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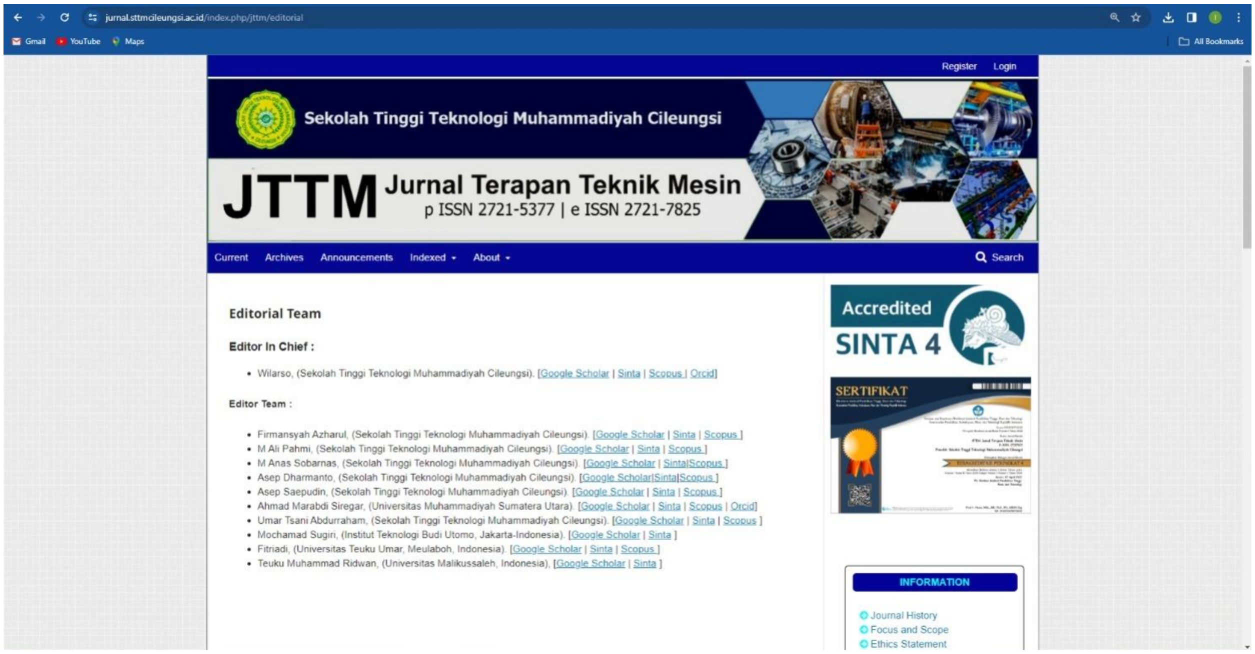

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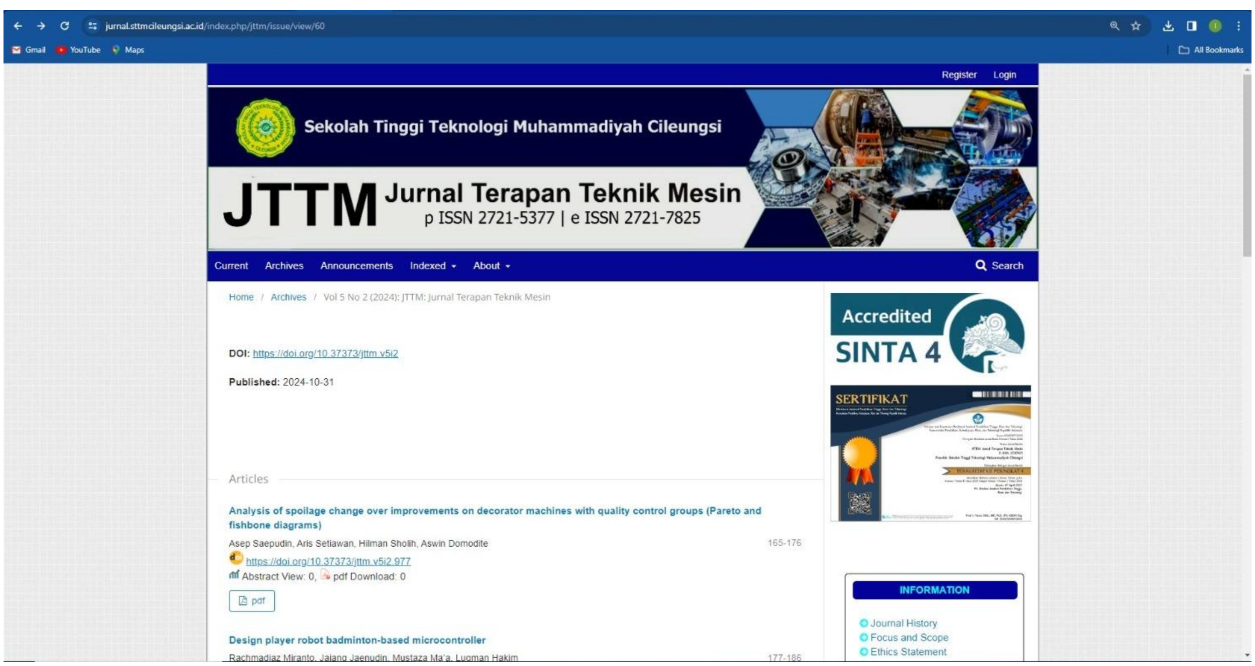

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Effect of air velocity variation on hardness vickers of 6061 aluminum TIG welding joints

