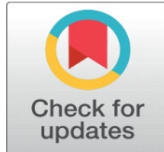


# STUDY ON THE GRINDING PRESSURE AND WELDING POSITION ON THE SPARK DISTANCE

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## ABSTRACT

In industry, different kinds of activities are taking place such as cutting, grinding, welding, etc. Conducting these activities requires considering safety issues such as sparking that causes a fire, especially in flammable areas. This study aims to analyze the influence of the cutting pressure and welding direction on the spark distance. Three different cutting pressures include 14, 23, and 28 kPa. Two different cutting and welding positions including transverse and longitudinal directions are applied to the steel pipe. The results of this study show that, with increased cutting pressures the spark distances are also increased. The higher spark distance of cutting was observed at 360 cm and welding was 93.33 cm in longitudinal and transverse direction respectively.

**Keywords:** Cutting Pressure, Welding Direction, Spark Distance

## 1. INTRODUCTION

In industries, several activities regarding the production process are very common. These activities consist of grinding, cutting, welding, and so on. For cutting material sometimes the grinding machine is used, as this machine is easier to apply for this kind of activity. For welding purposes, different types of welding machines or methods can be used, such as Stick, Arc, and Electron-Beam Welding [Jara \(2019\)](#). In the modern industry of petroleum and gas the pipe material of High Strength Low

Alloy Steel (HSLA) is used, which is referred to American Petroleum Institute standard (API 5L X70) [Sutrimo & Putra \(2021\)](#).

Referred to cutting, and welding activities, safety matters are very important to be considered mostly within flammable environment. Cutting or welding characteristics depend on size, form, and type of material. Harder material requires higher pressure to cut which may require more safety precautions. For welding activities there are several position including flat (down hand), horizontal, vertical, and overhead [Achmadi. \(2024\)](#). For cutting with a grinding machine, the position of the tool is slightly angled to the work pieces. Increasing the angle of the grinding wheel provides more aggressive grinding if reducing the grinding angle lessens the pressure being applied [Jescovitch, & Schafer \(2018\)](#).

Gasoline and diesel fuel is a flammable substance that undergoes fire when reaches the temperature of the auto ignition state. Auto ignition temperature of gasoline is occurred at 232 oC [Christopher \(2003\)](#) and diesel fuel at different properties is between 177 - 285 oC [Tang \(2005\)](#). Meanwhile, the temperature of metal sparks produced from the angle grinder can reach a temperature of 1100 oC [ToolsOwner.com. \(n.d.\)](#). The spark temperature produced from different types of welding is almost higher than 1700 oC, such as stick welding at 1760 oC [Kumar \(2022\)](#). In addition, the temperature of the spark from brazing welding is 540 oC and friction welding is between 450 to 500 oC.

In fuel storage and supply stations such as PERTAMINA SA in Dili, the activities referred to cutting or welding of pipe material are practical happened. These activities regarding flammable environments such as in fuel station industries, which are considered high-risk ambient that easily causes accidents, explosions, and fire [Frans et al. \(2013\)](#). Then the understanding of these activities on the safety issues is an important matter. This study aims to analyze the cutting and welding process on the spark distance to identify the safety area within the flammable environment. This study applies three different of cutting pressures in the transverse and longitudinal directions and includes welding activity using steel pipe material.

## 2. MATERIALS AND METHODS

### 2.1. RESEARCH MATERIAL

This experiment was conducted in the laboratory of the mechanical engineering department FECT-UNTIL. The material used in the study is the steel pipe with 16 cm diameter; this material is obtained from PERTAMINA International SA. This pipe material is according to ANPI standard XL570 which is used in the industry of petroleum and gas. The characteristics and chemical composition of this material can be seen in Sutrimo and Putra (2021) [Sutrimo & Putra \(2021\)](#). The pipe for this experiment is shown in [Figure 1](#)

