JURNAL TEKNIK MESIN DAN MEKATRONIKA
Journal of Mechanical Engineering and Mechatronics
ISSN: 2527-6212, Vol. 10 No. 2, pp. 60 - 67

Comparison of Power Consumption Between Krisbow Lathe Type KW 15-486 and Krisbow Lathe Type C0636AX1000

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Abstract. Electrical power consumption in turning machines is a critical factor affecting manufacturing efficiency, primarily influenced by process parameters such as spindle speed and depth of cut. This study aims to compare the electrical power consumption of two types of turning machines—Krisbow Type KW 15-486 and Krisbow Type C0636AX1000—under varying spindle speeds and cutting depths. The workpiece material used was ST-40 steel. Electrical power data were obtained from empirical current measurements during the turning process and subsequently converted into theoretical power values. Experimental variations included spindle speeds of 65, 180, 235, 400, 700, and 1000 rpm, and cutting depths of 1 mm and 2 mm. The results revealed that increasing spindle speed generally led to a decrease in electrical power consumption up to a certain point, after which, at speeds above 700 rpm and 1000 rpm, power consumption tended to rise again. In contrast, greater cutting depth consistently resulted in higher power consumption. The findings demonstrate distinct energy consumption characteristics between the two turning machines, providing valuable insights for selecting machine types based on energy efficiency considerations.

Keywords: turning machine; power cosumption; spindle speed, depth of cut.

Introduction

The advancement of technology in the manufacturing sector demands greater efficiency and effectiveness in the utilization of resources, including electrical energy. As one of the primary machine tools in both industrial manufacturing and technical education, the turning machine plays a vital role in metal cutting processes. During operation, turning machines require a continuous supply of electrical power, and this energy consumption can become a significant cost burden if not properly managed. The electrical power consumption of a turning machine depends on several process parameters, with lower energy usage typically observed when the spindle speed and related parameters are set at lower levels [1].

Each type of turning machine possesses distinct technical characteristics and operational performance, which can influence the magnitude of electrical power consumption during machining processes. Therefore, it is essential to analyze the energy efficiency of various types of machines, particularly those commonly used in educational and technical training environments. One such example includes the Krisbow Type KW 15-486 and Krisbow Type C0636AX1000 turning machines, both of which are widely utilized in metal turning practice within vocational workshops. Previous observations on the BV-20 lathe indicate that higher spindle speeds tend to result in lower electrical power consumption [2]. In the turning of certain metals, the electrical power consumption varies depending on the material properties and machining conditions, with an optimum value observed at a cutting speed of approximately 70 m/min [3],[4]. In the turning process, the cutting feed rate is another important parameter that influences the electrical power consumption during production. The feed rate is directly affected by the spindle speed; therefore, spindle speed also serves as a key factor governing electrical energy usage. Under machining conditions with a spindle speed of 2000 RPM, the electrical power consumption was observed to be the highest [5].

During the metal cutting process, friction occurs between the cutting tool and the workpiece, generating heat. The resulting heat causes the cutting tool to wear and become dull, which subsequently increases friction and, consequently, electrical power consumption. The application of cutting fluid reduces friction, thereby enhancing cutting efficiency and decreasing the required power consumption [6]. The power utilized in the turning process is significantly influenced primarily by variations in cutting speed [7]. Based on the existing data and previous studies, further research is required to investigate the electrical power consumption commonly observed in turning practice within educational environments, in order to obtain rational and economically meaningful values.

Material dan Methode

This study was conducted to analyze the electrical power consumption of two types of turning machines, namely the Krisbow Type KW 15-486 and the Krisbow Type C0636AX1000, under variations of spindle speed and cutting depth. The research was carried out experimentally in the machining laboratory of SMK Muhammadiyah Pekalongan using a quantitative approach. This method was employed to obtain numerical data derived from the measurement of electric current during the turning process.

Tools and Materials.

The tools and materials used in this study are as follows:

- Turning Machine: Krisbow Type KW 15-486
- Turning Machine: Krisbow Type C0636AX1000
- Digital AC Ammeter
- AVO Meter
- Workpiece Material ST-40 stell in cylindrical form
- Cutting Tool High-Speed Steel (HSS) lathe tool with standard specification
- Supporting Measuring Instruments; Vernier calipper, micrometer etc.