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Abstract: Aluminum 6061, a commonly used metal, demands critical attention in welding due to its mechanical properties influencing structural strength. The welding of aluminum 6061 is affected by various factors, including air velocity conditions during the welding process. This research objectives to analyze Vickers hardness values in TIG-welded Aluminum 6061. The research focuses on TIG welding of aluminum 6061, analyzing the impact of air velocity variations in the welding environment on hardness values. The experimental design considers air velocity variations at 3.6 km/h, 4 km/h, and 5 km/h during TIG welding of aluminum 6061. Specimens from each research variable undergo Vickers hardness testing to analyze the correlation between air velocity variations and Vickers hardness values. Research findings reveal specimen 1 with an average hardness of 96 HV, specimen 2 at 105 HV, and specimen 3 at 110 HV. These differences depict hardness variations among specimens, emphasizing the complexity of air velocity variations' effect on welded joints' hardness. Hardness testing results consistently show the lowest hardness values at point number 2, while the highest values for specimens 1 and 2 are at point number 6. However, specimen 3 exhibits the highest hardness at point number 8. The research concludes that air velocity variations in the welding environment significantly impact hardness values in the welding results. Vickers hardness testing indicates an increase in hardness values with increasing air velocity, highlighting a proportional relationship between air velocity variations and hardness values.

Keywords: TIG welding; hardness testing; air velocity; Aluminum 6061; hardness Vickers

1. INTRODUCTION

Welding, a crucial technology in metal joining, involves the fusion of base and filler metals, creating a continuous connection. The welding process encompasses various types, such as Gas Metal Arc Welding (GMAW). It is crucial to carefully regulate the voltage level to achieve optimal welding results [1]. Additionally, Friction Welding involves the joining process of similar or dissimilar metals by rubbing the two metal surfaces together [2]. Furthermore, Shielded Metal Arc Welding (SMAW) necessitates attention to the current magnitude to attain optimal mechanical properties in the welded joints [3]. Moreover, Gas Tungsten Arc Welding (GTAW), commonly known as TIG (Tungsten Inert Gas) welding, utilizes tungsten electrodes that only generate an electric arc upon contact with the workpiece [4],[5].

Aluminum exhibits different mechanical properties in each series or alloy. One method to enhance its mechanical characteristics is through cold working processes such as forging, rolling, or extrusion [6]. Aluminum's advantages include low melting point, high corrosion resistance, relative affordability, and abundant availability [7]. Aluminum 6061 is frequently utilized in various applications, with the mechanical properties of its welded joints being a critical aspect for ensuring structural properties [8]. Air velocity, as an environmental factor, has the potential to effect thermal characteristics and cooling during the TIG welding process. A profound understanding of the relationship between air velocity variations and Vickers hardness values in TIG-welded joints on aluminum 6061 is essential for ensuring the reliability and performance of the material in practical applications.

Previous studies have addressed issues related to TIG welding processes on aluminum Al-6061. These studies highlighted that changes in welding current in TIG processes affect the tensile strength values of welded joints in aluminum and dissimilar metal materials [9], [10]. Other research identified common defects such as solidification cracking, porosity, and distortion occurring frequently during the welding of aluminum alloys, with strong current effect being a major cause of welding failures [11]–[13]. Earlier studies also clearly emphasized the extensive application of aluminum materials, as lightweight metals with strength surpassing mild steel, finding widespread use in the automotive manufacturing industry, aircraft components, including ship construction [14]–[16]. Additionally, some previous research highlighted the effect of tungsten inert gas flow rate and welding current strength on hardness values and the microstructure or mechanical properties of TIG-welded joints [17]–[19]. However, there is still a lack of information regarding the specific interaction between air velocity and hardness values in TIG-welded joints on aluminum 6061. Therefore, this research aims to fill this knowledge gap and provide added value by offering better insights into the factors influencing the mechanical properties or hardness values of welded joints.

The research problem revolves around understanding the effect of varying air velocity on the hardness values of TIG-welded joints in Aluminum 6061. Thus, the research aims to determine Vickers hardness values in TIG-welded Aluminum 6061. To achieve the formulated objectives, the problem-solving approach in this research involves conducting Vickers hardness tests on TIG-welded joints in Aluminum 6061. This research approach encompasses air velocity variations during the TIG welding process of aluminum 6061. Recent literature also highlights changes in the mechanical properties of TIG-welded Aluminum 6061 due to variations in environmental temperature using friction stir welding [20]. Nevertheless, specific research on the impact of air velocity variations on the hardness of TIG-welded joints in Aluminum 6061 is limited, as friction stir welding methods are more commonly employed for Aluminum 6061 joints [21]–[23]. Therefore, this study focuses on TIG welding of aluminum 6061 to analyze the effect of air velocity variations in the welding environment on the hardness values of the welded joints.

2. METHOD

The methodology employed in this research is experimental, with research specimens tested using Vickers hardness testing to analyze the correlation between air velocity variations and the hardness values of TIG-welded joints in Aluminum 6061.

2.1 Research design

This research utilizes an experimental design focusing on air velocity variations in the TIG welding process of aluminum 6061. The main independent variable is air velocity variation at 3.6 km/h, 4 km/h, and 5 km/h, while the dependent variable is the Vickers hardness value of the welded joints.

2.2 Research material

The primary material in this study is Aluminum 6061 plate, further shaped into workpiece specimens with dimensions of 100x40x4 mm, as depicted in Figure 1. The use of Aluminum Alloy 6061 is chosen for its relevant mechanical properties for hardness testing. Workpiece specimens will be prepared precisely according to the predetermined dimensions to support welding and hardness testing procedures.

