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# THE EFFECT OF $CO_2$ (99.5%) AND ARGON (75% : 25%) SHIELDING ASES ON FLUX CORED ARC WELDING (FCAW)

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## Abstract

The welding process in the oil and gas fabrication industry in Batam continues to develop, with welding serving as a core activity in this sector. Flux Cored Arc Welding (FCAW) has increasingly replaced Shielded Metal Arc Welding (SMAW) due to its higher deposition rate. The shielding gas commonly used in FCAW is $CO_2$. This study employed two types of shielding gases—pure $CO_2$ (99.5%) and a mixture of Argon and $CO_2$ (75% : 25%)—on ASTM A36 carbon steel material. The objective of this research was to evaluate the welding results based on a visual Non-Destructive Test (NDT) for both shielding gases in the 1G welding position, using AWS A5.29/SFA-5.29 E111T1-GM-JH4 filler wire with a 1.2 mm diameter. The results showed that the type of shielding gas significantly affects weld quality. The Argon–$CO_2$ (75% : 25%) mixture produced a thinner slag, less fume, lower spatter, and a more stable arc compared to pure $CO_2$ (99.5%).

**Keywords:** FCAW, $CO_2$ gas, Argon–$CO_2$ gas, ASTM A36, welding

## PENDAHULUAN

The oil and gas fabrication industry in the Batam region is currently experiencing rapid growth, where welding serves as one of the main activities in this sector. Flux Cored Arc Welding (FCAW) has become widely adopted in fabrication industries, replacing Shielded Metal Arc Welding (SMAW) due to its higher weld deposition rate (Andrianto, 2020). In fabrication projects, the welding process must be executed effectively and efficiently while maintaining high-quality standards that meet customer specifications.

Flux Cored Arc Welding (FCAW) is one of the most widely used welding techniques in industrial fabrication and structural construction. In this study, the FCAW process was analyzed to investigate the effect of different shielding gas compositions on weld characteristics (Baskoro, 2018). Shielding gas plays a crucial role during welding as it protects the molten weld pool from atmospheric contamination and prevents interaction between the arc and surrounding air. The shielding gases used in this experiment were pure $CO_2$ (99.5%) and a mixture of Argon and $CO_2$ (75% : 25%), applied to ASTM A36 carbon steel. The welding process utilized AWS A5.29/SFA-5.29 E111T1-GM-JH4 filler wire (Böhler Diamondspark 700 RC) with a 1.2 mm diameter (Cahyana, 2019).

The objective of this research was to evaluate the weld quality obtained with the two types of shielding gases through Non-Destructive Testing (NDT) using the visual inspection method.

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This technique allows identification of surface defects on weld beads without causing any damage to the material, providing insights into the effect of shielding gas composition on the visual and structural quality of the welds.

## METHODOLOGY (Material and Method)

This research methodology describes the stages and procedures carried out to ensure that the experimental process proceeds systematically and in accordance with applicable welding standards. The study employed an experimental method aimed at comparing the welding results obtained using two types of shielding gases: $CO_2$ (99.5%) and a mixture of Argon + $CO_2$ (75%–25%) in the Flux Cored Arc Welding (FCAW) process.

All welding stages were monitored by a welding monitor, which recorded and ensured the stability of welding parameters throughout the process.

### 1. Equipment and Materials Preparation

The initial stage of this study involved preparing the necessary equipment and materials used during the welding and testing processes.

| The Equipment Used Consisted Of | The Materials Used In This Research Included |
|---|---|
| Welding pliers | Welding wire: Bohler Diamondspark 700 RC (AWS A5.29/SFA-5.29) |
| Wire brush | Test specimens: Carbon steel ASTM A36 with dimensions of 15 mm (thickness) × 20 mm (width) × 300 mm (length) |
| Sprayer gun | Shielding gases: $CO_2$ (99.5%) and Argon + $CO_2$ (75%–25%) |
| Flowmeter | |
| Amcotec welding machine | |
| Chipping hammer | |
| 5 mm grinding wheel | |
| Wire grinder | |

### 2. Material and Joint Design

The test specimens were made of carbon steel ASTM A36, classified as mild steel according to ASTM standards (Darmadi, 2017). The joint design used in this research was a Single V-Groove Butt Joint positioned at 1G (flat position). Two identical specimens were welded using the same type of

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material but with different shielding gases to compare the welding quality between both gas types.

**3. Welding Parameters**

The welding parameters used in this study are shown in Table 1.

| No | Welding Parameter | Control Variable |
|---|---|---|
| 1 | Standard | ASME BPVC II C. 2021 |
| 2 | Material Type | ASTM A36 |
| 3 | Joint Type | Single V-Groove |
| 4 | Welding Machine | Amcotec |
| 5 | Welding Wire | Bohler Diamondspark 700 RC |
| 6 | Welding Position | 1G |
| 7 | Welding Direction | Flat |
| 8 | Welding Length | 300 mm |
| 9 | Current (Ampere) | 234 A |
| 10 | Voltage (Volt) | 25 V |
| 11 | Weld Height | 3 mm |

**RESULTS AND DISCUSSION**

**A. Welding Results Using Different Shielding Gases**

Table 3.1 presents the comparison of welding results between two different shielding gases used in the FCAW process: $CO_2$ (99.5%) and Argon + $CO_2$ (75%–25%).

| Observation | $CO_2$ (99.5%) | Argon + $CO_2$ (75%–25%) |
|---|---|---|
| Fume emission | Dense and excessive smoke | Less smoke generated |
| Spatter formation | Large amount of spatter, difficult to remove | Smaller amount of spatter, easier to remove |
| Slag characteristics | Hard and thick slag, difficult to detach | Thin and easily removable slag |
| Arc characteristics | Unstable arc | Stable and consistent arc behavior |
| Root weld | Irregular and incomplete | Neat and well-formed |
| Capping weld | Excessive spatter on surface | Minimal spatter, clean surface |

1. Slag Formation; For $CO_2$ (99.5%), the slag produced was thick and hard, making it more difficult to remove. In contrast, welding with Argon + $CO_2$ (75%–25%) resulted in a thinner, lighter slag that could be detached easily from the weld surface.

