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Material analysis of tool feed on scrap machines using the vibration method

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Abstract: Flexibility comes from the cutting force generated when the workpiece and tool react and are moved to different areas of the scrap machine. The chisel will get damaged as a result. The material and cutting speed that are used can cause damage. Given this, further studies employing the vibration method are required to determine the ways in which material affects the speed at which scrap is chopped. PVC, iron, and aluminum 5052 were the materials used in this investigation. The cutting rotational speeds varied from 32 to 80 m/min. To measure vibration, the accelerometer is positioned along the x, y, and z axes. The measurement outputs of the accelerometer are connected to the FFT Analyzer, which performs analysis using Matlab. When comparing cutting speeds above or below 50 m/min, the research results indicate that the x-axis has the largest amplitude and the most form variants. The most widely used material is PVC, which is followed by iron and aluminum. This is because, unlike aluminum and iron, which have microstructures in the form of crystal grains, PVC is a thermoplastic polymer with a microstructure made of chain molecules. Because all of the cutting energy is used in the frictional action between the chip and the workpiece when the tool is being used, the high frequency is the result. As a result, the friction on the sliding plane is breaking up atomic or molecular bonds. Additionally, the cutting force exerts a significant amount of pressure on the tool's wearing active surface.

Keywords: Scrap machine; material variations; cutting speed; vibration; wear and tear

1. INTRODUCTION

A scrap machine is a kind of machine tool used to level the surface of a workpiece that is inclined, terraced, or grooved to the required size and shape. When working with scrap metal, there will inevitably be a collision because the chisel and the workpiece will come into contact. The workpiece and chisel will experience an impact load as a result of this interaction [1]. When the tool and workpiece react and are moved to different parts of the junk machine, a flexible cutting force is produced [2]. That little degree of flexibility is enough to result in vibrations that can reduce tool life and lower product quality, as well as errors in geometry in the finished product [3]. Vibration on a scrap machine rises as the workpiece becomes harder; other factors influencing vibration include chip thickness and cutting speed [4] .

Numerous earlier researchers have looked into the effects of feed motion, cutting speed, and thickness. For example, they have examined the effects of these variables on the vibration frequency and acceleration [4]. Numerous studies on vibration in production and automotive machinery have been carried out by Mercubuana University's Department of Mechanical Engineering, demonstrating that the vibration method can predict damage in both the rotary and static fields [5],[6].

In this study, we used the vibration method to investigate the effects of cutting speed on workpiece material and tool damage during the scrap process [7]. This study used iron, PVC, and aluminum 5052 with cutting rotational speeds ranging from 32 to 80 rpm [8]. Since the cutting is in an unstable area, if the chip thickness reaches its stability limit (blim), there will be a sudden jump in vibration amplitude [9]. Throughout the cutting process, the influence of chip thickness cannot be freely increased. Chatter is the vibration of the workpiece and chisel during the cutting process that occurs during fine machining. Vibration, tool life, and the cutting surface can all be impacted by chatter [10].

2. METHOD

Figure 1 makes the research sequence easier to see. The first steps in the research process include reading up on prior studies, testing and measuring workpiece and cutting speed variations with the FFT Analyzer, running a bump test, and processing the data in MATLAB and Microsoft Excel. Assessment, Discussion, and Informational Conclusions.

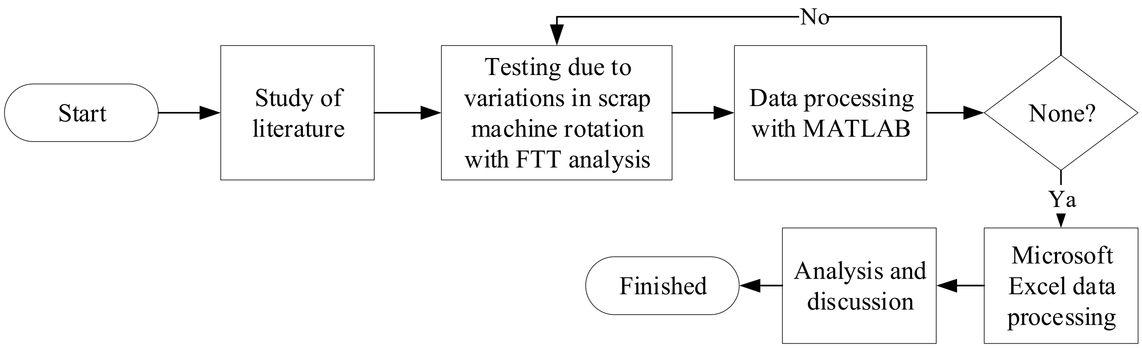

Figure 1. Research flow

The research object runs a scrap machine in the lab. Mercubuana University's production is shown in Figure 2. Testing the vibration of scrap machines in three dimensions with different work objects (x, y, and z). The scrap machine's specifications are listed in Table 1.

