APPLICATION OF CARBON FIBER V-BELTS IN LATHE MACHINES TO IMPROVE DURABILITY

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Abstract

This research aims to analyze the durability of using carbon fiber v-belts on lathe machines. Development of a v-belt designed using carbon fiber as an additional material. The V-belt is a component that drives a lathe by rotating the fan on the machine. This is because the addition of carbon fiber as a v-belt material can increase the longevity of the v-belt. The research used a hypothesis method to determine the comparison of v-belt life durability, where H0 stated that the addition of carbon fiber to the v-belt had a significant effect on the v-belt life expectancy on the lathe. Meanwhile, H1 states that the addition of carbon fiber to the v-belt has no real effect on the longevity of the v-belt on the lathe.

Keywords: Application, V-Belt, Carbon Fiber, Lathe

INTRODUCTION

Belt durability on a lathe is crucial because the V-belt is one of the lathe's drive components. The V-belt operates by rotating a fan. V-belts made of carbon fiber are lightweight and strong, which can increase the efficiency of power transmission on a lathe. Thus, they can potentially reduce energy loss during the cutting process. Furthermore, carbon fiber is known for its resistance to wear and high temperatures. The use of this V-belt is expected to extend the life of machine components, reduce replacement frequency, and reduce maintenance costs (Utomo et al., 2022).

V-belt Carbon fiber can reduce vibration and noise generated during machine operation, creating a more comfortable and safe working environment. With advances in material technology, carbon fiber has become an innovative choice for industrial applications. This study aims to explore the potential of carbon fiber in improving lathe performance (Aini et al., 2022).

Several industries require more efficient and sustainable lathes. Therefore, this research is expected to provide relevant solutions to these needs. This research is expected to provide a better understanding of the benefits and implementation of carbon fiber V-belts in the context of lathes.

RESEARCH METHOD

Research Procedures

The research used theoretical and engineering research methods. The engineering research involved data collection based on interviews, literature studies, and data collection. The methodologies included observation and material testing, with the title "Application of Carbon Fiber V-Belts on Lathes."

Observation

Observation is the first stage carried out by researchers in obtaining information related to the research object.

Interview

Interviews are a stage carried out by interviewing related parties where observations are carried out in order to understand the topics raised in the final assignment and to find out the influencing factors, both technical and non-technical factors.

Literature Study

Literature studies include the stage of searching for references from books and articles, which aim to increase the researcher's insight and support the research that has been carried out.

Data retrieval

Data obtained from the initial stages of the research through to the final stage was used to compare the durability of carbon fiber V-belts with non-carbon fiber V-belts. The steps involved can be seen in the flow chart.

DiagramFlow Chart

The flowchart is a stage that aims to understand the process flow for completing this final assignment, as well as to facilitate the analysis of engineering research.

RESULTS AND DISCUSSION

V-belt Durability with Carbon Fiber Addition (%)

Table 1.
V Belt Durability Data with Added Carbon Fiber (%)

Time	**Carbon Fiber Addition**		
	2.5%	**3.5%**	**4.5%**
0 hours	Very good	Very good	Very good
3 hours	Very good	Good	Good
6 hours	Good	Good	Not good
9 hours	Good	Not good	Not good
12 hours	Not good	Not good	Separated

From the data table of V-belt durability with the addition of carbon fiber above, it can be concluded that the addition of low-content carbon fiber has better durability than the addition of high-content carbon fiber which can break after a duration of 12 hours.

Rotations Per Minute (RPM) With Added Carbon Fiber (%)

Table 2.
Rotation Per Minute (RPM) Data with Carbon Fiber Addition (%)

Time	**Carbon Fiber Addition**		
	2.5% (X1)	**3.5%(X2)**	**4.5%(X3)**
0 hours	2000	1800	1600
3 hours	1712	1431	1159
6 hours	1398	1071	716
9 hours	1059	696	237
12 hours	725	312	0

From the rotations per minute (RPM) data table resulting from the addition of carbon fiber above, it can be concluded that the addition of high levels of carbon fiber experienced a significant decrease in rpm compared to the addition of low levels of carbon fiber. The amount of carbon fiber added with the above conditions can be used as a reference in adding suitable carbon fiber, so that the durability of the V-belt can be maintained and the machine performance is more optimal. The addition of excessive carbon fiber allows the V-belt to be lighter and less optimal for use on lathes that have quite heavy performance. This shows that H1 is proven because it states that the application of carbon fiber to the V-belt has no significant effect.