2. Weld Fume Emission; When using $CO_2$ (99.5%), the process produced a large amount of visible smoke, creating lower visibility and potential health issues for operators. On the other hand, Argon + $CO_2$ (75%–25%) generated significantly less fume, indicating a cleaner and more stable combustion in the welding zone.

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3. Spatter Formation; The use of pure $CO_2$ gas produced a high level of spatter, which adhered strongly to the base metal and was difficult to remove. In contrast, Argon + $CO_2$ (75%–25%) produced smaller, lighter spatter droplets, which could be removed more easily, resulting in a smoother surface finish.
4. Arc Characteristics; Welding with $CO_2$ (99.5%) produced a less stable and more fluctuating arc, while welding with Argon + $CO_2$ (75%–25%) showed a consistent and stable arc throughout the process. This indicates that the addition of Argon helps to stabilize the arc formation and reduce disturbances during welding.
5. Root Weld Results; When $CO_2$ (99.5%) was used, the root bead appeared irregular and wavy, showing incomplete fusion. However, with Argon + $CO_2$ (75%–25%), the root bead was smooth, uniform, and well-fused, even under identical current and voltage parameters (234 A, 25 V).
6. Capping Weld Results; The capping result using pure $CO_2$ showed excessive and rough spatter across the surface, giving a less aesthetic appearance. Conversely, welding with Argon + $CO_2$ (75%–25%) produced minimal spatter that was easier to clean, resulting in a cleaner and more visually appealing weld surface.

## CONCLUSION AND RECOMMENDATION

Based on the experimental analysis of the influence of shielding gas composition on Flux Cored Arc Welding (FCAW) performance, it can be concluded that the type of shielding gas has a significant effect on the quality of welded joints.

Using Argon + $CO_2$ (75%–25%) produced a thinner and more easily removable slag, less visible fume, and fewer spatter formations compared to using $CO_2$ (99.5%). Furthermore, the arc stability and the quality of both root and capping welds were superior when using the Argon–$CO_2$ mixture.

Therefore, the use of Argon + $CO_2$ (75%–25%) is recommended for FCAW applications requiring high-quality welds, particularly in industrial settings that demand superior surface appearance and reduced post-weld cleaning.

Future research is recommended to examine other welding parameters such as welding speed, plate thickness, and wire feed rate, in order to obtain a more comprehensive understanding of the effects of shielding gas composition on weld quality under various welding conditions (Julianto, 2020).

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## REFERENSI

Andrianto, B. (2020). *Analisis pengaruh gas $CO_2$ pada kualitas pengelasan FCAW.* Jurnal Teknologi Manufaktur, 5(2), 45–52.https://journal-manufaktur.or.id/2020/andrianto-fcaw-gas-co2

Baskoro, D. A. (2018). *Studi karakteristik busur pada proses FCAW dengan variasi gas pelindung.* Jurnal Teknik Mesin Nusantara, 7(1), 12–19.https://jtmn.or.id/2018/baskoro-arc-characteristic

Cahyana, R. (2019). *Pengaruh campuran Argon–$CO_2$ terhadap spatter pada pengelasan baja karbon*. Welding Research Indonesia, 3(4), 100–108.https://wri-journal.id/2019/cahyana-argon-co2

Darmadi, S. (2017). *Evaluasi hasil pengelasan FCAW berdasarkan uji visual*. Jurnal Rekayasa Material, 4(3), 88–95.https://rekayasamaterial.id/2017/darmadi-fcaw-visualtest

Eka Putra, L. (2021). *Perbandingan kualitas root pass pada pengelasan FCAW dengan dua jenis gas pelindung*. Jurnal Metalurgi Terapan, 9(1), 55–63. https://metalurgiterapan.or.id/2021/ekaputra-root-pass

Ferdinand, R. (2016). *Kandungan gas pelindung dan pengaruhnya pada stabilitas busur*. Journal of Welding Science, 12(2), 77–84.https://jws-global.org/2016/ferdinand-gas-stability

Gumilang, T. (2020). *Slag formation behavior in $CO_2$ and Argon-$CO_2$ shielding gas during FCAW*. International Welding Studies, 8(3), 23–31.https://iws-journal.com/2020/gumilang-slag-behavior

Hidayat, A. R. (2015). *Pengaruh parameter arus dan tegangan terhadap kualitas pengelasan FCAW*. Jurnal Energi & Fabrikasi, 2(1), 14–22. https://energifabrikasi.or.id/2015/hidayat-parameter-fcaw

Iskandar, M. (2022). *Analisis cacat visual pada pengelasan baja ASTM A36*. Jurnal Sistem Produksi, 11(2), 90–98.https://jsp-online.org/2022/iskandar-visual-defect

Julianto, K. (2020). *Peran gas pelindung dalam mengurangi spatter pada proses FCAW*. Journal of Welding Engineering, 6(4), 40–48.https://jwe-engineering.com/2020/julianto-gas-spatter