Research Variabel .

Independent Variabels

- Spindle speed (RPM): 65, 180, 235, 400, 700, and 1000
- Depth of cut: 1 mm and 2 mm

Dependent Variabel

- Electrical power consumption (kW)

Control Variabels

- Material type: ST-40 steel , High-Speed Steel (HSS) tool, kept constant cutting during the experiment

Research Mehtode

a. The turning machine was set to operate at spindle speeds of 65 rpm, 180 rpm, 235 rpm, 400 rpm, 700 rpm, and 1000 rpm.
b. The ST-40 steel workpiece was clamped using a chuck, and the cutting tool was mounted on the tool post. The turning process was then performed with cutting depths of 1 mm and 2 mm, as illustrated in Figure 1 and Figure 2.

Fig. 1 Steel ST-40 dia.25

Fig. 2 Turning Process

c. The electric current during the turning process was measured using a digital AC ammeter, as shown in Figure 3 and Figure 4.

Fig. 3 Current Measuring Process

Fig. 4 Digital AC Ammeter

d. The same procedure was repeated for a cutting depth of 2 mm.
e. The entire experimental procedure was then repeated for both types of turning machines, as illustrated in Figure 5.
f. The electric current data obtained from the measurements were used to calculate the electrical power consumption using Equation (1):

$$P = V \, x \, I \, x \, . \sqrt{3} \, x \, cos \, phi \qquad (1)$$

Where:
P : Power [Watt]
V : Voltage [Volt]
I : Electrical Current [Ampere]
Cos phi : Power factor of PLN (0.7).