**Figure 1**



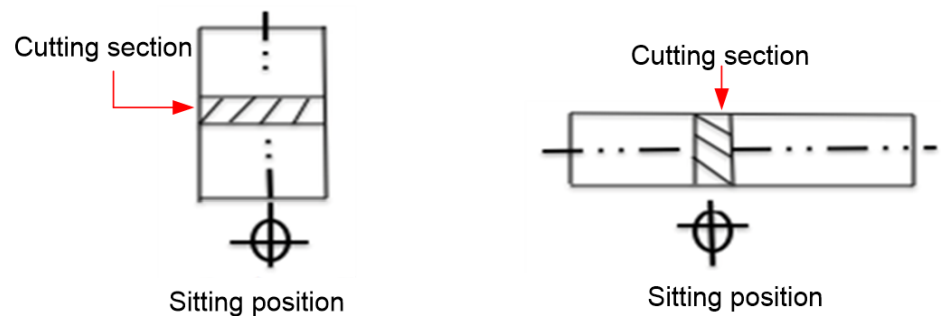
**Figure 1** Piping Material for Experiment

## 2.2. RESEARCH METHOD

### 2.2.1. RESEARCH PROCEDURE

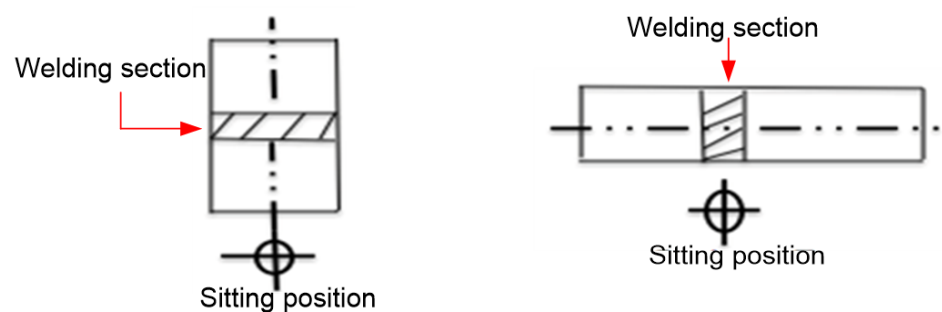
In conducting the experiment, three cutting pressure were determined including 14, 23, and 28 kPa. The cutting pressures were identified by the balancing meter which includes the weight from hands and the grinding machine itself. The cutting was in horizontal with two different movements including transverse and longitudinal as shown in Figure 2. From this cutting then the fire spark is measured to identify the distance. The total distance of the spark is composed of the flying spark and the falling spark. The flying spark is the distance from the cutting point to the falling point. The falling spark period is the time that starts when the spark falls until disappears and is then converted into distance. The same condition is also applied to the distance in the welding test. The horizontal welding position was applied with two different movements including transverse and longitudinal as shown in Figure 3. The type of welding used in this experiment is Electron-Beam Welding (EBW).

**Figure 2**



**Figure 2** Cutting Direction, (a) Transverse Direction, and (b) Longitudinal Direction

**Figure 3**



**Figure 3** Welding Direction, (a) Transverse Direction, and (b) Longitudinal Direction

### 2.2.2. CALCULATION METHODS

- **Calculation for area**

The piping material used in this experiment is 64 cm in length, 16.4 cm outside diameter, 15 cm inside diameter, and 7 mm thick, and the area is 34.5 cm<sup>2</sup>.

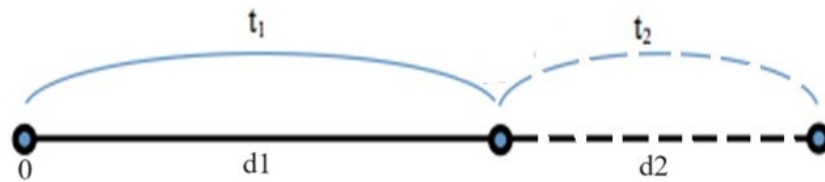
- **Calculation for cutting pressure**

The cutting pressure applied in the experiment was based on the mass from the grinding machine and hand force. Both parameters are measured with the balance meter. The mass of the grinding machine is 2 kg summing with three values of mass from hand force (3, 6, and 8 kg), and then obtained cutting pressure of 14, 23, and 28 kPa.

