Pengaruh Konsentrasi Nanopartikel dan Rasio Volume Quenchant/Material terhadap Performa Nanofluida berbasis Al2O3-Air sebagai Media Quench pada Perlakuan Panas Baja S45C = Effect of Nanoparticle Concentration and Quenchant/Material Volume Ratio on the Performance of Al2O3-Water-Based Nanofluids as Quenching Media in the Heat Treatment of S45C Steel

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Abstrak

Laju pendinginan baja selama proses quenching memiliki pengaruh signifikan terhadap mikrostruktur, sifat mekanik, dan kinerja keseluruhan dalam aplikasi industri. Penelitian ini bertujuan untuk mengkaji pengaruh konsentrasi nanopartikel alumina dan volume quenchant terhadap laju pendinginan baja S45C. Nanofluida disintesis dengan variasi konsentrasi nanopartikel alumina (0,1%, 0,3%, dan 0,5% w/v) dan volume (100 ml, 500 ml, dan 1000 ml), yang distabilkan menggunakan 3% w/v surfaktan SDBS. Stabilitas nanofluida dievaluasi melalui pengujian zeta potential. Disiapkan juga air suling dengan volume 100 ml, 500 ml, dan 1000 ml sebagai pembanding. Sampel baja yang digunakan berbentuk setengah silinder dengan diameter 1 inci dan tinggi 1 cm. Hasil penelitian menunjukkan bahwa volume quenchant yang lebih besar berkontribusi pada peningkatan laju pendinginan, di mana semakin besar volumenya, semakin cepat laju pendinginan yang dihasilkan. Namun, penambahan surfaktan sebanyak 3% w/v ditemukan tidak optimal untuk stabilitas nanofluida, yang mengakibatkan performa pendinginan lebih rendah dibandingkan fluida dasar, sehingga kekerasan akhir baja juga lebih rendah. Hal ini menunjukkan perbedaan signifikan dibandingkan literatur sebelumnya. Penelitian ini berkontribusi dalam pengembangan media pendingin inovatif yang mendukung efisiensi proses perlakuan panas dan keberlanjutan lingkungan.

.....The cooling rate of steel during quenching significantly affects its microstructure, mechanical properties, and overall performance in industrial applications. This study aims to investigate the influence of alumina nanoparticle concentration and quenchant volume on the cooling rate of S45C steel. Nanofluids were prepared with varying concentrations of alumina nanoparticles (0.1%, 0.3%, and 0.5% w/v) and volumes (100 ml, 500 ml, and 1000 ml), stabilized using 3% w/v SDBS surfactant. The stability of the nanofluids was evaluated through zeta potential testing. Distilled water with volumes of 100 ml, 500 ml and 1000 ml is also prepared as a comparison. The steel samples used were half-cylinder shaped, with a diameter of 1 inch and a height of 1 cm. The results indicate that larger quenchant volumes contribute to higher cooling rates, with increasing volume leading to faster cooling. However, the addition of 3% w/v surfactant was found to be suboptimal for nanofluid stability, resulting in lower cooling performance compared to the base fluid, which also led to lower final hardness of the steel. This finding contrasts with previous literature. This study contributes to the development of innovative cooling media that enhance the efficiency of heat treatment processes while supporting environmental sustainability.