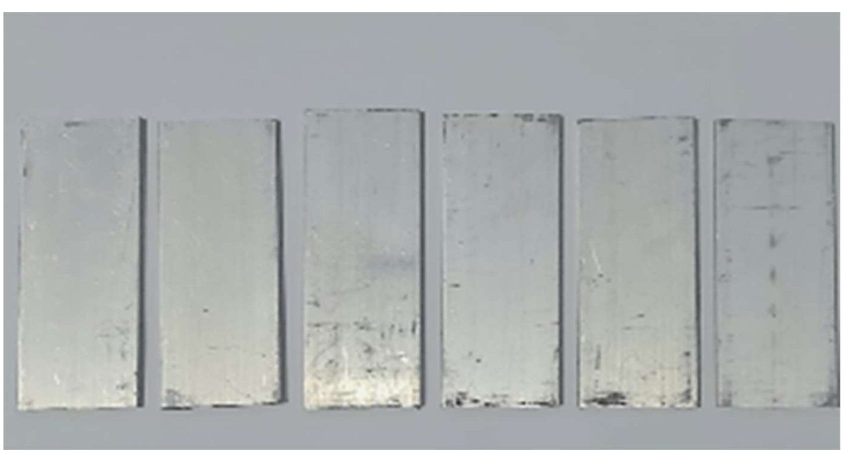

Figure 1. Al6061 plate with dimensions 100x40x4 mm

2.3 Research location

This research will be conducted at multiple locations, detailed as follows:

a) Mechanical Engineering Machining Laboratory, Faculty of Industrial Technology and Informatics, Prof. DR. Hamka Muhammadiyah University Jakarta: This location will be used for specimen preparation and the execution of the welding process.
b) Mechanical Engineering Machining Laboratory, University of Indonesia: This site will be utilized for hardness testing data collection on the produced specimens.

2.4 Research procedure

2.4.1 TIG welding stages

The TIG welding process is conducted in the Mechanical Engineering Laboratory, Faculty of Industrial Technology and Informatics, Muhammadiyah University of Prof. DR. Hamka, Jakarta. The execution stages of the welding process are as follows:

a) Thoroughly clean the Aluminum 6061 plate to remove surface dirt and oxides. Mark each welding section according to the experimental design.
b) TIG welding is performed using a calibrated TIG welding machine type 315p. A clean tungsten electrode is used to achieve a stable electric arc.
c) Air velocity is regulated using manometer measuring tool positioned at a fixed distance from the welding area. Air velocity is varied at different levels according to the predetermined research variables.
d) For each air velocity variation, TIG welding is performed with consistent parameters such as welding current, voltage, and welding speed.

2.4.2Vickers hardness testing

Vickers hardness testing of the Aluminum 6061 TIG-welded joints is conducted in the Mechanical Engineering Machining Laboratory, University of Indonesia. The testing stages are as follows:

a) Install the indenter, adjusted to the desired testing type, such as using a steel ball.
b) Set the indentation point in the predetermined area for hardness testing.
c) Apply a load in the compression stage.
d) Hardness values are determined by the movement of the needle on the indicator measuring device.

Welded joint hardness is measured using a Vickers hardness testing machine. Testing is performed on each test specimen, and hardness values are recorded.

3. RESULTS AND DISCUSSION

The results of TIG welding on Aluminum 6061 are presented in three specimens, as shown in Figure 2. Visual inspection revealed welding defects such as porosity in the welded joints of Aluminum 6061 TIG welding in all three specimens. Furthermore, the preparation of test samples for Vickers hardness testing on Aluminum 6061 TIG-welded joints is illustrated in Figure 3.

