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American Gear Manufacturers Association

Technical Resources

American National Standard

Tooth Proportions for Plastic Gears

ANSI/AGMA 1006-A97

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Tooth Proportions for Plastic Gears
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ABSTRACT

This standard presents a new basic rack, AGMA PT, which, with its full round fillet, may be preferred in many applications of gears made from plastic materials. It also explains and illustrates the general concept of the basic rack. It contains a description, with equations and sample calculations, of how the proportions of a spur or helical gear may be derived from the design tooth thickness and the basic rack data. These equations and calculations use traditional AGMA symbols and inch units. In several annexes, there are discussions of possible variations from this basic rack and also a procedure for defining tooth proportions without using the basic rack concept.

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Foreword

[The foreword, footnotes, and annexes are provided for informational purposes only and should not be construed as a part of ANSI/AGMA 1006-A97, *Tooth Proportions for Plastic Gears.*]

AGMA has issued standards for gear tooth proportions over a period of many years. The most recent versions have been AGMA 201.02 (withdrawn 1995), *Tooth Proportions for Coarse-Pitch Involute Spur Gears*, and ANSI/AGMA 1003-G93, *Tooth Proportions for Fine-Pitch Involute Spur and Helical Gears*. These standards and their predecessors were prepared in response to the need to standardize gear generating cutting tools such as hobs and shaper cutters. Without such standards, the variety of tools needed by gear shops would have become unlimited.

The manufacture of gears by the molding process is not subject to the same practical constraints as manufacture by the gear cutting process. Every mold is inherently "non-standard". The geometry of the mold cavity cannot follow a standard because of varying allowances for shrinkage. Furthermore, there are some methods for manufacturing the mold cavity which do not depend on cutting tools and, even for those that do, special tools are generally required. Thus, tooth proportions for molded plastic gears need not follow those established for machined gears.

Some of the special properties of plastic materials influence the selection of gear tooth proportions as the two following examples illustrate:

- The structure and orientation of plastic molecules, regardless of processing method, makes the strengths of the materials particularly sensitive to sharp internal corners. A substantially stronger tooth will result if sharp fillets at the base of the tooth are avoided. The tooth proportions for gears made according to the AGMA fine-pitch standard noted above generally result in relatively sharp fillets.

- In certain applications, the higher expansion properties of plastic materials may create the need for a greater depth of engagement between mating gears than permitted by the other standard tooth forms.

As a result of this preference for a different tooth form, members of the plastic gear molding industry have adopted their own individual sets of tooth proportions. One set that has gained wide usage by plastic gear designers, and is often specified in place of the AGMA Fine-Pitch Standard, has been developed by William McKinley [1]. Because these tooth forms contain the preferential features for molded plastic gears and because they are already well recognized in the industry, they were used, with some changes, as models in the preparation of this standard. The first of the four variations in this set has a depth of engagement, or working depth, that is the same as in the above mentioned AGMA standards. The other three have increased depths of engagement in varying degrees. This standard has selected only the first variation, which is the one in widest use, as the model for the new tooth proportions. However, data similarly based on the other three variations are included in annex B.

The tooth forms in this standard are defined with the use of the basic rack concept. For those that might be unfamiliar with this concept, a detailed description of the basic rack is included as annex A.

Suggestions for improvement of this standard will be welcome. They should be sent to the American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, Virginia 22314.

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American National Standard –

Tooth Proportions for Plastic Gears

1 Scope

1.1 Basic rack

This standard defines a basic rack for spur and helical plastic gears. However, the specific basic rack can be applied to any type of gear which employs the basic rack concept to help define its geometry.

> **NOTE:** This basic rack is an optional alternative to other AGMA basic racks. It will often be preferred for those applications in which tooth bending strength is a major factor in the design of plastic gears.

A detailed description of the basic rack concept, including its features and its application to various types of gears, is given in annex A.

The data for three other basic racks, differing primarily in depth of engagement, are given in annex B.

1.2 Gear tooth proportions

This standard shows how basic rack dimensions determine the tooth proportions of the gear once the tooth thickness has been established. Specific values of the gear tooth thickness and the resulting gear tooth proportions are not covered by this standard. However, many of the considerations that go into such a selection are discussed in annex C.

The tip relief from a modified basic rack is discussed in annex D.

1.3 Non–traditional practices for defining tooth proportions

Annexes E and F describe some non–traditional practices currently used to help achieve gear designs that are optimum for their applications. Their use with molded plastic gears has been made more convenient by modern methods of mold cavity manufacture. These practices include modifying standard basic racks, creating custom designed basic racks, and designing tooth proportions without reference to basic racks. In the annexes, the description of each method is accompanied by potential advantages and design cautions. An example of one procedure for the last method, designing without reference to basic racks, is presented in annex F.

2 Definitions and symbols

2.1 Definitions

The terms used in this standard conform to ANSI/AGMA 1012–F90, *Gear Nomenclature, Definition of Terms with Symbols*.

Terms used in this standard which require elaboration and concepts which are specific to plastic gears are covered where they are first used.

2.2 Symbols

The symbols used in the tables and formulas are shown in table 1.

> **NOTE:** The symbols and definitions used in this standard may differ from similar items in other AGMA standards. The user should not assume that familiar symbols can be used without a careful study of these definitions.

Table 1 – Nomenclature: symbols and terms

Symbol	Term	First Used
a_{BR}	Addendum of basic rack	Figure 1
a_{TBR}	Effective addendum of the basic rack (distance from pitch line to start of the circular–arc tip modification)	Figure 2
b_{BR}	Dedendum of basic rack	Figure 1

(continued)