

ABSTRAK

Industri minyak dan gas bumi mempunyai peranan penting dalam perekonomian nasional yang pengelolaannya harus dilakukan secara maksimal. Salah satu komponen vital dalam industri migas yaitu komponen pipa. Metode penyambungan pipa pada penelitian ini menggunakan kombinasi pengelasan *Gas Tungsten Arc Welding* (GTAW) dan *Shielded Metal Arc Welding* (SMAW) dengan mempertimbangkan aspek teknik dan aspek *sustainability* untuk mencapai industri yang berkelanjutan. Aspek-aspek berkelanjutan diantaranya aspek ekonomi, aspek lingkungan dan aspek sosial. *Sustainable welding* merupakan proses pengelasan logam yang dilakukan menggunakan metode yang lebih ramah lingkungan dan efisien dari segi ekonomi. Aspek *sustainable welding* yang diaplikasikan pada penelitian ini yaitu konsumsi energi, emisi karbon, kadar *fumes*, dan kekuatan impak dengan tiga variabel bebas yaitu kuat arus (60 A, 80 A, 100 A), sudut kampuh (50° , 70° , 90°), dan posisi pengelasan (1G, 2G, 5G) yang kemudian dilakukan pendekatan eksperimental menggunakan matriks BBD (*Box-Behnken Design*) dengan metode RSM (*Response Surface Methodology*). Pendekatan eksperimental tersebut menghasilkan 15 rancangan percobaan. Berdasarkan rancangan tersebut kemudian dilakukan perhitungan yang menghasilkan kekuatan impak tertinggi sebesar $1.08091 \text{ Joule/mm}^2$ dari variasi kuat arus 80 A, sudut kampuh 70° , dan posisi pengelasan 2G yang ketiga, nilai konsumsi energi terendah sebesar 6.06 kW dihasilkan dari variasi kuat arus 100 A, sudut kampuh 90° , dan posisi pengelasan 2G, nilai emisi karbon terendah sebesar $4763.16 \text{ kgCO}_2/\text{kWs}$ dari variasi kuat arus 100 A, sudut kampuh 90° , dan posisi pengelasan 2G, dan nilai kadar *fumes* terendah sebesar $388,5 \mu\text{g/m}^3$ dari variasi kuat arus 60 A, sudut kampuh 50° , dan posisi pengelasan 2G. Namun, berdasarkan analisis data dengan *software* minitab 19 menggunakan metode *response surface* tidak ada parameter yang berpengaruh signifikan terhadap konsumsi energi, emisi karbon, dan kekuatan impak. Sementara pada kadar *fumes* hanya parameter sudut kampuh yang berpengaruh signifikan.

Kata kunci: Pipeline, pengelasan GTAW dan SMAW, *sustainable welding*, kekuatan impak, *Response Surface Methodology*

ABSTRACT

The oil and gas industry has an important role in the national economy and its management must be carried out optimally. One of the vital components in the oil and gas industry is the pipe component. The pipe connection method in this research uses a combination of Gas Tungsten Arc Welding (GTAW) and Shielded Metal Arc Welding (SMAW) by considering technical aspects and sustainability aspects to achieve a sustainable industry. Sustainable aspects include economic aspects, environmental aspects and social aspects. Sustainable welding is a metal welding process carried out using methods that are more environmentally friendly and economically efficient. The sustainable welding aspects applied in this research are energy consumption, carbon emissions, fumes content, and impact strength with three independent variables, namely current strength (60 A, 80 A, 100 A), seam angle (50°, 70°, 90°), and welding position (1G, 2G, 5G) which was then carried out an experimental approach using the BBD (Box-Behnken Design) matrix with the RSM (Response Surface Methodology) method. This experimental approach resulted in 15 experimental designs. Based on this design, calculations were then carried out which resulted in the highest impact strength of 1.08091 Joule/mm² from variations in current strength of 80 A, seam angle of 70°, and the third 2G welding position, the lowest energy consumption value of 6.06 kW resulted from variations in current strength of 100 A, seam angle of 90°, and welding position 2G, the lowest carbon emission value was 4763.16 kgCO₂/kW from variations in current strength of 100 A, seam angle 90°, and welding position 2G, and the lowest fumes content value was 388.5 µg/m³ from variations current strength 60 A, seam angle 50°, and welding position 2G. However, based on data analysis with Minitab 19 software using the response surface method, there are no parameters that have a significant effect on energy consumption, carbon emissions and impact strength. Meanwhile, on the fumes level, only the buttress angle parameter has a significant effect.

Keywords: Pipeline, GTAW and SMAW, sustainable welding, impact strength, Response Surface Methodology