Analysis of Sharpening Rotation Variations on Changes in the Microstructure of *Taji* Materials in Craftsmen in Dawan Kaler Village, Klungkung

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Abstract. *Taji* is a type of special knife made for certain purposes, which in Balinese means sharp. The material for these spurs in the Bali area is made from used temple stone cutter knives. The material for this temple stone cutter knife is made from HSS (high-speed steel). The process of making spurs starts with cutting the main material using a water-cutting process. The main process, namely grinding, aims to shape the material according to the required shape, especially the pointy and sharp parts. The rotation or RPM of the bench grinder and hand grinder is 1400. This very high rotation will of course cause friction which results in heat in the main material even though cooling is used. This change in structure will result in changes in the mechanical properties of the material. Reducing heat can be done by reducing the friction that occurs. Reducing friction is done by varying the rotation of the grinding machine. This grinding machine is equipped with variable rotation which can be adjusted according to needs. This research will be carried out by varying the grinding rotation during the grinding process, namely 100 RPM, 200 RPM, and 300 RPM. The temperature is measured on the main material before and after the grinding process treatment. The grinding results are subjected to a photo microscope process to see the microstructure of the material. The grinding process with this rotation only provides a maximum increase of 11.12% from the initial temperature of 27.47°C to 30.90°C. The grinding machine can be used for the process of making spurs by craftsmen because it does not affect microstructure changes that can affect the mechanical properties of HSS steel.

Keywords: Grinding, Micros, Structures, *Taji*

1 Introduction

Taji is a type of special knife made for certain purposes (Rais & Sidin, 2020). *Taji* is a Balinese term which means sharp (Partami et al., 2016). Knives with this type of spur are often connoted as items for gambling in cockfighting arenas. *Taji* is better known in the Bali area as a sharpened knife which is widely used as a tool for fighting cocks (Kusuma et al., 2021). Spurs may be also special cutting tools used for other purposes. Apart from being used for fighting cocks, spurs are also widely used as

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gegawan knives. *Gegawan* is a Balinese term that means provisions or something that must be carried. This gegawan knife is often carried during ceremonies or traditional events. Apart from being a provision, this type of knife is also used for activities such as sharpening bamboo or other purposes. These spurs are made from special materials and are made by people with special skills. The material for these spurs in the Bali area is made from used temple stone cutter knives. The material for this temple stone cutter knife is made from HSS (high-speed steel). HSS is known to have special powers according to its function. HSS is a mixture of iron and several other materials such as carbon, chromium, vanadium, molybdenum, tungsten, and cobalt (Klaten, 2022). Some of these materials are mixed with special percentages according to the needs for cutting certain materials.

The process of making spurs is not as easy as one might think because it requires special treatment so that the mixture of the main ingredients does not change. The main aim of this special treatment is not to reduce the capabilities or original properties of the main ingredient. The process of making spurs starts with cutting the main material (temple stone cutter). Cutting the material into a certain shape is carried out using a water-cutting process. This water-cutting process is carried out in Bandung and Surabaya because there is none in Bali. Water cutting is a cutting process using water media with a certain pressure (Suheri et al., 2019). Water is sprayed under pressure towards the nozzle so that it can cut materials, especially materials with special needs. This cutting with water aims to ensure that the structure of the material does not change significantly. After the cutting process, the connection process is carried out with the spur handle made of carbon steel. The joining process uses oxy-acetylene welding with added brass material (Wisnujati, 2017). This process is carried out very carefully so that the main material of the spur does not experience structural changes due to the heat process. After the material is connected to the handle, it continues with the main process, namely grinding and sanding. This process is carried out very carefully with a special grinding stone. The grinding process is a process of thinning or changing the shape of the material using special stone media according to needs (Harbintoro & Sutisna, 2020). This grinding process uses a grinding stone with a specification of 1000. The grinding process aims to shape the material to the required shape, especially the pointy and sharp parts. The grinding process by spur craftsmen has been carried out using a bench grinder. The next process is sanding, which is a process carried out for sharpening and cleaning. The sanding process is carried out for sharpening or sharpening as well as cleaning the material from remnants of the previous process. This sanding process uses a hand-grinding tool. The rotation or RPM of the bench grinder and hand grinder is 1400. This very high rotation will of course cause friction which results in heat in the main material even though cooling is used. The heat generated due to this friction will affect the microstructure of the material in the spur (Harbintoro & Agus Sutisna, 2020). This change in structure will result in changes in the mechanical properties of the material.