- **Calculation for spark distance**

The spark distance is calculated based on the spark distance [Figure 4](#), starting from the cutting point to the falling point ( $d_1$ ), spark time starting from the cutting point to the falling point ( $t_1$ ), spark time after falling until extinct ( $t_2$ ),  $d_2$  is the distance corresponds to  $t_2$ , and the total distance is the summing of  $d_1$  and  $d_2$ . This calculation is also applied to define the distance of the sparks from the welding.

**Figure 4**

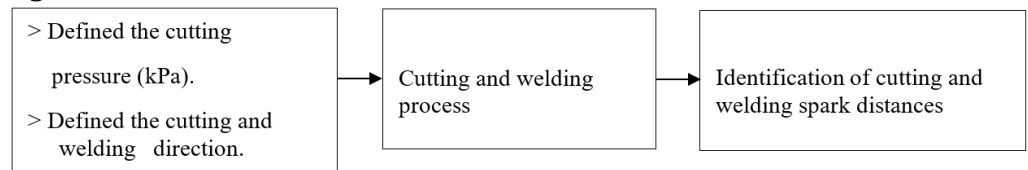


**Figure 4** Spark Distance Schema

## 2.3. EXPERIMENTAL DIAGRAM

The research diagram is presented in [Figure 5](#). The equipment used in this study is composed of a grinding machine, welding machine, and balancing meter. Once the experiment is conducted, the camera is ready to record the test, to identify the spark distances.

**Figure 5**



**Figure 5** Experimental schema

## 3. RESULTS AND DISCUSSIONS

### 3.1. CUTTING RESULTS

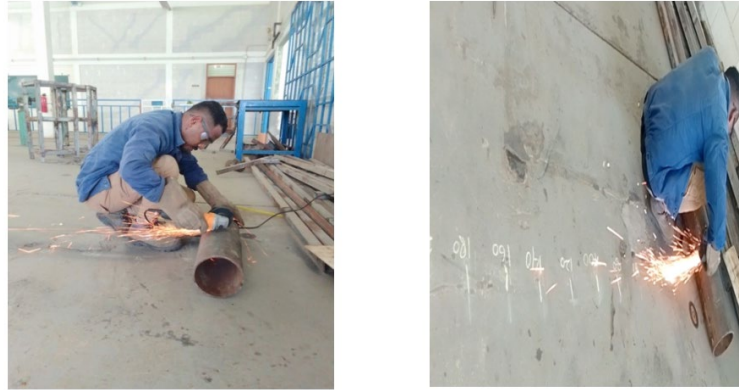
To identify the spark distance, the distance measurement was established and a camera was mounted to record the sparks falling and define the spark distance. Following, describing the cutting experiment in the longitudinal and transverse direction with 3 different cutting pressures.

#### 3.1.1. CUTTING IN LONGITUDINAL DIRECTION

- **Cutting in longitudinal direction at pressure 14 kPa**

The experiment result in [Figure 6](#) shows the cutting activity and distance measurement lines. In this cutting pressure, the maximum spark was falling and reached 180 cm.

**Figure 6**

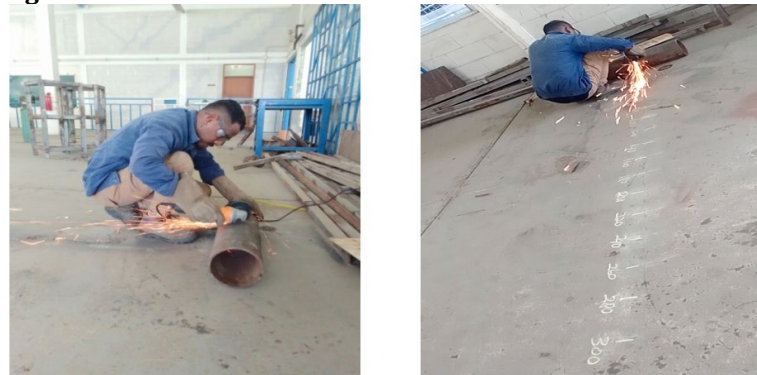


**Figure 6** Cutting in Longitudinal Direction at Pressure 14 kPa

- **Cutting in longitudinal direction at pressure 23 kPa.**

Figure 7 shows the cutting activity and distance measurement lines for pressure at 23 kPa. In this experiment, the maximum spark was falling and reached 220 cm.

