Performance of fan chips on drilling aluminium process

A Sifa*, D Suwandi, T Endramawan and A A Rachman
Mechanical Engineering Department-Politeknik Negeri Indramayu Jl.Raya Lohbener No.08 Lohbener-Indramayu 45252

*agus.sifa@polindra.ac.id

Abstract. The metal fabrication process, especially in the metal drilling process, one of the parameters that affect the quality of metal drilling results is cooling media, because it affects the life of the tool used. This paper aims to determine the performance of using fan chips as an alternative to cooling media in the metal drilling process area. The method used with flow simulation and drilling process experiments on workpiece made from aluminum alloy 5086 in experimental testing uses a variation of the spindle rotation of a metal drilling machine with the aid of taking test data with an anemometer and infrared thermometer in the drilling process of the aluminum alloy 5086 workpiece. After experimenting with chips through spindle rotation variations, cooling of the process area occurs when the engine spindle rotation rotates above 1000 rpm and the temperature decreases at the end of the tool area by 5°C compared to without using fan chips. A decrease in the temperature of the work area of the drilling workpiece aluminum alloy 5086 compared without using fan chips has an impact on increasing the tool life limit by 12% or increasing tool life by 5 minutes.

1. Introduction
One of the fabrication processes in the manufacturing industry is the drilling process. The drilling process carried out there are several parameters that affect the quality of drilling results. Among the parameters that influence are tool geometry [1,2], cutting speed, spindle speed, feed thickness [3], and cooling media [4].

In the drilling process using the dry cutting method is the drilling process without using cooling media, but the problem in the dry cutting process [5] is the friction of the tool with the workpiece resulting in rising temperatures in the process area that can cause wear chisels, blunt chisels and short tool life, so this will potentially cause product failure. One of the other conditions in the drilling process with the water cooling method [6], the temperature rise process area that occurs is not too significant or it can be said that the temperature of the process area is stable, but in the process of water cooling chips, the drilling process disturbs the process area, besides that the water process cooling can potentially corrode the workpiece.

This paper aims to determine the performance of the use of fan chips as an alternative to cooling media in the metal drilling process area to maintain tool temperature and workpieces as well as tool life.
2. Material and methods

2.1. Material workpiece and tool

The workpiece material used in this study is Aluminium Alloy 5086 material. Specifications of mechanical properties of Aluminum Alloy 5086 are shown in Table 1 [7], for the tool used this study is HSS material with the specifications shown in Table 2 [8].

| Properties                  | Metric | Imperial |
|-----------------------------|--------|----------|
| Proof Stress                | 125 Min MPa | 1800 lbs |
| Tensile Strength            | 275 - 350 MPa |
| Hardness, Rockwell C        | 75 HB  |
| Elongation                  | 12 Min % |

Table 1. Mechanical properties Aluminum Alloy 5086.

Mechanical properties used for the fan chip prototype were made using a 3D printing machine [9] with PLA material diameter 1.75 mm [10] with the specifications in Table 3.

| Mechanical Properties                  | Polylactic Acid          |
|----------------------------------------|--------------------------|
| Tensile Strength (MPa)                 | 15.5 – 72.2              |
| Tensile Modulus (GPa)                  | 2.020 – 3.550            |
| Elongation at Break (%)                | 0.5 – 9.2                |
| Flexural Strength (MPa)                | 52 – 115.1               |
| Flexural Modulus (GPa)                 | 2.392 – 4.930            |

Table 3. Mechanical properties of PLA.

2.2. Method

In this study, a simulation was performed with Flow Simulation Solidworks and experimenting with the drilling process by adding a fan-integrated tool to the engine chuck that aims as a cooling medium in the drilling process area and as a media for cleaning chips from the drilling process, with variations in the engine spindle speed as a variable in Aluminium Alloy 5086.

This study is experimentally by installing fan chips on the drill chuck. So that when the chuck rotates, the fan chips spin blew off the rest of the drilling process. The installation of fan chips on conventional drilling machines is shown in Figure 1. The fan chips used have 9 blades, for the dimensions of the fan chips shown in Figure 2.
In this study the application of fan chips is used on vertical drilling machines. The specifications of drilling machine used are shown in Table 4.