The process of making spurs can be divided into 3 (three), namely cutting material, grinding, and sanding. The processes that have the most influence on changes in the microstructure of materials are grinding and sanding because there is friction which creates heat (Kumaruddin & Mulyo, 2021). Reducing heat can be done by reducing the friction that occurs (Shidiq & Sidiq, 2022). Reducing friction is done by varying the rotation of the grinding machine. Grinding machines with variable rotation are not found on the market or among tool providers. In this research, tools were made to reduce friction that occurs during the grinding and sanding process. This grinding machine is equipped with variable rotation which can be adjusted according to needs. This research will be carried out by varying the grinding rotation during the grinding and sanding process. This rotation variation was carried out several times to find out how much the microstructure of the main material of the spur changed. These microstructural changes will be compared with the main material before the grinding and sanding process is carried out. The microstructure of the material before and after this process will be studied to see the effect of this grinding process. Grinding and sanding with these tools is still carried out by craftsmen in Dawan Village to reduce errors or human error in the process of making spurs.

2 Methodology

The problem will be limited by applying existing applied knowledge to examine the effect of variations in this rotation. In this research, we use some equipment as follows, the grinding machine uses a DC motor equipped with variable speed. grinding and processing are carried out by the operator at the spur mill with rotations used are 100 rpm, 200 rpm, and 300 rpm. The changes in microstructure are only seen visually from the results of microscope photos which will be compared with existing theory to obtain analysis.

2.1 Design

The application of a DC motor to this grinding tool so that the rotation can be adjusted according to needs. DC motors are a type of electric motor with DC and low voltage (Bagja & Parsa, 2018). DC motors are easier to control their rotation by increasing and decreasing the voltage. The DC motors used are often found in places that provide technical equipment such as shops. The DC motor was chosen because it requires a small amount of electrical energy (50 watts) compared to a bench grinder which requires a very large amount of electrical energy (350 watts). This DC motor is equipped with a gearbox to reduce rotation. The grinding tool is equipped with a variable speed so you can control the rotation. This variable speed uses a potentiometer. The work desk is adjusted to Indonesian standards. The working position is done by sitting on a chair to reduce operator fatigue, which up to now has been done by looking down because the grinding machine is used without a work table.

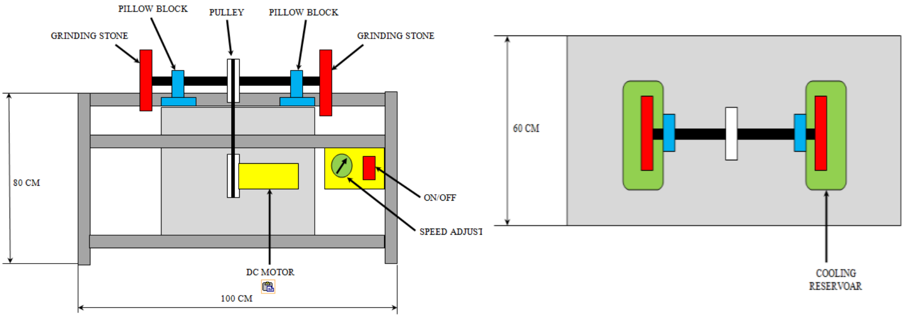

Figure 1. Grinder design

This research flow is divided into several stages, the stages are as follows:

Tool Needs Analysis. Craftsmen in Dawan Village have been using bench grinding machines with a rotation of 1400 rpm. This rotation is very high which can affect changes in the microstructure of the material due to the friction that occurs. A special tool with variable speed control is needed to be able to regulate the grinding rotation to reduce the friction that occurs. Craftsmen want these tools to be used to reduce material damage that occurs which affects the quality and quantity of the product.

