimension	Shroud	Diffuser
Inlet diameter (cm)	22.6	20.1
Throat diameter (cm)	20.1	---
Exit diameter (cm)	25.0	25.0
Contraction length (cm)	2.5	---
Expansion length (cm)	5.2	5.2
Nozzle half angle (°)	27	---
Diffuser half angle (°)	25	25
Outer wall angle (°)	8	25

3 Dataset

The dataset contains experimental values of power and trust coefficients for the shrouded and unshrouded turbines. The first column in each file is TSR and second column is the coefficients.

Tip speed ratio, power and trust coefficients are calculated as follows:

$$TSR = \frac{R\omega}{V}$$

$$C_p = \frac{Q\omega}{1/2 \rho AV^3}$$

$$C_T = \frac{T}{1/2 \rho AV^2}$$

where Q and T are torque and thrust of the turbine and ω and V are respectively the angular velocity of the turbine shaft and the flow speed. The power and thrust coefficients are calculated based on the swept area of the rotor blade, A.