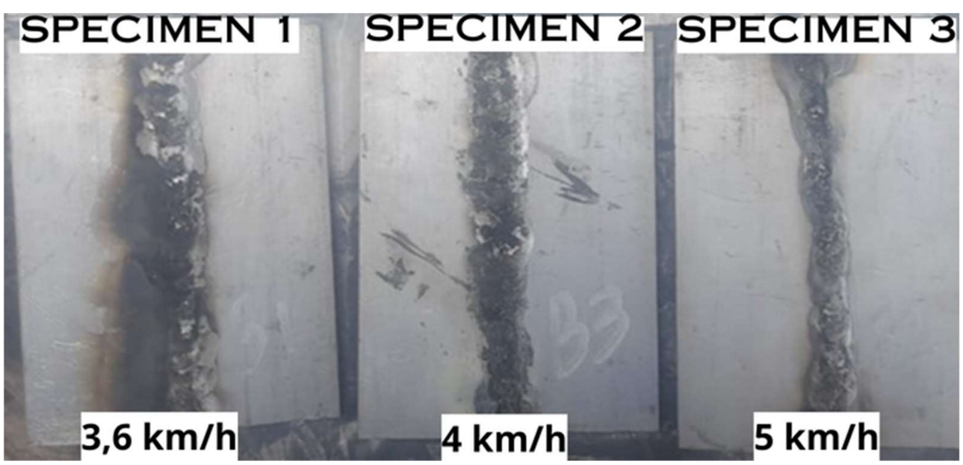

Figure 2. TIG welding results on aluminum 6061

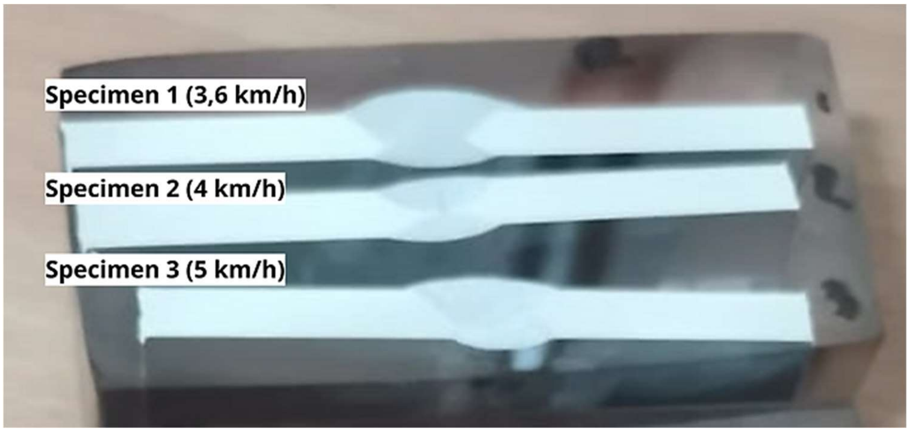

Figure 3. Preparation of vickers hardness testing specimens

Vickers hardness (HV) testing on each specimen was conducted at thirteen points, six from the joint and seven points after the joint with a 1mm interval, as seen in Figure 4. The main objective was to evaluate the correlation between air velocity variations and the hardness of TIG-welded joints in Aluminum 6061.

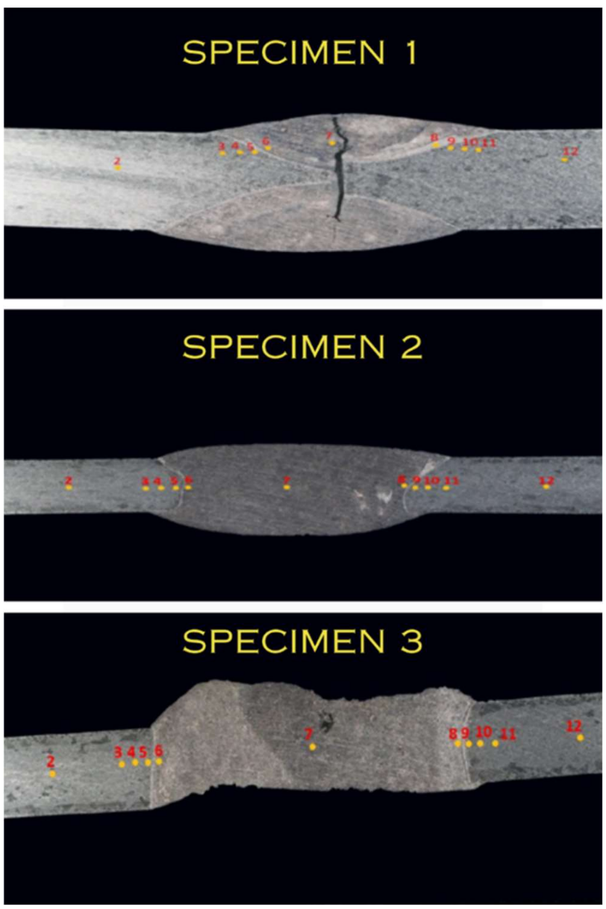

Figure 4. Vickers hardness testing results

Figure 4 shows the Vickers hardness testing results for each specimen with varying air velocitys. From the observations, it is noted that in specimen 1, there is a crack at point number 7 in the middle of the joint. In contrast, specimens 2 and 3 do not exhibit significant cracks as seen in specimen 1. This indicates the effect of air velocity variations on the hardness of welded joints. This phenomenon may be explained by the potential for high thermal stress due to differential cooling rates in that area.

The crack could result from uneven cooling conditions, likely caused by air velocity variations during the welding process.

The characterization of Vickers hardness testing results on TIG-welded Aluminum 6061 can be observed in more detail in Table 1.

Table 1. Hardness vickers testing results

Point Number	Hardness Vickers (HV)		
	Specimen 1	Specimen 2	Specimen 3
1	76,3	76,3	76,3
2	75,3	75,5	75,5
3	103,0	111,0	118,2
4	101,3	112,5	118,2
5	103,0	116,2	110,2
6	110,2	128,6	154,4
7	99,7	118,2	127,2
8	106,5	118,2	160,9
9	104,7	118,2	118,2
10	110,2	114,1	110,2
11	102,3	110,2	106,5
12	76,4	76,4	76,4
13	76,3	76,3	76,3
Average value of hardness Vickers	**96**	**105**	**110**

Table 1 provides characterization of Vickers hardness testing results on the three tested specimens. The highest hardness value in specimen 1 is at points 6 and 10, both measuring 110.2 HV. Conversely, the lowest hardness value is at point 2, with a value of 75.3 HV. In specimen 2, point 6 has the highest hardness at 128.0 HV, while point 2 has the lowest hardness at 75.5 HV. Specimen 3 shows the highest hardness at point 8 (160.9 HV) and the lowest hardness at point 2 (75.5 HV). Calculating the average Vickers hardness values, specimen 1 has an average of 96 HV, specimen 2 at 105 HV, and specimen 3 at 110 HV. These differences highlight hardness variations among specimens, emphasizing the complexity of the effect of air velocity variations on welded joints.

Comparison of Vickers hardness values in Table 1 indicates significant variations between specimens 1, 2, and 3. In specimen 1, there is a noticeable increase in hardness at points 6 and 10, possibly related to differences in heat distribution during the welding process. This correlation suggests that air velocity variations can affect heat distribution and, consequently, the hardness of welded joints. It is essential to emphasize critical points in specimens that show the highest and lowest hardness values. In all specimens, there is a consistent lowest hardness value at point number 2, while the highest hardness values in specimens 1 and 2 are at point number 6. However, specimen 3 shows the highest hardness at point number 8 (160.9 HV). These findings provide a basis for understanding consistent hardness variations at specific locations, likely affected by specific characteristics of the welding area. The discovery of consistent hardness values at point number 2 and the highest value at point number 8 in Sample 3 is intriguing for further analysis. A detailed understanding of the microstructure at these critical points can provide profound insights into the underlying phenomena. Microstructure analysis is needed to identify the causes of hardness variations at these specific locations.