Spin Variations. The rotation will affect the friction that occurs between the material and the grinding stone. This friction will generate heat which will affect changes in the microstructure of the material (Anwar et al., 2019). Changes in microstructure will affect the mechanical properties of the material. These mechanical properties will of course affect the quality of the spurs. Rotation variations are carried out to get the right rotation to reduce changes in the microstructure of the material. Tests need to be carried out to be able to determine this change due to rotation and friction that occurs.

Microstructure. Microstructure can indicate the elemental composition, phases, and defects of a material. This information can be used to predict the physical and mechanical properties of the material. Forming processes (hot and cold working) and heat treatment have been known to influence mechanical properties because they cause changes in the size and shape of metal crystal grains. It is hoped that the microstructure due to the grinding and sharpening process in the main material of the spur will not change so that it does not change the original physical properties of the main material.

2.2 Data analysis

Tests in the research entitled Analysis of Sharpening Rotation Variations on Changes in the Microstructure of "Spur" Materials for Craftsmen in Dawan Kaler Village, Klungkung were carried out by direct observation at the crafters' locations. Grinding and sanding are carried out by craftsmen operators to reduce process errors. The fixed variable in this research is the motor speed given, namely 100 RPM, 200 RPM, and 300 RPM. The rotation is made variable according to the request of the craftsman for grinding and sharpening, it requires low rotation to reduce friction and heat from the material. This process is assumed to be the same as the sharpening process with a conventional sharpening stone. The independent variables are temperature and microstructure of the material before and after undergoing the process.

Data analysis uses descriptive analysis. Descriptive analysis is analysis resulting from a graphic phenomenon or image that is compared with the actual situation (Nasution, 2017). Material testing after this process is carried out using metallography tests. A metallography test is a test using a photo microscope process to see the phenomena of existing materials (Mustofa et al., 2018). The photo results after the process will be compared with the material before the process. The hope is that this process cycle will greatly influence changes in the microstructure of the spur material.

3 Result and Discussion

3.1 Result

The material is made from special steel which has specifications according to needs. HSS steel is used as a material for making spurs. HSS steel is a type of steel that has a diverse material composition. Usually, HSS consists of a mixture of iron, carbon, tungsten, chrome, vanadium, and manganese. This material has more metal content than carbide. HSS is a high-speed steel consisting of a combination of more than 7% molybdenum, vanadium, and tungsten, as well as more than 0.06% carbon, there is also additional cobalt mixed into it. This HSS steel is obtained from stone-cutting knives. HSS material is cut to the desired shape using a water-cutting process. This water-cutting process is used to avoid changes in the structure of the metal mixing the material. After being cut, the material is subjected to a microscope photo process to see the detailed structure in 2 dimensions as in Figure 2.

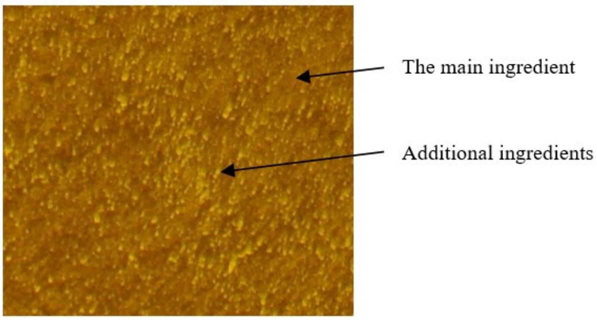

Figure 2. Microstructure before the grinding process

Figure 2 shows the microstructure of the spur material before the grinding process. The density of the metal content that makes up the spur material is visible. The structure of austenite ferrite. Several dots or dots indicate additional material from HSS steel. The main material structure is steel as a barrier between additional materials.

