

INTISARI

Slack adjuster dump truck Scania berbahan besi cor nodular rentan mengalami keretakan akibat pembebanan siklik selama operasional. Penelitian ini menganalisis pengaruh tiga metode perlakuan panas, yaitu *Austempered Ductile Iron* 110°C (ADI-110°C), *annealing*, dan *normalizing*, seluruhnya menggunakan austenisasi 900°C selama 60 menit, terhadap sifat mekanis material. Pengujian meliputi analisis komposisi kimia, kekerasan *Brinell*, ketahanan aus *Ogoshi*, ketangguhan impak *Charpy*, dan analisis struktur mikro. ADI-110°C menghasilkan matriks martensit dominan karena suhu penahanan 110°C berada di bawah garis *Martensite Start* dan media *salt bath* berada dalam kondisi padat, sehingga diperoleh kekerasan tertinggi (576,6 BHN) dan laju keausan spesifik terendah ($W_s = 1,960 \times 10^{-5} \text{ mm}^3/\text{kg}\cdot\text{m}$), namun ketangguhan impak terendah (0,062 J/mm²). *Annealing* menghasilkan matriks ferit dominan dengan ketangguhan impak tertinggi (0,227 J/mm²) tetapi kekerasan (153,0 BHN) dan ketahanan aus paling rendah ($W_s = 4,410 \times 10^{-5} \text{ mm}^3/\text{kg}\cdot\text{m}$). *Normalizing* menghasilkan matriks perlit halus dan homogen dengan kekerasan setara *raw material* (246,2 BHN), laju keausan $3,726 \times 10^{-5} \text{ mm}^3/\text{kg}\cdot\text{m}$, dan ketangguhan impak 0,141 J/mm² atau meningkat 22,6% dibandingkan *raw material*. Terdapat korelasi positif yang konsisten antara kekerasan dan ketahanan aus, serta korelasi negatif antara kekerasan dan ketangguhan pada seluruh kondisi yang diuji. Berdasarkan moda kegagalan dominan *slack adjuster* di lapangan berupa keretakan akibat kelelahan material, *normalizing* ditetapkan sebagai perlakuan panas yang paling sesuai karena memberikan peningkatan ketangguhan yang bermakna tanpa penurunan kekerasan yang berarti.

Kata kunci: *slack adjuster*, besi cor nodular, perlakuan panas, *normalizing*, sifat mekanis

ABSTRACT

Scania dump truck slack adjusters made from ductile iron are prone to cracking caused by cyclic loading during operation. This study analyzes the effect of three heat treatment methods, namely Austempered Ductile Iron at 110°C (ADI-110°C), annealing, and normalizing, all using austenitization at 900°C for 60 minutes, on the mechanical properties of the material. Testing included chemical composition analysis, Brinell hardness, Ogoshi wear, Charpy impact, and microstructural analysis. ADI-110°C produced a predominantly martensitic matrix because the 110°C holding temperature falls below the Martensite Start line and the salt bath medium was in a solid state, yielding the highest hardness (576.6 BHN) and the lowest specific wear rate ($Ws = 1.960 \times 10^{-5} \text{ mm}^3/\text{kg}\cdot\text{m}$) but the lowest impact toughness (0.062 J/mm²). Annealing produced a ferritic matrix with the highest impact toughness (0.227 J/mm²) but the lowest hardness (153.0 BHN) and wear resistance ($Ws = 4.410 \times 10^{-5} \text{ mm}^3/\text{kg}\cdot\text{m}$). Normalizing produced a fine homogeneous pearlitic matrix with hardness equivalent to the raw material (246.2 BHN), a specific wear rate of $3.726 \times 10^{-5} \text{ mm}^3/\text{kg}\cdot\text{m}$, and impact toughness of 0.141 J/mm², representing a 22.6% improvement. A consistent positive correlation between hardness and wear resistance, and a negative correlation between hardness and toughness, were identified across all conditions. Based on the dominant field failure mode of fatigue cracking, normalizing is recommended as the most appropriate heat treatment, providing a meaningful improvement in impact toughness without significant hardness reduction.

Keywords: *slack adjuster, ductile iron, heat treatment, normalizing, mechanical properties*