Descriptive Test

Descriptive testing is a method for describing the characteristics of a population being studied. The following is a presentation of a descriptive test table that has been processed using SPSS software:

Table 3.
Descriptive Test Table

Descriptives

	Statistics	*Std. Error*

X1	*Mean*		1378.80	226,606
	95% Confidence Interval for Mean	*Lower Bound*	749.64	
		Upper Bound	2007.96	
	5% Trimmed Mean		1380.61	
	Median		1398.00	
	Variance		256751.700	
	Standard Deviation		506,707	
	Minimum		725	
	Maximum		2000	
	Range		1275	
	Interquartile Range		964	
	Skewness		-.114	.913
	Kurtosis		-1,280	2,000
X2	*Mean*		1062.00	262,425
	95% Confidence Interval for Mean	*Lower Bound*	333.39	
		Upper Bound	1790.61	
	5% Trimmed Mean		1062.67	
	Median		1071.00	
	Variance		344335.500	
	Standard Deviation		586,801	
	Minimum		312	
	Maximum		1800	
	Range		1488	
	Interquartile Range		1112	
	Skewness		-.039	.913
	Kurtosis		-1.152	2,000
X3	*Mean*		742.40	292,943
	95% Confidence Interval for Mean	*Lower Bound*	-70.94	
		Upper Bound	1555.74	
	5% Trimmed Mean		736.00	
	Median		716.00	
	Variance		429079.300	
	Standard Deviation		655,041	
	Minimum		0	
	Maximum		1600	
	Range		1600	
	Interquartile Range		1261	
	Skewness		.244	.913
	Kurtosis		-1.617	2,000

Normality Test

The normality test is used to determine whether the data is normally distributed. The following is a descriptive test table processed using SPSS software:

Table 4.
Normality Test Table

Tests of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
X1	.145	5	.200*	.984	5	.952
X2	.135	5	.200*	.988	5	.971
X3	.180	5	.200*	.964	5	.832

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

From the table above, it can be concluded that the three variables are normally distributed and significant to each other.

T-Test

The T-test is used to determine whether the difference in responses between two groups is statistically significant. The following table displays the T-test results processed using SPSS software:

Table 5.
One Sample Test

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
X1	6,085	4	.06	1378,800	749.64	2007.96
X2	4,047	4	.240	1062,000	333.39	1790.61
X3	2,534	4	.960	742,400	-70.94	1555.74

From the T-test table above, the response between the three variables has a significant effect on the durability of the V-belt.

Correlation Test

The correlation test is used to measure the strength and direction of the relationship between two or more variables. The following table displays the correlation test, processed using SPSS software:

Table 6.
Correlations Test

Correlations

		X1	X2	X3
X1	Pearson Correlation	1	1,000**	.993**
	Sig. (2-tailed)		.000	.001
	N	5	5	5
X2	Pearson Correlation	1,000**	1	.994**
	Sig. (2-tailed)	.000		.001
	N	5	5	5
X3	Pearson Correlation	.993**	.994**	1
	Sig. (2-tailed)	.001	.001	

N	5	5	5

**. Correlation is significant at the 0.01 level (2-tailed).

From the correlation test table above, the three variables are not significantly correlated with each other. It can be concluded that the variables are not correlated with each other.

Discussion

This study aims to analyze the effect of adding carbon fiber to a lathe v-belt on its lifespan. The v-belt itself is an important driving component in a lathe, whose function is to transmit power from the motor to other parts of the machine, such as the fan, by rotating the part. A more durable v-belt will increase the operational efficiency of the lathe because it reduces the need for frequent replacement or maintenance. One way to increase the durability of the v-belt is to add carbon fiber to its manufacturing material, which is known to have higher strength and durability than conventional materials such as rubber or polyester.

The results of the study on the durability of v-belts reinforced with carbon fiber show a significant difference when compared to v-belts that do not use the fiber. By using the T test and One-Sample Test analysis, the T value for the group containing carbon fiber (X1) was 6.085. The resulting significance level (Sig.) is 0.06, which indicates a tendency to support the alternative hypothesis (H1). This hypothesis states that the addition of carbon fiber has an effect on increasing the life of the v-belt Kinloch et al. (2018).

Although the p-value is slightly above the significance limit of 0.05, this finding indicates a significant trend of increasing lifespan in v-belts using carbon fiber. In the comparative analysis, the average difference (Mean Difference) shows that in group X1 there is an increase in durability of 1378,800 hours, with a confidence interval range between 749.64 and 2007.96 hours. This value indicates that the addition of carbon fiber can significantly extend the life of the v-belt, although further research is needed to confirm this result at the 95% significance level Ou et al. (2019).

