ABSTRAK

PENGARUH WAKTU ANNEALING 60, 90, DAN 120 MENIT TERHADAP SIFAT MEKANIS DAN STRUKTUR MIKRO BAJA KARBON RENDAH HASIL PENGELASAN MIG

Penelitian ini bertujuan untuk menganalisis pengaruh variasi waktu penahanan *(holding time)* selama proses annealing terhadap sifat mekanis dan struktur mikro baja karbon rendah yang telah mengalami pengelasan MIG. Fokus utama penelitian adalah mengevaluasi perubahan sifat tarik, kekerasan, serta karakteristik struktur mikro pada area logam las (*weld* metal/WM) dan *heat affected zone* (HAZ) akibat perlakuan panas tersebut. Penelitian dilakukan secara eksperimental dengan perlakuan *annealing* pada suhu 820°C selama 60, 90, dan 120 menit. Setelah tahap normalisasi dan pengelasan, spesimen menjalani uji inspeksi partikel magnetik, uji tarik, uji kekerasan Rockwell, serta analisis struktur mikro menggunakan mikroskop optik. Hasil penelitian menunjukkan bahwa peningkatan durasi *annealing* berbanding terbalik dengan kekuatan tarik dan kekerasan, di mana kedua sifat tersebut cenderung menurun seiring bertambahnya waktu perlakuan panas. Nilai kekuatan tarik tertinggi sebesar 180,06 MPa diperoleh dari spesimen tanpa proses *annealing*, begitu pula dengan nilai kekerasan maksimum sebesar 64,88 HRB. Sebaliknya, spesimen dengan waktu *annealing* selama 120 menit menunjukkan nilai kekerasan terendah sebesar 46,26 HRB. Sifat keuletan mengalami peningkatan terutama pada spesimen *base* metal, dengan nilai tertinggi mencapai 36,6%. Berdasarkan hasil pengamatan mikroskopik, proses *annealing* berperan dalam memperhalus ukuran butir dan meningkatkan homogenitas struktur mikro. Namun, durasi *annealing* yang terlalu lama justru menyebabkan pertumbuhan butir yang berlebihan, sehingga berdampak negatif terhadap kualitas struktur material.

Kata kunci: *Annealing*, Waktu Penahanan, Baja Karbon Rendah, Sifat Mekanik, Struktur Mikro, MIG *Welding*, Weld Metal (WM), *Heat Affected Zone* (HAZ).

ABSTRACT

THE EFFECT OF ANNEALING TIME AT 60, 90, AND 120 MINUTES ON THE MECHANICAL PROPERTIES AND MICROSTRUCTURE OF LOW CARBON STEEL WELDED BY MIG

This study aims to analyze the effect of holding time variations during the annealing process on the mechanical properties and microstructure of low-carbon steel that has undergone MIG welding. The main focus of the study was to evaluate changes in tensile properties, hardness, and microstructure characteristics in the weld metal area (WM) and heat affected zone (HAZ) due to the heat treatment. The study was conducted experimentally with annealing treatment at 820°C for 60, 90, and 120 minutes. After the normalization and welding stage, the specimen underwent magnetic particle inspection tests, tensile tests, Rockwell hardness tests, as well as microstructure analysis using optical microscopes. The results showed that the increase in annealing duration was inversely proportional to tensile strength and hardness, where both properties tended to decrease as the heat treatment time increased. The highest tensile strength value of 180.06 MPa was obtained from specimens without annealing, as well as a maximum hardness value of 64.88 HRB. In contrast, specimens with an annealing time of 120 minutes showed the lowest hardness value of 46.26 HRB. The ductility has increased, especially in base metal specimens, with the highest value reaching 36.6%. Based on the results of microscopic observations, the annealing process plays a role in smoothing the grain size and increasing the homogeneity of the microstructure. However, too long an annealing duration actually causes excessive grain growth, thus negatively impacting the quality of the material structure.

Keywords: Annealing, Holding Time, Low Carbon Steel, Mechanical Properties, Microstructure, MIG Welding, Weld Metal (WM), Heat Affected Zone (HAZ).