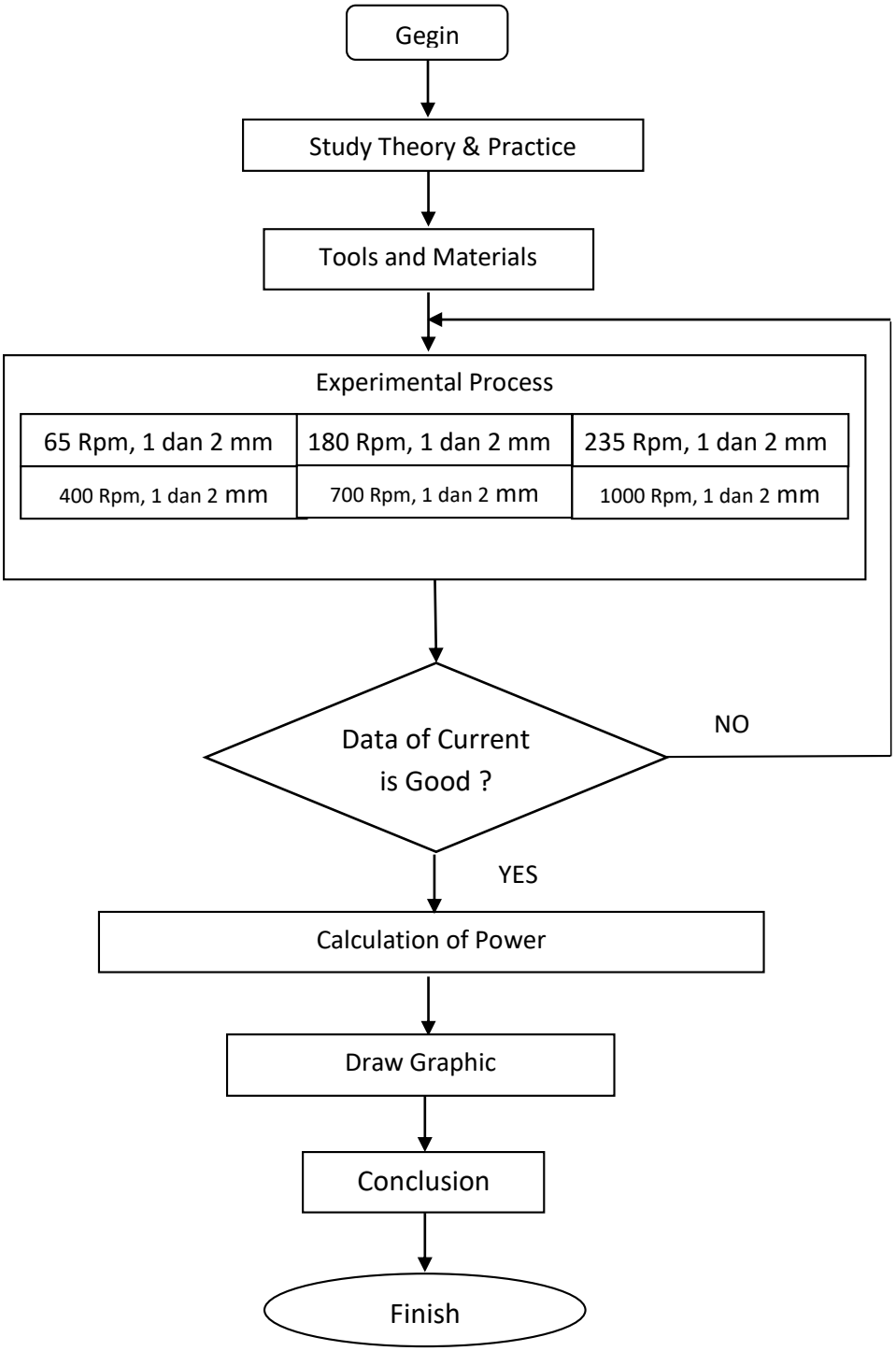

Fig. 5 Resarch Flow Diagram

Results and Discussion

Based on the experimental results, empirical data on electric current were obtained from measurements conducted on two types of turning machines, namely Krisbow Type KW 15-486 and Krisbow Type C0636AX1000. The tests were performed under variations of spindle speed and at two levels of cutting depth—1 mm and 2 mm—as presented in Table 1 and Table 2.

Electric Current Measurement Results

The measurement of electric current was carried out using an ammeter during the turning process. The following tables present the measured current values (in amperes) for each turning machine.

Table 1. Current (Ampere)

	65 Rpm	180 Rpm	235 Rpm	400 Rpm	700 Rpm	1000 Rpm
KW15-486, 1mm	2,36	2,22	1,98	2,15	2,44	2,69
KW15-486, 2mm	2,58	2,41	2,40	2,32	2,72	2,86
C0636AX1000, 1mm	2,25	2,12	1,98	1,90	2,30	2,50
C0636AX1000, 2mm	2,46	2,27	2,13	1,94	2,35	2,60

Electrical Power Calculation Results

Using a three-phase electrical voltage of 380 volts, the electrical power was calculated using Equation (1).

Table 2. Power (kWatt)

	65 Rpm	180 Rpm	235 Rpm	400 Rpm	700 Rpm	1000 Rpm
KW15-486, 1mm	1,086	1,022	0,911	0,989	1,123	1,238
KW15-486, 2mm	1,187	1,109	1,104	1,068	1,252	1,316
C0636AX1000, 1mm	1,035	0,976	0,911	0,874	1,058	1,150
C0636AX1000, 2mm	1,132	1,045	0,980	0,893	1,081	1,196

The theoretical power calculation based on the empirical current data for a cutting depth of 1 mm is presented in Figure 6, while the results for a cutting depth of 2 mm are shown in Figure 7.