Figure 2. Scrap machine

Tests on aluminum, PVC, and iron workpieces at 32, 50, and 80 revolutions per minute were carried out by the research using scrap machines.

Table 1. Scrap machine specifications

Item		Specification
Machine Type		B635A
Max. form long		350 mm
Max. distance, from the bottom edge of the ram to the table	Horizontal	330 mm
	Vertical	270 mm
Max. table travel		400 mm
Max. length between cutter and leading edge		500 mm
Max. table turning angle	Without vice	± 90 °
	With vice	± 55 °
Max. vertical travel of the tool head		110 mm
Hit frequency		32, 50, 80, 120 time/minute
Table feed per ram stroke		
Pawl riding over 1 ratchet tooth	Horizontal	0,18 mm
	Vertical	0,21 mm
A pawl atop four ratchet teeth	Horizontal	0,73 mm
	Vertical	0, 84 mm

Item		Specification
Motor		1.5KW1400r min
Vice dimensions (maximum width, depth, and opening)		180x55x150 mm
Overall dimensions		1390x860x1455 mm
Packaging Size	Export	1530x930x1370 mm
	Import	1580x980x1380 mm
Net weight		1000 kg
Bruto		1200 kg

When testing scrap machines for vibration, FRF measurements are employed [11]. The excitation force is provided by hammer blows and variations in cutting speed for variations in material given at three measurement positions (the X, Y, and Z axes) [12]. The measurement locations for tests carried out with and without oil are shown in Figure 3.

[A] [B] [C]

Figure 3. Position of FRF measurements in the direction of [A] X-axis, [B] Y-axis, [C] Z-axis

The applicable frequency range is 0–20 KHz. When testing in a motionless state, the frequency range is used to enable the creation of a graph displaying the vibration analyzer measurement results, which is then processed into Matlab software [13]. The test parameters for acquiring experimental data are shown in Figure 6. The test results will be analyzed using MATLAB software, and the data will be processed again in Microsoft Excel to determine the specific frequency at each measurement position. These are the supplies and testing equipment:

- An accelerometer sensor that measures how vibrations are felt
- Type: Bosch Japan Corporation Type CCLD Piezoelectric Accelerometer.
- Accelerometer Kabel: 1.5 meters
- A portable FFT analyzer (CF-3600A, 4-ch) with a touch screen that records data and simulates analysis. FortykHz is the highest frequency at which analysis is possible. Goods from Japan's Ono Sokki.
- Software matlab 2019.

The test set up to obtain experimental data is shown in Figure 4

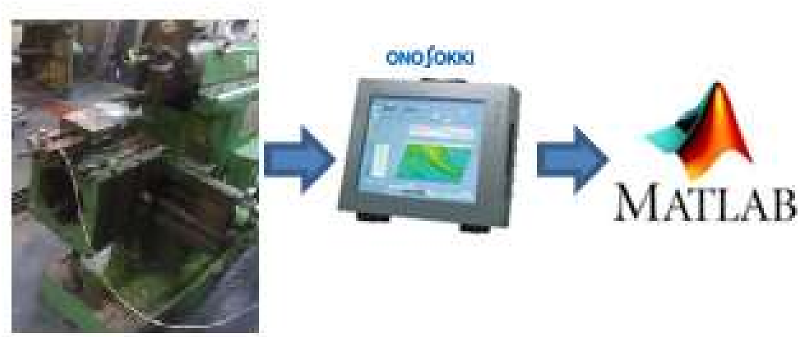

Figure 4. FRF Measurement Test Set Up.

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3. RESULTS AND DISCUSSION

Before vibration data is gathered, specific settings for the FFT Analyzer CF-3600 must be configured. Setting the frequency range to be between 1 and 20 kHz is the first setting. 2048 data points were gathered for this investigation [10]. A BNC cable was installed to connect the data to the accelerometer sensor, which was positioned on the X, Y, and Z axes, after it had been entered into the FFT Analyzer CF-3600. The measurement results were then analyzed using Matlab [14].

