UNIVERSITI TEKNOLOGI MARA

AN IMPROVEMENT OF MECHANICAL PROPERTIES OF DUCTILE IRON AND NIOBIUM ALLOYED DUCTILE IRON THROUGH NEW HEAT TREATMENT CYCLES

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ABSTRACT

This research is focused three different heat treatments and they are austempering, tempering and a new heat treatment cycle of ductile iron and niobium alloyed ductile iron. The selection of all heat treatment parameters were based on TTT and CCT diagram which were simulated by JMart Pro Software. The microstructures were observed after etching with 2% Nital using light microscopy and Scanning Electron Microscope (SEM). The structures were verified by XRD analyses. The physical and mechanical tests were then evaluated through density measurement, Rockwell hardness (ASTM E18), Tensile (TS EN 10001-01) and Charpy impact (ASTM E23) tests. The fracture surfaces after tensile test and impact test samples were examined using Scanning Electron Microscope (SEM). The results showed improvement of 60% on tensile strength and 84% on impact toughness with addition of niobium into ductile iron. Superior mechanical properties were obtained after the new heat treatment cycle compared to austempering and tempering processes. This is due to the formation of fine ferrite platelets and lower bainitic structures and dimple rupture fractograph. It was also found that the tensile strength and impact toughness of austempered and tempered samples decreased with respect to longer holding times and higher heat treatment temperature. The development of the new heat treatment cycle in this research is successful in producing high strength materials. This treatment can easily be utilised in heat treatment industry compared with austempering process which required a special salt bath as quenching media.

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CHAPTER I

INTRODUCTION

1.1 Introduction

The history of ductile iron begins with discovery by Keith Millis in early 1943. Ductile iron is basically a type of cast iron which was modified by adding the magnesium in the cast iron composition thus resulted in change of its microstructure. The magnesium added lead to production of spheroidal graphite that gives ductile iron a unique characteristic compared to the conventional cast iron. Cast iron and it varieties are usually brittle but ductile iron in general are more flexible and elastic due to its nodular graphite inclusions. Ductile iron material had gained remarkable properties with the combination of good strength and toughness, better cast ability and ductility compared to grey cast iron.

Presently, ductile iron is widely used in engineering applications. The mechanical properties of ductile iron have been acknowledged from every aspect in the industry fields. The advantages of ductile iron have made it a very popular material amongst other type of cast iron. Ductile iron is widely use in the pipe productions. The pipes of ductile iron is much stronger, easy to tap, requires less support and provide greater flow area compared to pipe that are made from other materials, for examples, PVC, concrete, polyethylene, or steel. Additionally, other applications of ductile iron are in the production of automotive components where