The graph above shows a positive correlation between air velocity and Vickers hardness values in aluminum welding. In other words, as air velocity increases, the Vickers hardness value also tends to rise. The increase in air velocity is accompanied by an increase in hardness values, indicating that this factor can be considered a significant parameter in influencing the mechanical properties of the welding results. It is crucial to note that air velocity can affect the amount of hydrogen involved in the welding process.

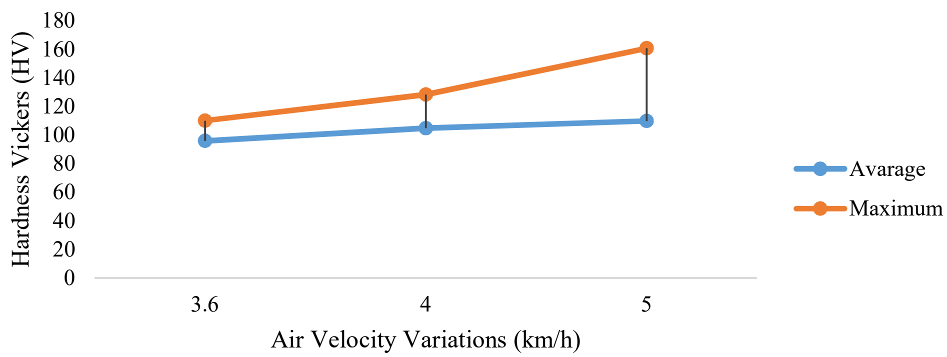

Figure 5. Graph of relation between hardness value and air velocity variation

Figure 5 the impact of air velocity on welding can lead to the required amount of hydrogen in the welding process, causing hydrogen to be driven as a pressure cover exposed to air velocity, namely oxygen. The higher the air velocity received by the TIG (Tungsten Inert Gas) welding arc, the more challenging it is for hydrogen to combine with the metal, potentially increasing defects in welding. Therefore, careful control of air velocity parameters is necessary to avoid negative impacts on the quality of aluminum welding. The relationship between air velocity, hydrogen content, and material hardness needs further discussion. The effect of air velocity on hydrogen content can affect welding quality. Strict control of this parameter is required to avoid potential welding defects and imperfections.

3 CONCLUSION

Based on the results and discussion of this research, it can be concluded that variations in air velocity within the welding environment have a significant impact on the hardness values of the welding outcomes. Vickers hardness tests demonstrate an increase in hardness values with the rise in air velocity, ranging from 3.6 km/h to 5.0 km/h, resulting in hardness values ranging from 110.2 HV to 160.9 HV. Therefore, higher air velocity corresponds to greater hardness values. These findings hold crucial implications, particularly for enhancing the quality of Aluminum 6061 welding. Recommendations center on the control and adjustment of air velocity parameters during the welding process. Reducing the risk of hydrogenation can be achieved through a comprehensive understanding of factors influencing hydrogen in the welding process. For further research, it is advisable to conduct microstructure analysis in specific areas displaying hardness variations. A thorough comprehension of microstructure characteristics can provide additional insights into the relationship between welding parameters, hydrogen distribution, and material hardness in Aluminum 6061 welding outcomes

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Effect of air velocity variation on hardness vickers of 6061 aluminum TIG welding joints

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Abstract: Aluminum 6061, a commonly used metal, demands critical attention in welding due to its mechanical properties influencing structural strength. The welding of aluminum 6061 is affected by various factors, including air velocity conditions during the welding process. This research objectives to analyze Vickers hardness values in TIG-welded Aluminum 6061. The research focuses on TIG welding of aluminum 6061, analyzing the impact of air velocity variations in the welding environment on hardness values. The experimental design considers air velocity variations at 3.6 km/h, 4 km/h, and 5 km/h during TIG welding of aluminum 6061. Specimens from each research variable undergo Vickers hardness testing to analyze the correlation between air velocity variations and Vickers hardness values. Research findings reveal specimen 1 with an average hardness of 96 HV, specimen 2 at 105 HV, and specimen 3 at 110 HV. These differences depict hardness variations among specimens, emphasizing the complexity of air velocity variations' effect on welded joints' hardness. Hardness testing results consistently show the lowest hardness values at point number 2, while the highest values for specimens 1 and 2 are at point number 6. However, specimen 3 exhibits the highest hardness at point number 8. The research concludes that air velocity variations in the welding environment significantly impact hardness values in the welding results. Vickers hardness testing indicates an increase in hardness values with increasing air velocity, highlighting a proportional relationship between air velocity variations and hardness values.

Keywords: TIG welding; hardness testing; air velocity; Aluminum 6061; hardness Vickers

1. INTRODUCTION

Welding, a crucial technology in metal joining, involves the fusion of base and filler metals, creating a continuous connection. The welding process encompasses various types, such as Gas Metal Arc Welding (GMAW). It is crucial to carefully regulate the voltage level to achieve optimal welding results [1]. Additionally, Friction Welding involves the joining process of similar or dissimilar metals by rubbing the two metal surfaces together [2]. Furthermore, Shielded Metal Arc Welding (SMAW) necessitates attention to the current magnitude to attain optimal mechanical properties in the welded joints [3]. Moreover, Gas Tungsten Arc Welding (GTAW), commonly known as TIG (Tungsten Inert Gas) welding, utilizes tungsten electrodes that only generate an electric arc upon contact with the workpiece [4],[5].