The impact of feeding different materials into the scrap machine was examined after testing the frequency response function for the x, y, and z axes. This test is performed by beating the scrap machine part. The frequency response function results are shown in Figure 5.

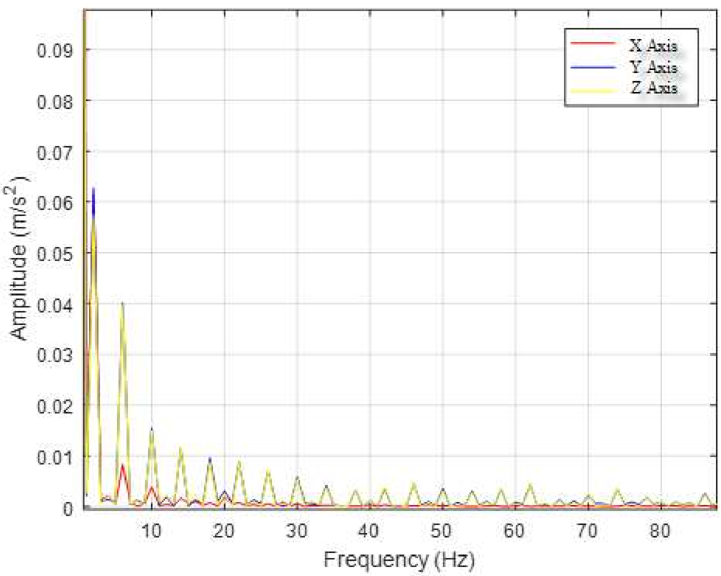

Figure 5. Frequency response function

Despite the similar frequencies on each axis in Figure 6, the amplitude on the x-axis is smaller than that on the y- and z-axes. The frequency at which the X and Y axes can be seen is 20 Hz. The results of the cutting speed analysis on a scrap machine are shown in Figure 6. The cutting speed results on aluminum material show that the amplitude decreases with increasing cutting speed, while the frequency increases at a cutting speed of 32 m/min after 250 Hz. down even though the x axis is being cut at 50 and 80 m/min and the first shape appears simultaneously in mode.

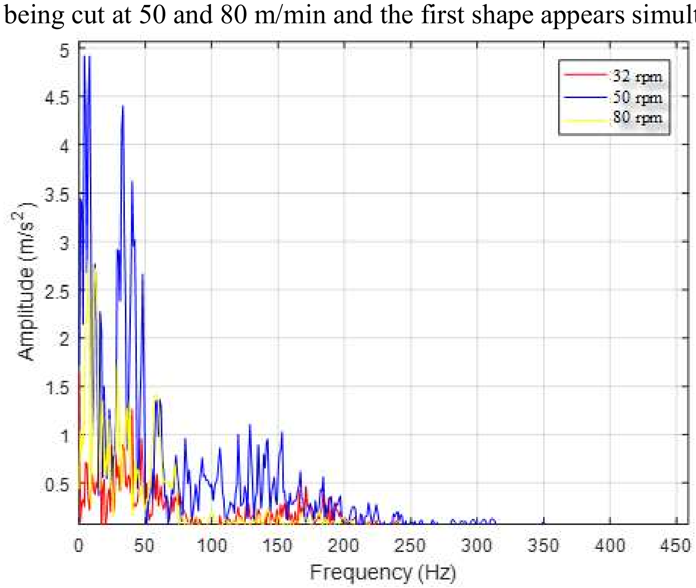

Figure 6. Cutting speed's impact on the X axis

It is shown that a cutting speed of 50 m/min has the largest amplitude and the most shape modes on the x axis when comparing cutting speeds above and below 50 m/min. This suggests that cutting aluminum material at a speed of roughly 30 m/min is appropriate. to reduce the vibrations generated during the processing.

Figure 7 shows the vibration method due to variations in the material's cutting speed. As Figure 7illustrates, PVC has the highest frequency when compared to materials composed of iron and aluminum. This is due to the fact that PVC is a thermoplastic material with a microstructure composed of chain molecules, as opposed to aluminum and iron, which have microstructures in the form of crystal grains [15].