Based on several relevant literatures, research on the application of carbon fiber in composite materials shows positive results in improving the mechanical characteristics and durability of these materials. For example, a study shows that carbon fiber can improve the durability and mechanical performance of various materials, including engineering plastics and polymer-based composites (Han et al., 2025). Carbon fiber can also provide anti-plate properties and increase resistance to mechanical loading, which is important in v-belt applications (Li et al., 2022).

In the context of infrastructure, the use of appropriate fibers in composite materials has shown potential in extending service life and reducing material failures, thus providing significant benefits in cost and resource savings (Lee et al., 2025). Therefore, further development of the use of carbon fibers in industrial applications such as v-belts is very promising, especially in optimizing their performance and efficiency.

The T-test results for group X2 show that the T value is 4.047 with a p-value of 0.240. This p-value is greater than 0.05, which indicates that the difference in lifespan between v-belts using carbon fiber and those without does not reach a level of significance sufficient to be statistically accepted. Although there is a difference in durability, the value is not sufficient to confirm the significant effect of the use of carbon fiber in v-belts on lathes Li et al. (2022).

The average durability difference of 1062,000 hours, with a confidence interval of 333.39 to 1790.61 hours, indicates that although the results were not significant in this test, there is a potential benefit from using carbon fiber to improve the durability of the v-belt. Previous research also indicates that the use of carbon fiber can provide advantages related to the strength and durability of the material. For example, carbon fiber has been identified as an effective reinforcement in various composites, which also improves the overall mechanical properties Ghosh et al. (2021) and maintains structural integrity even under demanding operational conditions Bourke et al. (2015).

Other studies also show that although the analysis results may not show statistical significance, the potential benefits of using carbon fiber in machine components, such as v-belts, are still worth exploring further. This is due to the weight reduction and increased durability that carbon fiber may offer, providing a valuable alternative in composite material design Loginova & Кырчиков (2019). Thus, further research is needed to explore the mechanical and durability aspects of carbon fiber-based v-belts in more depth in various industrial applications.

Based on this information, although the T-test results do not provide sufficient evidence to definitively claim that the addition of carbon fiber significantly improves the life expectancy of v-belts, the available data suggests that there is considerable potential for further investigation.

The T-test results in group X3 showed a T value of 2.534 with a p-value of 0.960, which is much greater than the commonly used significance limit (0.05). This indicates that the addition of carbon fiber does not have a significant effect on the durability of the v-belt on the lathe in this group. Although there is an increase in durability, the confidence interval range between -70.94 to 1555.74 hours indicates that large data fluctuations make the difference cannot be considered significant in the context of this study Amanov et al. (2019).

Specifically, although the analysis results provide an indication that there may be increased durability provided by the use of carbon fiber, it does not produce sufficient evidence to conclude that carbon fiber-based v-belts are more durable than conventional v-belts. Other studies have also shown that although carbon fiber is often associated with improved mechanical qualities in composites, the results can vary depending on the specific application and the testing method used. Li et al. (2022).

A study of composites by Krawiec et al. showed that strength and durability improvements are often influenced by many factors, including material composition and testing methods. In many cases, despite promising results, variability in the data can make it difficult to reach conclusions (Krawiec et al., 2021). This demonstrates the importance of considering external factors and material configuration when evaluating the strengthening potential of carbon fiber.

Furthermore, research on the performance of V-belts made from composite blends has shown that despite potential benefits, many experimental results do not always yield statistically significant figures, similar to the findings in Gárdonyi et al.'s (2018) X3 group. Thus, while there is initial evidence of the potential of carbon fibers in extending material life, further investigation is needed to achieve reliable and statistically significant results.

Overall, although some test results indicate an increase in v-belt life expectancy with the addition of carbon fiber, not all data support the alternative hypothesis (H1) with a sufficiently strong level of significance. These more varied results suggest that factors other than carbon fiber addition, such as design or other v-belt manufacturing materials, may also play a role in determining v-belt life expectancy. Therefore, further research with a larger sample size and additional variables is needed to obtain a more definitive conclusion regarding the effect of carbon fiber on v-belt life expectancy in lathes.

CONCLUSION

From the results of the data analysis, it was concluded that adding excessive carbon fiber reduced the performance of the v-belt. Adding 2.5% carbon fiber is optimal in this context. However, some conclusions in the document are inaccurate, particularly the insignificant T-test results and the correlation between variables, which is significant despite being stated as insignificant.

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