Aluminum exhibits different mechanical properties in each series or alloy. One method to enhance its mechanical characteristics is through cold working processes such as forging, rolling, or extrusion [6]. Aluminum's advantages include low melting point, high corrosion resistance, relative affordability, and abundant availability [7]. Aluminum 6061 is frequently utilized in various applications, with the mechanical properties of its welded joints being a critical aspect for ensuring structural properties [8]. Air velocity, as an environmental factor, has the potential to effect thermal characteristics and cooling during the TIG welding process. A profound understanding of the relationship between air velocity variations and Vickers hardness values in TIG-welded joints on aluminum 6061 is essential for ensuring the reliability and performance of the material in practical applications.

Previous studies have addressed issues related to TIG welding processes on aluminum Al-6061. These studies highlighted that changes in welding current in TIG processes affect the tensile strength values of welded joints in aluminum and dissimilar metal materials [9], [10]. Other research identified common defects such as solidification cracking, porosity, and distortion occurring frequently during the welding of aluminum alloys, with strong current effect being a major cause of welding failures [11]–[13]. Earlier studies also clearly emphasized the extensive application of aluminum materials, as lightweight metals with strength surpassing mild steel, finding widespread use in the automotive manufacturing industry, aircraft components, including ship construction [14]–[16]. Additionally, some previous research highlighted the effect of tungsten inert gas flow rate and welding current strength on hardness values and the microstructure or mechanical properties of TIG-welded joints [17]–[19]. However, there is still a lack of information regarding the specific interaction between air velocity and hardness values in TIG-welded joints on aluminum 6061. Therefore, this research aims to fill this knowledge gap and provide added value by offering better insights into the factors influencing the mechanical properties or hardness values of welded joints.

The research problem revolves around understanding the effect of varying air velocity on the hardness values of TIG-welded joints in Aluminum 6061. Thus, the research aims to determine Vickers hardness values in TIG-welded Aluminum 6061. To achieve the formulated objectives, the problem-solving approach in this research involves conducting Vickers hardness tests on TIG-welded joints in Aluminum 6061. This research approach encompasses air velocity variations during the TIG welding process of aluminum 6061. Recent literature also highlights changes in the mechanical properties of TIG-welded Aluminum 6061 due to variations in environmental temperature using friction stir welding [20]. Nevertheless, specific research on the impact of air velocity variations on the hardness of TIG-welded joints in Aluminum 6061 is limited, as friction stir welding methods are more commonly employed for Aluminum 6061 joints [21]–[23]. Therefore, this study focuses on TIG welding of aluminum 6061 to analyze the effect of air velocity variations in the welding environment on the hardness values of the welded joints.

2. METHOD

The methodology employed in this research is experimental, with research specimens tested using Vickers hardness testing to analyze the correlation between air velocity variations and the hardness values of TIG-welded joints in Aluminum 6061.

2.1 Research design

This research utilizes an experimental design focusing on air velocity variations in the TIG welding process of aluminum 6061. The main independent variable is air velocity variation at 3.6 km/h, 4 km/h, and 5 km/h, while the dependent variable is the Vickers hardness value of the welded joints.

2.2 Research material

The primary material in this study is Aluminum 6061 plate, further shaped into workpiece specimens with dimensions of 100x40x4 mm, as depicted in Figure 1. The use of Aluminum Alloy 6061 is chosen for its relevant mechanical properties for hardness testing. Workpiece specimens will be prepared precisely according to the predetermined dimensions to support welding and hardness testing procedures.

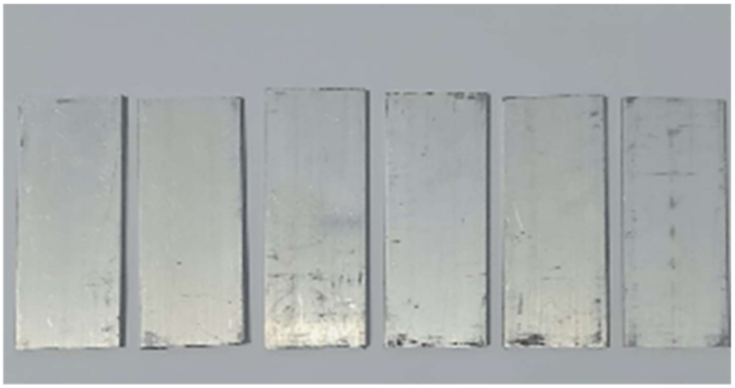

Figure 1. Al6061 plate with dimensions 100x40x4 mm

2.3 Research location

This research will be conducted at multiple locations, detailed as follows:

a) Mechanical Engineering Machining Laboratory, Faculty of Industrial Technology and Informatics, Prof. DR. Hamka Muhammadiyah University Jakarta: This location will be used for specimen preparation and the execution of the welding process.
b) Mechanical Engineering Machining Laboratory, University of Indonesia: This site will be utilized for hardness testing data collection on the produced specimens.

2.4 Research procedure

2.4.1 TIG welding stages

The TIG welding process is conducted in the Mechanical Engineering Laboratory, Faculty of Industrial Technology and Informatics, Muhammadiyah University of Prof. DR. Hamka, Jakarta. The execution stages of the welding process are as follows:

a) Thoroughly clean the Aluminum 6061 plate to remove surface dirt and oxides. Mark each welding section according to the experimental design.
b) TIG welding is performed using a calibrated TIG welding machine type 315p. A clean tungsten electrode is used to achieve a stable electric arc.
c) Air velocity is regulated using manometer measuring tool positioned at a fixed distance from the welding area. Air velocity is varied at different levels according to the predetermined research variables.
d) For each air velocity variation, TIG welding is performed with consistent parameters such as welding current, voltage, and welding speed.

