An Experimental Study of the Savonius Water Current Turbine by means of Myring Equation for \( n = 1 \)

P A Setiawan\(^1\), M Santoso\(^1\), R Indarti\(^2\), N Ariwiyono\(^3,4\), T Yuwono\(^3,4\), and W A Widodo\(^3\)

\(^1\)Department of Marine Engineering, Politeknik Perkapalan Negeri Surabaya, Surabaya, Indonesia, 60111
\(^2\)Department of Marine Electrical Engineering, Politeknik Perkapalan Negeri Surabaya, Surabaya, Indonesia, 60111
\(^3\)Department of Mechanical Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia, 60111
\(^4\)Center of Excellence in Automotive Control & System, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia, 60111

*priyo.as@ppns.ac.id

Abstract. This work has been done experimentally to the Savonius water current turbine by means of Myring equation for \( n = 1 \). The myring for \( n = 2 \) is called the conventional turbine with half circle or bucket. Experiment is tested in flume tank by 1.1 m of wide and 0.8 m of height. The free stream velocity is 0.22 m/s measured at 1.5 m from nozzle. The model is the Myring equation with \( n = 1 \) by 0.4 m of height and 0.4 m of turbine diameter. The experimental study has investigated the torque coefficient and the power coefficient. The power coefficient has been called the performance coefficient. The experimental results shows that the Myring formula \( n = 1 \) have the performance coefficient higher than the conventional blade. The myring blade for \( n = 1 \) increases in about 42.88 % compared to the conventional blade.

1. Introduction

The water turbine is one of the renewable energy producing the electrical power. The renewable energy will change the fossil energy producing the mission and disturbing the environment. The used turbine in this work is Savonius with 2 bucket and have the best performance [1]. The wind turbine have been conducted by means of the Myring equation numerically and the best performance at \( n \) of one [2].

The performance of Savonius has been employed numerically and improved the performance of Savonius turbine by adding a circular cylinder [3], [4], [5], [6]. The turbulence model variations have the performance trend by using the Reliazible k-epsilon [7]. The performance improvement have been done by varying overlap ratio. The best performance is occured at overlap ratio 0.1 – 0.15 [1] and overlap 0.2 [8]. This work will be done by using the equation of the Myring \( n = 1 \) experimentally and have been tested in water flow.

This work will be conducted investigation by comparing the coefficient of performance between myring \( n = 2 \) called conventional and myring blade with \( n = 1 \) tested experimentally. The data will be
taken in flume tank facility by results of the torque and power coefficient. The power coefficient is called the coefficient of performance.

2. Experimental Setup
This Savonius model use the Myring equation for n of 1 as shown in equation (1) and Figure 1. The model uses Myring without overlap ratio. The flume tank is used to test the Myring turbine that can be displayed in Figure 2. The Myring formula use equation (1), Tip Speed Ratio (TSR) use the equation (2). And than, torque coefficient and power coefficient use equation (3) and (4), respectively. The torque can be calculated by using equation (5).

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

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

\[
c_m = \frac{4T}{\rho U^2 D^2 H}
\]

\[
c_p = \frac{C_m}{TSR}
\]

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

![Figure 1. Savonius Rotation and Myring n = 1](image-url)
The Savonius model is represented as in Figure 1 and the conventional blade for \( n = 2 \) and Myring blade \( n = 1 \) as modification based on the equation (1). The Savonius has diameter 0.400 m and height 0.400 m. TSR, torque coefficient \((C_t)\), power coefficient \((C_p)\) 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 experimental results of torque coefficient can be seen in Figure 3. The graph of torque coefficient has been compared between the Myring for \( n = 1 \) and \( n = 2 \). The Savonius \( n = 2 \) is called the conventional blade. The torque coefficient results decrease by increase of tip speed ratio (TSR). The increase of torque coefficient due to as consequence the decrease of weight at experiment in flume thank. This has shown that The results have the torque coefficient \((C_m)\) higher than the conventional blade or Myring with \( n = 2 \).
3.2. The power coefficient as the function of TSR

The results of experiment results of power coefficient can be displayed in Figure 4. The performance turbine is represented as the power coefficient. The graph of performance has been conducted comparison the Myring with n=1 and n=2. In addition, the Savonius with n=2 is represented the conventional Savonius. In general, the performance coefficient results increase by increase of tip speed ratio (TSR) and the performance has reached peak performance at certain TSR. And than, the performance of turbine decrease by increase of the tip speed ratio. This work has indicated that The the Myring n=1 have the performance higher than the Myring with n = 2 that is called conventional.
3.3. Improvement of Savonius turbine performance

The performance improvement can be calculated 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.

Table 1. Improvement of turbine performance

| Blade shape     | Peak of performance (power coefficient) | TSR   | Improvement of performance (%) |
|-----------------|----------------------------------------|-------|--------------------------------|
| Conventional    | 0.2842                                  | 0.7679| 0                              |
| (Myring n=2)    |                                        |       |                                |
| Myring n=1      | 0.4061                                  | 0.8069| 42.88                          |

4. Conclusion

The results showed that the Myring y using n = 1 has given the performance higher than the conventional Savonius. The Savonius turbine performance has increased in about 42.88% compared to the conventional blade.

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