**Table 4. Drilling machine specification.**

| Machine       | Krisbow (Vertical Drilling Machine) |
|---------------|-------------------------------------|
| Model         | ZN5032                               |
| Max Drill Capacity | 32mm                                |
| Serial No.    | C05072                               |
| Power Source  | 3-50 Hz 400V                         |
| Total Power   | 1.38 kW                              |
| Total Current | 10A                                  |
| Protection Class | IP44                      |

3. Results and discussion

3.1. Fan chips
Making fan chips with the 3D Printing process with Polylactic Acid (PLA) material found the results of fan chips with a mass of 38 grams. The results of the fan chip product are shown in Figure 3. The fan chips can be used as a cleaning media by blowing the bram which has the mass shown in Figure 4.

![Figure 3. Fan chips.](image1)

![Figure 4. Bram mass.](image2)

3.2. Simulation results
The simulation uses a Solidworks simulation flow. The parameters determined before conducting the simulation are about the type of rotation of the flow simulation, global conditions, and the fluid used is air. The initial temperature is assumed to be 30°C to determine the minimum and maximum temperature changes that occur. Data from the simulation results are then compared with experimental test data. Below is a picture of the fluid flow simulation results that have been carried out shown in Figure 5.

![Figure 5. Simulation result.](image3)
3.3. Study experimental

In this study to collect data about temperature changes that occur in the conventional drilling process area using a measuring instrument which is an anemometer and infrared thermometer. Before testing the performance of the fan chip, drilling process data is practiced using a dry cutting method or performance without cooling the media. The variation used is the variation of the spindle rotational speed of the drilling machine.

Fan chip application experimental data, the central temperature of this process is still rising, but the temperature rise is not too significant than without using a fan chip. The relationship between temperature data without fan chip with temperature data with the results of fan chip application simulation and experimental testing is shown in Figure 6.

![Figure 6. Temperature of tool.](image)

The application of fan chips in the drilling process area is almost the same as without using a fan chip, namely an increase in temperature in the process area with an increase in the spindle rotation speed [11], but after a spindle rotation above 1000 RPM, fan chips work to reduce the temperature of the process area, even though the temperature reduction that happens is not too significant but the temperature of the process area can be saved. In the simulation and experimental results, a difference of 1.5°C or there is an error of 5%.

Fan chips are also used as cleaning of the drilling process. The wind produced by the fan chips is used to blow the Bram. The wind data obtained from the fan chip turns is shown in Table 5.

| RPM  | Velocity |
|------|----------|
| 535  | 1.6      |
| 865  | 2.6      |
| 1070 | 3.2      |
| 1520 | 4.7      |
| 1720 | 5.3      |
| 3030 | 8.8      |
| 3030 | 8.8      |

Table 5. Velocity.

This study also examined the effect of chip fans on the tool life of conventional drill bits. Data on the comparison of tool life without using a fan chip with the fan chip application is shown in Figure 7.
Figure 7 shows the cutting speed is increased with feeding motion and depth fixed deductions will result in increased tool edge wear so the tool life will decrease [12]. The influence of fan chips on tool life based on the graph above is 12% or based on experiments there is an increase in tool life 5 minutes.

4. Conclusion
In experimental studies, the performance of fan chips as a cooling media and influence on the tool life of the drilling machine, the faster the engine spindle rotates, the greater the air produced by the fan chips and is more effective in lowering the temperature of the drilling process area. The results of simulation with experimental tests occur a difference of 1.5° C or an error of 5%. The performance of fan chips for cooling the process area occurs when the engine spindle rotation rotates above 1000 rpm and the temperature can be reduced by 5°C compared to without using fan chips. Keeping the temperature of the drilling process area will affect the increase in tool life, so there is an influence on the application of fan chips. Fan chip performance on tool life has an effect of 12% or increases tool life 5 minutes.

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