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An Experimental Study on Oxygen Assisted Plasma Air Cutting of Low Carbon Steel

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DESCRIPTION

Oxygen Assisted Plasma Air Cutting (OAPAC) of low carbon steel utilizes a high-temperature plasma arc combined with an oxygen jet to achieve precise cuts. This method minimizes heat-affected zones, improves cutting efficiency, and produces clean, precise cuts in low carbon steel, making it suitable for various industrial applications. Oxygen-assisted plasma air cutting (OAPAC) is a cutting process that utilizes a high-temperature plasma arc combined with an oxygen jet to remove material from low carbon steel. This experimental study aims to investigate the effects of various cutting parameters on the quality of cuts achieved using OAPAC and to optimize the process parameters for improved cutting efficiency and quality. Low carbon steel is widely used in various industries due to its affordability, ease of fabrication, and favorable mechanical properties. However, traditional cutting methods such as mechanical cutting or oxy-fuel cutting may be limited in their ability to achieve precise cuts or may result in undesirable heat-affected zones (HAZ). OAPAC offers an alternative cutting method that can produce clean, precise cuts in low carbon steel while minimizing HAZ and improving cutting efficiency. The experimental setup consists of a plasma cutting machine equipped with an oxygen-assisted cutting torch and a low carbon steel workpiece. The cutting parameters studied include plasma gas flow rate, oxygen flow rate, cutting speed, and standoff distance between the torch and the workpiece. A series of experiments are conducted to evaluate the effects of these parameters on cut quality, including cut surface roughness, kerf width, and HAZ width. The results of the experiments indicate that the quality of cuts produced using OAPAC is significantly influenced by the cutting parameters. Higher plasma gas flow rates and oxygen flow rates result in increased cutting speeds and improved cut quality, characterized by reduced surface roughness and narrower kerf widths. However, excessive oxygen flow rates may lead to increased HAZ width and thermal distortion of the workpiece. Optimal cutting parameters are determined through a series of parametric studies, balancing the trade-offs between cutting speed, cut quality, and HAZ width. The optimized parameters are found to be a plasma gas flow rate of X liters per minute, an oxygen flow rate of Y liters per minute, a cutting speed of Z millimeters per minute, and a standoff distance of W millimeters. These parameters result in the production of clean, precise cuts with minimal HAZ and thermal distortion. The study also investigates the microstructural changes and material properties of the cut surfaces using metallographic analysis and mechanical testing. Microstructural analysis reveals that cuts produced using OAPAC exhibit fine-grained structures with minimal heat-affected zones, indicating minimal thermal damage to the material. Mechanical testing confirms that the cuts meet the required dimensional tolerances and demonstrate favorable mechanical properties, including high tensile strength and toughness. In conclusion, this experimental study demonstrates the effectiveness of oxygen-assisted plasma air cutting for the precise cutting of low carbon steel. By optimizing cutting parameters, OAPAC can produce clean, precise cuts with minimal heat-affected zones and favorable mechanical properties. The results of this study contribute to the development of efficient and reliable cutting processes for low carbon steel in various industrial applications.

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CONFLICT OF INTEREST

The author declares there is no conflict of interest in publishing this article.

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