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AMERICAN GEAR MANUFACTURERS ASSOCIATION

Austempered Ductile Iron for Gears

AGMA 939-A07

AGMA INFORMATION SHEET

(This Information Sheet is NOT an AGMA Standard)

American Gear Manufacturers Association

Austempered Ductile Iron for Gears
AGMA 939–A07

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Approved January 31, 2007

ABSTRACT

This information sheet gives the background and basic guidelines to consider the feasibility of austempered ductile iron (ADI) for gear applications. It contains experimental, experiential and anecdotal information to assist in the specification, purchase and manufacture of ADI components. The metallurgy of ADI, the relevant factors in its production, allowable stress numbers, and stress cycle curves are reviewed. It also has references, relevant standards, and evaluation methods used in the manufacture of ADI components.

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of AGMA 939−A07, *Austempered Ductile Iron for Gears*.]

In early 2004, members of the AGMA Helical Gear Rating Committee recognized the need to gather process and rating data for the use of austempered ductile iron (ADI) in gear applications. At that time, ADI was in use in a number of industries without standardized guidance for its use in gearing. Concurrent activities were taking place in the AGMA Mill Gearing Committee and in an ISO Technical Committee (TC 25/SC 2) for materials.

The first draft of AGMA 939−A07 was made in December, 2005. It was approved by the AGMA Technical Division Executive Committee in January, 2007.

Suggestions for improvement of this standard will be welcome. They should be sent to the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314.

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American Gear Manufacturers Association –

Austempered Ductile Iron for Gears

1 Scope

This information sheet is designed to familiarize the gear designer with austempered ductile iron and, in particular, its use in gears and power train components. It covers the areas of designing, purchasing, specifying and verifying the material for the application.

1.1 Introduction

Austempered ductile iron (ADI) is produced by heat treating ductile iron (also known as nodular iron or spheroidal graphite, SG, iron), using the austempering process, as described in clause 5. Austempering is a specialized, isothermal heat treatment. When compared to conventional ductile iron, ADI can have over twice the strength for a given level of ductility. ADI can have fatigue strength comparable to that of cast and forged steels. ADI's strength can be greatly enhanced by subsequent grinding, fillet rolling or shot peening.

Although the first commercial application of ADI did not occur until 1972, the material has found applications in many industrial market segments. Its principal attribute is its high strength–to–weight ratio, allowing it to replace steel forgings, castings and weldments at equal, or lesser weight and reduced cost. ADI gears can be found in everything from diesel engines to wind turbines.

The numeric values in this information sheet are intended to be used with ANSI/AGMA 2101–D04 only. Use in other standards should be carefully reviewed.

1.2 Attributes

ADI components can be machined in the as–cast condition (before austempering); partially machined, austempered and then finish machined; or, in some cases, machined complete after austempering. The ausferrite matrix in ADI (a matrix of acicular ferrite and carbon stabilized austenite) undergoes a strain transformation hardening when exposed to a high normal force. This same strain transformation hardening is what gives ADI wear resistance better than its bulk hardness would indicate. The effect makes machining of ADI challenging, but knowledge of this effect allows the machinist to adjust the feeds, speeds, coolant and tool angles to adequately compensate.

Other attributes of the material include good noise dampening, fracture toughness, low temperature properties, and reasonable stiffness. Because most ADI gears are produced from engineered, cast blanks, they can be nearer net shape than those produced of bar stock and can have cast–in design features.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of this information sheet. At the time of publication, the editions were valid. All publications are subject to revision, and the users of this information sheet are encouraged to investigate the possibility of applying the most recent editions of the publications listed.

ANSI/AGMA 1012–G05*, Gear Nomenclature, Definition of Terms with Symbols*

ANSI/AGMA 2101–D04, *Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth*

ANSI/AGMA 6114–A06, *Gear Power Rating for Cylindrical Shell and Trunnion Supported Equipments*

ASTM A247–06, *Standard Test Method for Evaluating the Microstructure of Graphite in Iron Castings*

ASTM A536–04, *Standard Specification for Ductile Iron Castings*

ASTM A897/A897M:2006, *Standard Specification for Austempered Ductile Iron Castings*

ASTM E562–02, *Standard Test Method for Determining Volume Fraction by Systematic, Manual Point Count*