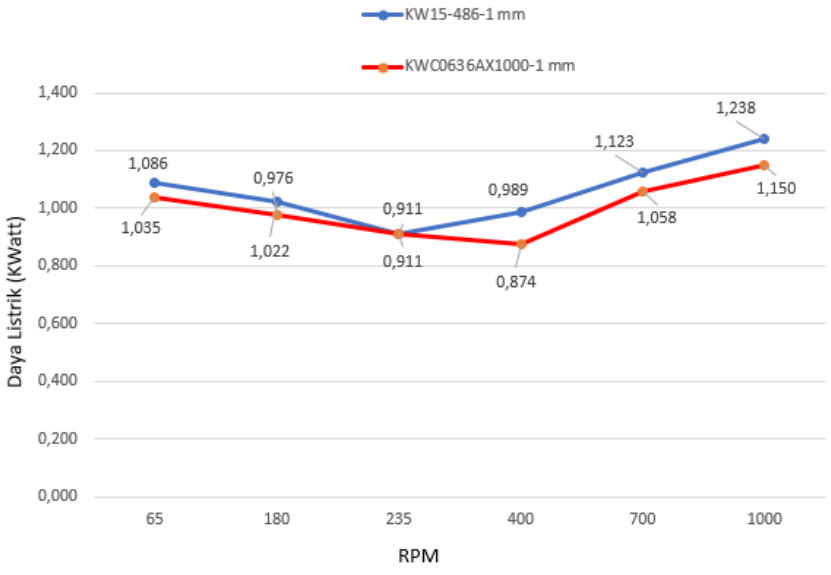

Fig. 6 Comparison of Power Consumption at a Cutting Depth of 1 mm

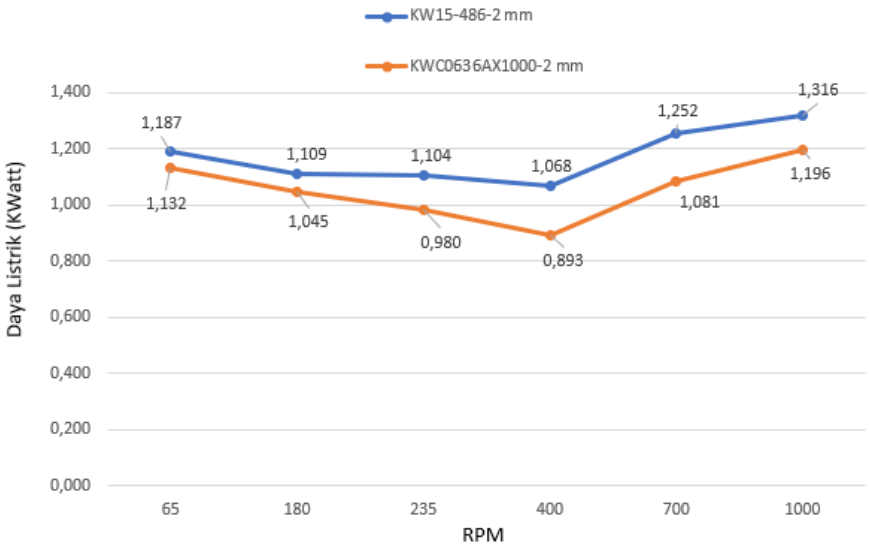

Fig. 7 Comparison of Power Consumption at a Cutting Depth of 2 mm

As shown in Figures 6 and 7, the C0636AX1000 lathe machine consistently demonstrates lower power consumption under all cutting conditions, indicating better energy efficiency. The difference in electrical power consumption may become significant over extended operating hours in the long term.

Conclusion

Based on the results of the study on the analysis of electrical power consumption in Krisbow Type KW 15-486 and Krisbow Type C0636AX1000 turning machines, the following conclusions can be drawn:

a. Spindle speed has a significant influence on electrical power consumption. As the spindle speed (rpm) increases, power consumption tends to decrease for both machines. This indicates that energy efficiency improves with higher spindle speeds, within the tested parameter range.
b. Cutting depth also has a direct impact on power consumption. A cutting depth of 2 mm results in higher power consumption compared to 1 mm across all spindle speeds and for both types of turning machines.
c. The Krisbow Type C0636AX1000 turning machine demonstrates more efficient power consumption performance than the Krisbow Type KW 15-486 across all test variations, indicating superior energy efficiency for turning operations.
d. The difference in electrical power consumption between the two machines can serve as a consideration in selecting a lathe machine, particularly in educational institutions and small-scale industries that require operational cost efficiency.
e. At spindle speeds above 400 rpm, there is a tendency for power consumption to increase in both machines. This suggests that the electric motor requires higher current to maintain the increased rotational speed. This observation can serve as a reference in determining the optimal spindle speed that balances rotational performance and electrical energy cost.

In conclusion, this study demonstrates that the selection of cutting parameters and the type of lathe machine used significantly affect electrical energy efficiency. For applications in both educational and industrial settings, choosing an energy-efficient machine such as the Krisbow Type C0636AX1000 can be a practical solution to support long-term operational efficiency.

Acknowledgment

The authors would like to express their sincere gratitude to the testing operators for their valuable assistance and cooperation during the experimental work. Special thanks are also extended to the Institute for Research and Community Service (LPPM) of Universitas Muhammadiyah Pekajangan Pekalongan for providing financial support, which enabled this research to be carried out successfully and smoothly.

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