A NOVEL HEAT TREATMENT PROCESS

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Introduction

A novel concept of two-step austempering in a magnetic field has been conceived by this investigator. This two-step process involves first quenching the alloy to a lower temperature after austenitizing and then immediately rising the temperature of the quenching media to a higher temperature and the whole austempering process is carried out in the presence of a high magnetic field. In this investigation, Austempered Ductile Iron (ADI) was processed by this novel two-step austempering process in a high magnetic field of 20 teslas. The microstructure and the mechanical properties of the ADI processed in a magnetic field has been characterized and compared with ADI processed by conventional process.

Experimental

Ductile Cast Iron of conventional composition was cast in the form of round cylindrical bars. The as-cast material was predominantly (over 80%) pearlitic in nature. Cylindrical specimens for tensile tests, compact tests, & fracture toughness tests were prepared as per ASTM standards. Two batches of samples were prepared. One batch of samples (Batch A) was processed by the conventional single-step austempering process, and the second batch of samples (Batch B) was processed by the two-step austempering process in presence of a magnetic field. The Batch A were initially austenitized at 927°C (1700°F) for 2 hours and then austempered at 385°C (725°F) for 2 hours. The second batch of samples (Batch B) was also austenitized at 1700°F for 2 hours and then quenched to 260°C (500°F) in presence of a magnetic field. Immediately after that the temperature of the salt bath was raised to 725°F. These samples were then austempered at this temperature for 2 hours in the presence of a magnetic field of 20 teslas. This heat treatment was carried out in the National High Magnetic Field Laboratory in Tallahassee, Florida. The mechanical properties and microstructure of these samples were characterized.

Results and Discussion

Test results are reported in table 1. Test results show simultaneous improvement in mechanical properties for samples processed by magnetic austempering.

Table 1: X-ray analysis data & mechanical properties

Material Condition	Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	Strain Hardening Exponent	Fracture Toughness (MPa√m)	Volume fraction % ferrite	Volume fraction of Austenite	Carbon content of austenite (%)
Batch A Conventional austempering process	650	1080	0.10	60.5	63.9	36.1	1.92
Batch B Two-step austempering process (Magnetic field)	1250	1470	0.11	76.6	92.3	7.7	2.108

Conclusions

1. The two-step austempering process in a magnetic field has resulted in higher yield and tensile strength and hardness and fracture toughness compared to conventional austempering process in ADI.
2. This novel two-step austempering process in a magnetic field has resulted in finer ferrite and austenite and a larger volume fractions of ferrite in ADI.

The two-step austempering process in a magnetic field has resulted in simultaneous improvement in mechanical properties compared to conventional austempering process.