AMERICAN GEAR MANUFACTURERS ASSOCIATION

Mechanisms of Gear Tooth Failures

AGMA 912-A04

AGMA INFORMATION SHEET

(This Information Sheet is NOT an AGMA Standard)

American Gear Manufacturers Association

Mechanisms of Gear Tooth Failures
AGMA 912–A04

Approved October 23, 2004

ABSTRACT

This information sheet describes many of the ways in which gear teeth can fail and recommends methods for reducing gear failures. It provides basic guidance for those attempting to analyze gear failures. It should be used in conjunction with ANSI/AGMA 1010–E95 in which the gear tooth failure modes are defined. They are described in detail to help investigators understand failures and investigate remedies. This information sheet does not discuss the details of disciplines such as dynamics, material science, corrosion or tribology. It is hoped that the material presented will facilitate communication in the investigation of gear operating problems.

Published by

American Gear Manufacturers Association
500 Montgomery Street, Suite 350, Alexandria, Virginia 22314

Printed in the United States of America

ISBN: 1–55589–838–6

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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 Information Sheet 912–A04, *Mechanisms of Gear Tooth Failures*.]

AGMA Standard 110.01 was first published in October 1943 as means to document the appearance of gear teeth when they wear or fail. The study of gear tooth wear and failure has been hampered by the inability of two observers to describe the same phenomenon in terms that are adequate to assure uniform interpretation. AGMA Standard 110.02 became a national standard, B6.12, in 1954. A revised standard with photographs, AGMA 110.03, was published in 1960. The last version, AGMA 110.04, was published in 1979 and reaffirmed by the members in 1989, with improved photographs and additional material.

ANSI/AGMA 1010–E95, approved December 1995, is a revision of AGMA 110.04. It provides a common language to describe gear wear and failure, and serves as a guide to uniformity and consistency in the use of that language. It describes the appearance of gear tooth failure modes and discusses their mechanisms, with the sole intent of facilitating identification of gear wear and failure. Since there may be many different causes for each type of gear tooth wear or failure mode, it does not standardize cause, nor prescribe remedies.

AGMA 912–A04 was developed to compliment ANSI/AGMA 1010–E95 with some information on probable cause and recommendations for remedies. Gear design and failure analysis are both art and science. To design gears, the gear engineer needs analytical tools, plus practical field experience. Gear failures can be a part of this experience. They can provide valuable information and their correct analysis can help find the correct remedy to reduce future problems.

The first draft of AGMA 912–A04 was developed in October, 1995. It was approved by the AGMA membership on October 23, 2004.

Suggestions for improvement of this document 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 –

Mechanisms of Gear Tooth Failures

1 Scope

This information sheet describes many of the ways in which gear teeth can fail and recommends methods for reducing gear failures. It provides basic guidance for those attempting to analyze gear failures. The information sheet should be used in conjunction with ANSI/AGMA 1010–E95 in which the gear tooth failure modes are defined. Similar definitions can also be found in ISO 10825. They are described in detail to help investigators understand failures and investigate remedies.

The information presented in this document applies to spur and helical gears. However, with some exceptions the information also applies to bevel, worm and hypoid gears. Discussion of material properties is primarily restricted to steel.

1.1 System investigations

Gear system dynamic problems are beyond the scope of this information sheet. However, it is important to recognize that many gear failures are influenced by problems with the gear system, such as high loads caused by vibration. When investigating gear failures, it is necessary to consider that the cause may stem from a problem with the system rather than the gears.

1.2 Analysis by specialists

It is not the intent of this information sheet to discuss the details of disciplines such as dynamics, material science, corrosion or tribology. It is hoped that the material presented will facilitate communication in the investigation of gear problems.

2 Normative references

The following standards contain provisions which are referenced in the text of this information sheet. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the standards indicated.

ANSI/AGMA 1010–E95, *Appearance of Gear Teeth – Terminology of Wear and Failure*

ISO 10825:1995, *Gears – Wear and damage to gear teeth – Terminology*

3 Analysis

3.1 Failure experience

Gear design is both an art and a science. To design better gears, the gear engineer needs good analytical tools plus practical field experience. Gear failures are a part of this experience because they provide valuable information about the multitude of failure modes that can occur. Gear failures should be analyzed to identify the failure mode, and attempt to determine the cause of the failure. Failure analysis can help to find the correct remedy to reduce future problems.

3.2 Quantitative analysis

Gear “failure” is frequently subjective. For example, a person observing gear teeth that have a bright, mirror finish may think that the gears have “run–in” nicely. However, another observer may believe that the gears are wearing by polishing. Whether the gears should be considered usable or not depends on how much wear is tolerable. The gears might be unusable if the wear causes excessive noise or vibration. But the word “excessive” in itself is subjective, and some measure of gear accuracy, noise or vibration can be used to resolve whether the gears are usable. Some failures are more obvious, such as when several gear teeth fracture and the transmission of power ceases. In these cases the gears have failed. However, there may not be agreement on the cause of the failure (failure mode). To find the basic cause or causes of a failure, one