2.4.2Vickers hardness testing

Vickers hardness testing of the Aluminum 6061 TIG-welded joints is conducted in the Mechanical Engineering Machining Laboratory, University of Indonesia. The testing stages are as follows:

a) Install the indenter, adjusted to the desired testing type, such as using a steel ball.
b) Set the indentation point in the predetermined area for hardness testing.
c) Apply a load in the compression stage.
d) Hardness values are determined by the movement of the needle on the indicator measuring device.

Welded joint hardness is measured using a Vickers hardness testing machine. Testing is performed on each test specimen, and hardness values are recorded.

3. RESULTS AND DISCUSSION

The results of TIG welding on Aluminum 6061 are presented in three specimens, as shown in Figure 2. Visual inspection revealed welding defects such as porosity in the welded joints of Aluminum 6061 TIG welding in all three specimens. Furthermore, the preparation of test samples for Vickers hardness testing on Aluminum 6061 TIG-welded joints is illustrated in Figure 3.

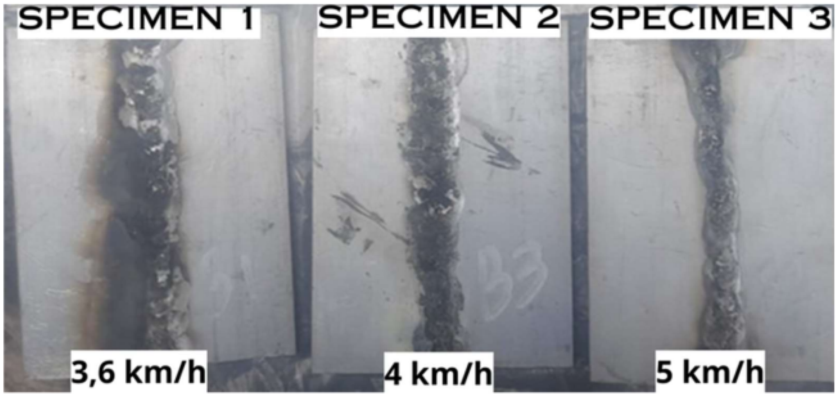

Figure 2. TIG welding results on aluminum 6061

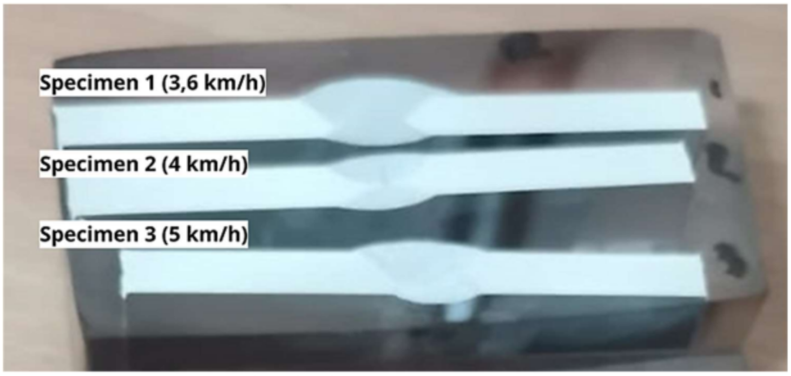

Figure 3. Preparation of vickers hardness testing specimens

Vickers hardness (HV) testing on each specimen was conducted at thirteen points, six from the joint and seven points after the joint with a 1mm interval, as seen in Figure 4. The main objective was to evaluate the correlation between air velocity variations and the hardness of TIG-welded joints in Aluminum 6061.

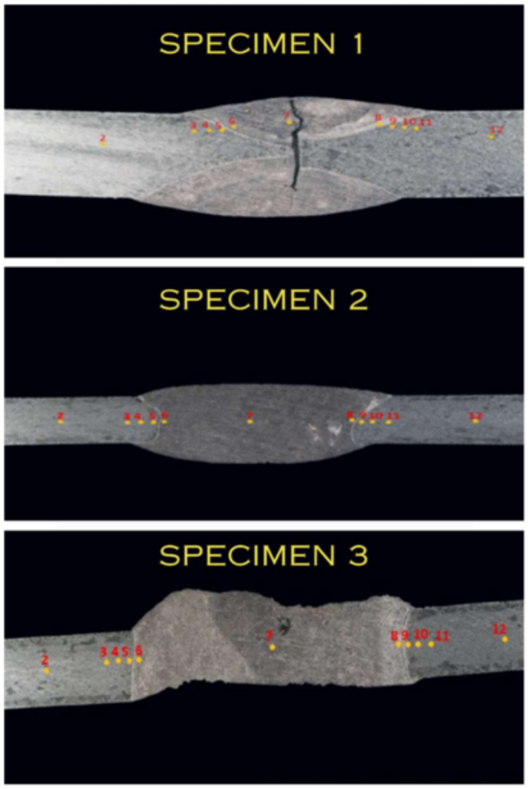

Figure 4. Vickers hardness testing results

Figure 4 shows the Vickers hardness testing results for each specimen with varying air velocitys. From the observations, it is noted that in specimen 1, there is a crack at point number 7 in the middle of the joint. In contrast, specimens 2 and 3 do not exhibit significant cracks as seen in specimen 1. This indicates the effect of air velocity variations on the hardness of welded joints. This phenomenon may be explained by the potential for high thermal stress due to differential cooling rates in that area.