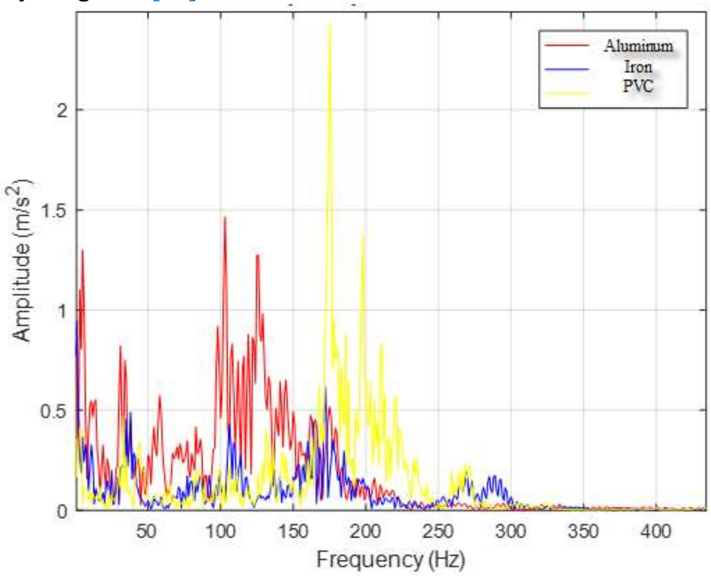

Figure 7. Effect of cutting speed on the y axis due to material influence

Finding out the features of broken or, more frequently, aberrant chisels (wear and tear) is vital for research purposes. In their Standard terminology related to erosion and wear (3rd ed.), Annual Book of Standards, Vol. 3.02 [2], the American Society for Testing and Materials (ASTM) defines wear as surface damage to an object that causes increased material loss due to the relative movement of the work object and a contact substance. Figure 8 shows how vibration analysis affects tool wear.

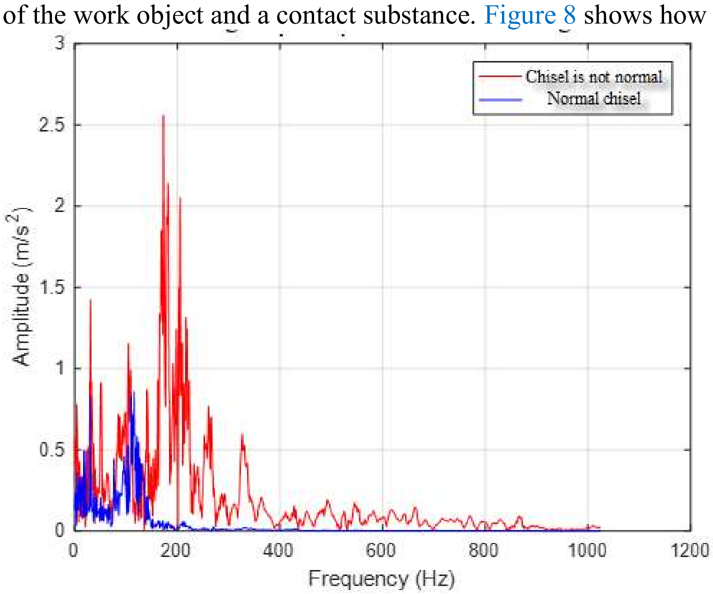

Figure 8. Effect of cutting speed of 60 m/s on the z axis due to the influence of the tool

Tool wear occurs more frequently than with unworn tools, as Figure 8 shows. often, worn-out chisels have a large amplitude at 200 Hz, while normal chisels often have a decreasing frequency after that point. Because all of the cutting energy is consumed in the frictional process between the chip and the workpiece when the tool is being used, the high frequency is the result. Thus, atomic or molecular bonds are being broken as a result of the friction in the sliding plane. Significant pressure is also produced by the cutting force on the wear-prone active surface of the tool. It is shown using the vibration method that more cutting force is produced at frequencies higher than 200 Hz as wear and tear increases over time.

3 CONCLUSION

As a result of the bump test, it was found that the frequency on the scrap machine was global in the x, y, and z axes. When comparing cutting speeds above or below 50 m/min, the x axis, which displays variations in cutting speed, has the biggest amplitude and the most form options. This shows that a cutting speed of about 30 m/min is appropriate for aluminum material in order to limit vibrations induced by processing. PVC is the material with the highest frequency, followed by iron and aluminum. This is because, unlike aluminum and iron, which have microstructures in the form of crystal grains, PVC is a thermoplastic polymer with a microstructure made of chain molecules. Because all of the cutting energy is consumed in the frictional process between the chip and the workpiece when the tool is being used, the high frequency is the result. As a result, the friction in the sliding plane is breaking up atomic or molecule connections. Moreover, the cutting force exerts a significant amount of pressure on the tool's wearable active surface.

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