An Experimental Study of Overlap Ratio Effect to Savonius water Current Turbine by using Myring Equation for n=1

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Abstract. This study has been employed experimentally towards Savonius water turbine by using Myring equation for n=1. This work will be varied to overlap ratio of 0, 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3. The overlap ratio of 0 can be called as the conventional turbine using half circle. The experiment is tested in flume tank by 1.1 m of wide and 0.8 m of height and the water velocity 0.22 m/s. The turbine have 0.4 m of height and 0.4 of diameter. This work will be calculated the torque coefficient and the power coefficient. The power coefficient is called the performance coefficient. The results indicated that the best performance coefficient has improved in about 62.83 % at overlap ratio of 0.2.

1. Introduction

The Savonius turbine is the simple shape of the turbine with bucket shape of half circle. Application of Savonius turbine can be used in fluid of water and air. The shaft of turbine can be applied axis and horizontal. Horizontal application has been conducted experimentally by Nakajima, et al [1]. Marine current energy has been employed by Yakkob [2]. The axis application has been conducted by varying the bucket number and 2 buckets have the best performance [3]. The myring equation has been performed numerically with best performance has been obtained at n of one [4].

The effect of cylinder is added in front and the side of turbine numerically applied in the turbine to improve the performance [5], [6], [7], [8]. The turbulence model effect have improved the accuracy performance trend by using the Reliaizable k-epsilon [9]. The improvement effort have been employed by varying overlap ratio and the best performance at overlap ratio 0.1 – 0.15 [3] and 0.2 [10]. This study uses the equation of the Myring n=1 experimentally and have been tested in water flow.

Purpose of this study is to investigate the effect of overlap ratio towards the turbine performance of myring n=1 experimentally. Overlap ratio is varied 0, 0.05, 0.1, 0.15, 0.2 and 0.25. The flume tank is the facility to test and take data of the torque and power. Power coefficient is called the performance coefficient.
2. Experimental Setup
The Myring equation is used to determine the shape of turbine as shown in equation (1). The myring model uses overlap ratio of 0 or without overlap ratio. The flume tank is the facility to get data information of the Myring turbine as seen in Figure 2. The Myring use equation (1), Tip Speed Ratio (TSR) use the equation (2), torque coefficient use (3), power coefficient use equation (4) and torque use equation (5).

\[
y = b\left[1 - \left(\frac{x}{a}\right)^2\right]^\frac{1}{n} \tag{1}
\]

\[
TSR = \frac{\omega \cdot R}{4U} \tag{2}
\]

\[
C_m = \frac{U}{\rho U^2 D^2 H} \tag{3}
\]

\[
C_p = TSR \cdot C_m \tag{4}
\]

\[
T = (F1 - F2)(r_{shaft} + d_r)g \tag{5}
\]

\[
\beta = \frac{e}{D} \tag{6}
\]

Overlap ratio (\(\beta\)) is defined gap (e) by diameter (D) that can be seen in equation (6). Schematic of overlap calculation is represented in Figure 1. Overlap ratio is varied 0, 0.05, 0.1, 0.15, 0.2 and 0.25. the experiment has been done in flume tank as shown in Figure 2.

![Figure 1. Myring turbine for n = 1](image-url)
Figure 2. Experimental setup in flume tank

The Myring Savonius has diameter of 0.400 m and height of 0.400 m. TSR, torque coefficient (Ct), power coefficient (Cp) are calculated from the equation (2), (3) and (4), respectively.

3. Results and Discussion

3.1. The torque coefficient as the function of TSR

The graphical results of torque coefficient can be seen in Figure 3 by varying overlap ratio of 0, 0.05, 0.1, 0.15, 0.2 and 0.25 with the myring formula n=1.

Figure 3. The torque coefficient as the function of TSR
The trend of torque coefficient decrease by increase of tip speed ratio (TSR). The increase of torque coefficient due to decrease of weight in weight pan at experiment in flume thank. The overlap ratio has the torque coefficient higher than the conventional blade shape.

3.2. The power coefficient as the function of TSR

The experimental results of power coefficient can be seen in Figure 4. The graph of power coefficient has been varied overlap ratio of 0, 0.05, 0.1, 0.15, 0.2 and 0.25. This study indicates that overlap ratio can increase the performance and the performance higher than the conventional blade shape. The performance is called the power as shown in Figure 4. The best performance is occurred at overlap ratio of 0.2.

![Figure 4. The power coefficient as the function of TSR](image)

3.3. Improvement of Savonius turbine performance

The improvement can be calculated by the maximum power coefficient that represents the performance coefficient. The performance improvement can be obtained by calculation based on conventional shape. The results of performance improvement in (%) can be displayed in Table 1.

| Blade shape  | Peak of performance (power coefficient) | TSR  | Improvement of performance (%) |
|--------------|----------------------------------------|------|---------------------------------|
| Conventional | 0.3260                                  | 0.7336 | 0                               |
| Overlap 0    | 0.3747                                  | 0.7329 | 14.93                           |
| Overlap 0.05 | 0.4103                                  | 0.7517 | 25.87                           |
| Overlap 0.1  | 0.4597                                  | 0.8992 | 41.01                           |
| Overlap 0.15 | 0.5175                                  | 0.8449 | 58.73                           |
| Overlap 0.2  | 0.5309                                  | 0.6946 | 62.83                           |
| Overlap 0.25 | 0.4851                                  | 0.7279 | 48.81                           |
4. Conclusion
The results showed that the overlap ratio by using Myring n = 1 has obtained the best performance at overlap ratio 0.2. The turbine performance has increased in about 62.83% compared to the other overlap ratio and conventional blade.

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