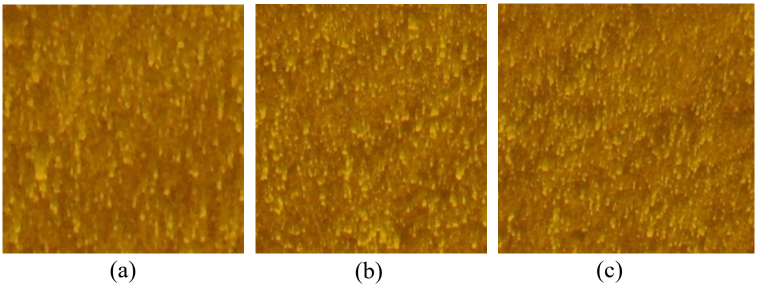

Figure 3. Microstructure after grinding process (a) 100 rpm, (b) 200 rpm, (c) 300 rpm

Figure 3 shows a 2-dimensional photo of HSS steel after going through the grinding process. The structure of the main material and additional materials is still identical to steel before the grinding process is carried out. The grinding process with 100 rpm to 300 rpm does not have a significant effect on changes in the microstructure of the material. The grinding process can still be tolerated so that there are no changes to the structure of the spur material as the craftsman hopes.

The temperature of the steel before the grinding process is carried out is measured. Measurements to get detailed temperature changes before and after the process. The grinding process is carried out for 30 minutes assuming the material is complete. Temperature measurements were carried out before and after the grinding process. The measurement results are as in Figure 4.

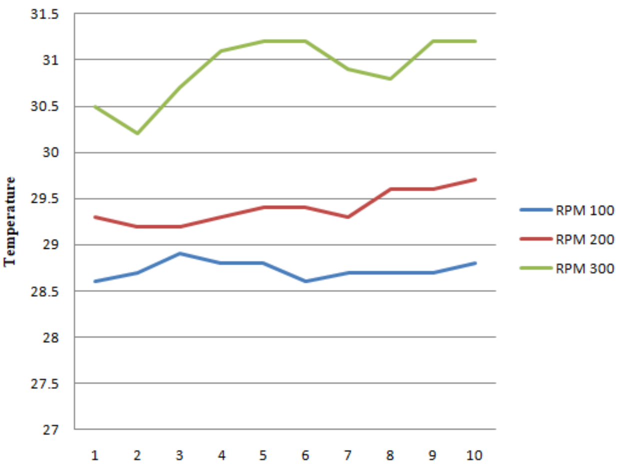

Figure 4. Material temperature after the grinding process

The temperature of the material before the grinding process was 27.47°C. The process was carried out on 10 different materials and then the temperature of each was measured after the process. The process with 100 RPM changes in temperature. The temperature increased by 4.38% from the temperature before the process to 28.73°C. The temperature increase occurred in the process with 200 RPM, namely 6.59% to 29.40°C. The temperature increase also occurred in the process with 300 RPM by 11.12% to 30.90°C. The increase in temperature occurs due to friction between the material and the grinding stone. This friction can cause heat to the spur material.

3.2 Discussion

The test results have not shown significant changes in the microstructure of the spur material. Friction between metals can cause heat to both the main metal and the grinding stone. The heat generated due to friction depends on the length of the process and the pressure applied to the material (Kumaruddin & Sri Mulyo, 2021). Friction also occurs due to rotation. High rotation can also have a high heat change effect on the main material (Kumaruddin & Sri Mulyo, 2021). The friction that occurs between the material and the grinding stone has not changed the microstructure of the spur material. The change in temperature in the 100 rpm process increased by an average of 1.26°C, in the 200 rpm process it increased by 1.94°C, and in the 300 rpm process the temperature increased by an average of 3.44°C. This temperature change was not able to change the microstructure of the material. Changes in the microstructure of a material when the treatment process occurs are above 900^{0}C (Zayadi et al., 2022). High temperatures can change the microstructure of the material. Changes that occur due to heat treatment can change the mechanical properties of a material (Duniawan, 2020). The results showed that the rotation of the grinding machine had no effect on changes in the microstructure of the main material of the spur. Low rotation does not affect the heat in the main material which causes microstructural changes.

4 Conclusion

The results of the research can be concluded that the grinding machine rotation from 100 rpm to 300 rpm does not generate heat which can result in changes to the microstructure of the spur material. Grinding machines can be used for the process of making spurs by craftsmen because they do not affect microstructural changes that can affect the mechanical properties of HSS steel.

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