**Figure 7**



**Figure 7** Cutting in Longitudinal Direction at Pressure 23 kPa

- **Cutting in longitudinal direction at pressure 28 kPa.**

Figure 8 shows the cutting activity and distance measurement lines for pressure at 28 Pa. In this experiment, the maximum spark fell and reached a higher distance of 320 cm.

**Figure 8**

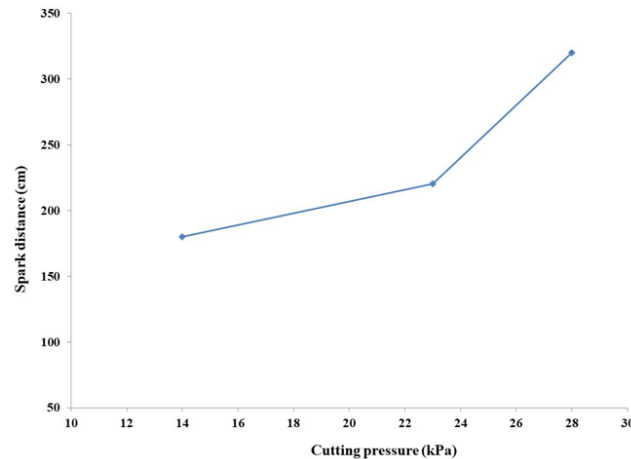


**Figure 8** Cutting in Longitudinal Direction at Pressure 28 kPa



Figure 9 shows the relationship between cutting pressure and spark distance obtained in this experiment. It is shown that the spark distance increased with the cutting pressure. The higher pressure applied for cutting can contribute significantly to the spark distance.

**Figure 9**



**Figure 9** Spark Distance and Cutting Pressure in the Longitudinal Direction

### 3.1.2. CUTTING IN TRANSVERSE DIRECTION

- **Cutting in transverse direction at a pressure of 14 kPa.**

Figure 10 presents the cutting activity in the transverse direction at a pressure of 14 kPa. It shows the sparks were falling at a distance of 180 cm.

**Figure 10**



**Figure 10** Cutting in the Transverse Direction at Pressure 14 Kpa

- **Cutting in transverse direction at a pressure of 23 kPa.**

Figure 11 presents the cutting activity in the transverse direction at pressure 23 kPa. It shows the sparks were falling at a distance of 220 cm.

**Figure 11**



**Figure 11** Cutting in the Transverse Direction at Pressure 23 Kpa

- **Cutting in transverse direction at a pressure of 28 kPa.**

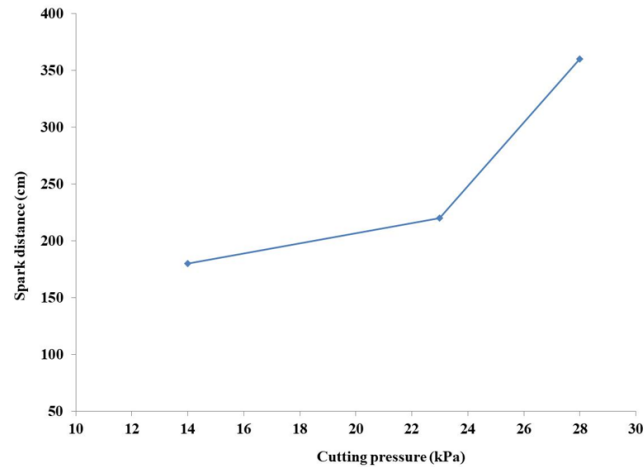
Figure 12 shows the cutting activity in a transverse direction at pressure 28 kPa. The result shows that the sparks were falling at a distance 360 cm.

