

# Studi Pembentukan Fasa Dan Sifat Mekanik Baja Bainitik Fe-Ni Berbasis Laterit Hasil Canai Dingin Melalui Proses Austempering Dengan Variasi Media Pendingin = Study of Phase Formation and Mechanical Properties on Cold Rolled Bainitic Fe-Ni Lateritic Steel Through Austempering Process with Various Cooling Media

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## Abstrak

Penelitian ini bertujuan memperoleh parameter optimal variabel proses dalam menghasilkan baja bainit Fe-Ni dengan kekuatan mencapai 1400 MPa yang mengacu standar rel tipe R60. Penelitian dilakukan dengan memvariasikan kandungan Ni yaitu 0%, 1%, 2%, 3% dan 4% berat. Selanjutnya sampel baja dilakukan canai dingin dengan variasi reduksi 10%, 30%, 50% dan 70%. Proses pemanasan diawali dengan austenisasi pada suhu 945 °C selama 20 menit dan dilanjutkan proses austemper pada suhu 400 °C selama 30 menit kemudian didinginkan menggunakan dua jenis media pendingin yaitu air dan udara. Struktur mikro dari analisis metalografi menggunakan etsa warna menunjukkan fasa bainit mulai terbentuk pada sampel Fe-3Ni. Ukuran butir semakin kecil seiring peningkatan unsur Ni. Adanya unsur Si mampu menekan pembentukan sementit karbida dengan dibuktikan tidak adanya kemunculan karbida melalui analisis *Scanning Electron Microscopy* (SEM). Analisis fasa juga dilakukan menggunakan *X-Ray Diffraction* (XRD). Pengujian tarik menunjukkan nilai optimal diperoleh pada baja Fe-4Ni red.70% berpendingin udara dengan nilai mencapai 972 MPa. Nilai kekerasan juga mengalami peningkatan seiring peningkatan unsur Ni.

The purpose of this study is to obtain optimal parameters from each variable process in producing Fe-Ni bainite steel with the target tensile strength up to 1400 MPa that fulfill the R60 standard. The study was conducted by varying the Ni content in steel which is 0%, 1%, 2%, 3% and 4% wt. Furthermore, steel specimens were carried out through cold rolled with various reduction of 10%, 30%, 50%, and 70%. The heating process starts at 945° C for 20 minutes and followed by austempering at 400 ° C for 30 minutes then cooled using two types of cooling media namely water and air. The microstructure of metallographic by color etching showed that the bainite phase appears to form in Fe-3Ni specimens for all cooling media. Grain size gets smaller as the nickel content increases. There was no indication about the existence of cementite carbide as evidenced by Scanning Electron Microscopy (SEM) analysis. Phase analysis was also carried out using X-Ray Diffraction (XRD) for further information. Tensile testing shows that the optimal value was obtained in red.70% Fe-4Ni steel with air cooling that is 972 MPa. The hardness also increases as Ni content increase.

**Keywords:** Lateritic steel, austempering, cold rolling, nickel, mechanical properties, railroad