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The crack could result from uneven cooling conditions, likely caused by air velocity variations during the welding process.

The characterization of Vickers hardness testing results on TIG-welded Aluminum 6061 can be observed in more detail in Table 1.

Table 1**.** Hardness vickers testing results

Point Number	Hardness Vickers (HV)		
	Specimen 1	Specimen 2	Specimen 3
1	76,3	76,3	76,3
2	75,3	75,5	75,5
3	103,0	111,0	118,2
4	101,3	112,5	118,2
5	103,0	116,2	110,2
6	110,2	128,6	154,4
7	99,7	118,2	127,2
8	106,5	118,2	160,9
9	104,7	118,2	118,2
10	110,2	114,1	110,2
11	102,3	110,2	106,5
12	76,4	76,4	76,4
13	76,3	76,3	76,3
Average value of hardness Vickers	**96**	**105**	**110**

Table 1 provides characterization of Vickers hardness testing results on the three tested specimens. The highest hardness value in specimen 1 is at points 6 and 10, both measuring 110.2 HV. Conversely, the lowest hardness value is at point 2, with a value of 75.3 HV. In specimen 2, point 6 has the highest hardness at 128.0 HV, while point 2 has the lowest hardness at 75.5 HV. Specimen 3 shows the highest hardness at point 8 (160.9 HV) and the lowest hardness at point 2 (75.5 HV). Calculating the average Vickers hardness values, specimen 1 has an average of 96 HV, specimen 2 at 105 HV, and specimen 3 at 110 HV. These differences highlight hardness variations among specimens, emphasizing the complexity of the effect of air velocity variations on welded joints.

Comparison of Vickers hardness values in Table 1 indicates significant variations between specimens 1, 2, and 3. In specimen 1, there is a noticeable increase in hardness at points 6 and 10, possibly related to differences in heat distribution during the welding process. This correlation suggests that air velocity variations can affect heat distribution and, consequently, the hardness of welded joints. It is essential to emphasize critical points in specimens that show the highest and lowest hardness values. In all specimens, there is a consistent lowest hardness value at point number 2, while the highest hardness values in specimens 1 and 2 are at point number 6. However, specimen 3 shows the highest hardness at point number 8 (160.9 HV). These findings provide a basis for understanding consistent hardness variations at specific locations, likely affected by specific characteristics of the welding area. The discovery of consistent hardness values at point number 2 and the highest value at point number 8 in Sample 3 is intriguing for further analysis. A detailed understanding of the microstructure at these critical points can provide profound insights into the underlying phenomena. Microstructure analysis is needed to identify the causes of hardness variations at these specific locations.

The graph above shows a positive correlation between air velocity and Vickers hardness values in aluminum welding. In other words, as air velocity increases, the Vickers hardness value also tends to rise. The increase in air velocity is accompanied by an increase in hardness values, indicating that this factor can be considered a significant parameter in influencing the mechanical properties of the welding results. It is crucial to note that air velocity can affect the amount of hydrogen involved in the welding process.

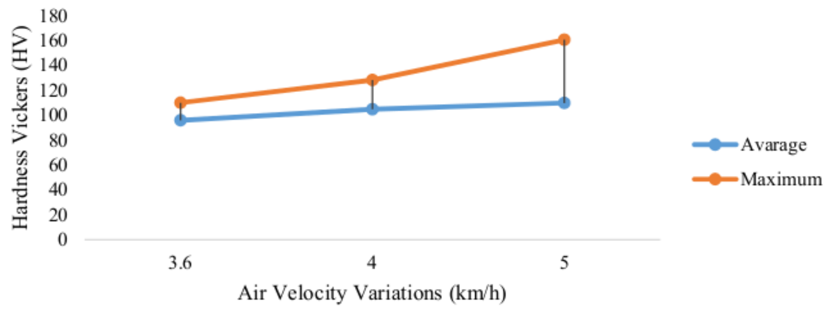

Figure 5. Graph of relation between hardness value and air velocity variation

Figure 5 the impact of air velocity on welding can lead to the required amount of hydrogen in the welding process, causing hydrogen to be driven as a pressure cover exposed to air velocity, namely oxygen. The higher the air velocity received by the TIG (Tungsten Inert Gas) welding arc, the more challenging it is for hydrogen to combine with the metal, potentially increasing defects in welding. Therefore, careful control of air velocity parameters is necessary to avoid negative impacts on the quality of aluminum welding. The relationship between air velocity, hydrogen content, and material hardness needs further discussion. The effect of air velocity on hydrogen content can affect welding quality. Strict control of this parameter is required to avoid potential welding defects and imperfections.

3 CONCLUSION

Based on the results and discussion of this research, it can be concluded that variations in air velocity within the welding environment have a significant impact on the hardness values of the welding outcomes. Vickers hardness tests demonstrate an increase in hardness values with the rise in air velocity, ranging from 3.6 km/h to 5.0 km/h, resulting in hardness values ranging from 110.2 HV to 160.9 HV. Therefore, higher air velocity corresponds to greater hardness values. These findings hold crucial implications, particularly for enhancing the quality of Aluminum 6061 welding. Recommendations center on the control and adjustment of air velocity parameters during the welding process. Reducing the risk of hydrogenation can be achieved through a comprehensive understanding of factors influencing hydrogen in the welding process. For further research, it is advisable to conduct microstructure analysis in specific areas displaying hardness variations. A thorough comprehension of microstructure characteristics can provide additional insights into the relationship between welding parameters, hydrogen distribution, and material hardness in Aluminum 6061 welding outcomes

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