**Figure 12**



**Figure 12** Cutting in the Transverse Direction at Pressure 28 Kpa

Figure 13 presents the relationship between cutting pressure and spark distance obtained for transverse direction. The result shows that the spark distance increased with the cutting pressure. The higher pressure applied for cutting also contributes significantly to the spark distance. The spark distance is higher at 360 cm than the cutting in the longitudinal direction at a higher pressure of 28 kPa. This may be influenced by the sitting position which indicates less body impediment on the spark.

**Figure 13****Figure 13** Spark Distance and Cutting Pressure in the Transverse Direction

### 3.2. WELDING RESULTS

Based on the same measurement procedures for the welding experiment, identify the spark distance based on the time and spark distance. In the welding experiment, the position of the welding electrode is about 45° in angle. Following, describe the welding experiment in the longitudinal and transverse directions.

#### 3.2.1. WELDING IN LONGITUDINAL DIRECTION

The result of the welding experiment in the longitudinal direction in [Figure 12](#) shows that the sparks were falling in the distance of 20 cm in 1.5 s. After the falling of the sparks, it takes about 2 seconds for the extinguishing of the sparks. The time of the 2 s is then converted into the distance, which corresponds to 26.67 cm. Then, the total distance for welding in the longitudinal direction is about 46.67 cm, and the speed of the spark is about 13.33 cm/s.

**Figure 14****Figure 14** Welding in the Longitudinal Direction

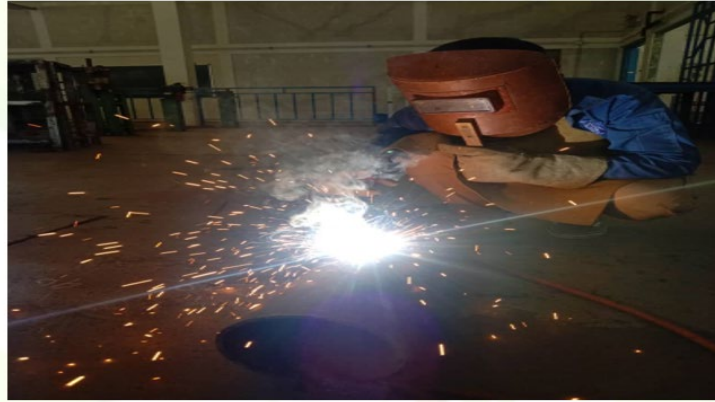
#### 3.2.2. WELDING IN THE TRANSVERSE DIRECTION

The result of the welding experiment in the transverse direction in [Figure 13](#) shows that the sparks were falling in a distance of 40 cm in 1.5 s. After the falling of



the sparks, it also takes about 2 seconds for the extinguishing of the sparks. The time of the 2 s was also then converted into the distance, which corresponds to 53.33 cm. Then, the total distance for welding in the transverse direction is about 93.33 cm and the speed of the spark distinguished is about 26.67 cm/s. The result from welding in the transverse direction is two times higher than welding in the longitudinal direction, which may be influenced by the electrode position.

**Figure 15**



**Figure 15** Welding in the Transverse Direction

#### **4. CONCLUSIONS AND RECOMMENDATIONS**

Cutting and welding of a High Strength Low Alloy Steel pipe was used in this study to identify the spark distance and understand the work environment in safe condition. Three cutting pressures were applied including 14, 23, and 28 kPa. Two directions of cutting and welding were used such as longitudinal and transverse direction. The results show that the spark distance for cutting in the longitudinal direction at three pressures was from 180 to 320 cm. Meanwhile, the spark distance in the transverse direction at three pressures was from 180 to 360 cm. The spark distance for welding in the longitudinal direction was 46.67 cm, and the spark distance in the transverse direction was 93.33 cm.

#### **CONFLICT OF INTERESTS**

None.

#### **ACKNOWLEDGMENTS**

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