



## **AGMA Technical Paper**

# Involute Spiral Face Couplings and Gears: Design Approach and Manufacturing Technique

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# Involute Spiral Face Couplings and Gears: Design Approach and Manufacturing Technique

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

## Abstract

Face gears typically have a straight or skewed tooth line and varying tooth profile in normal cross section at different radii from major to minor diameter. These face gears are engaged with spur or helical involute pinions at intersecting or crossed axes.

This paper presents spiral face gears with an involute tooth line and an identical tooth profile in the normal section at any radius. There are two main applications for such face gears. One of them is an alternative solution with certain advantages in performance and fabrication technology to the straight tooth, Hirth, or Curvic flange couplings. Another application is when a face gear is engaged with an involute helical pinion or worm at intersecting or crossed axes.

Potential advantages of spiral face couplings and gears include high power transmission density and highly productive machining of face spiral gears.

The paper describes gear geometry analysis, and design technique of spiral face involute gears with symmetric and asymmetric tooth profiles. It also explains a hobbing method of these gears and tool design specifics, and then illustrates gear and tool design with numerical examples.

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## Introduction

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## Geometry of involute spiral face gears

Spiral angle at some reference diameter  $d > d_b$  is:

$$\beta = \arccos\left(\frac{d_b}{c}\right) \quad (1)$$

Unlike conventional spur or helical gears that have involute tooth flank profiles and straight or helical tooth lines, these spiral face gears have straight tooth flank profiles in the normal section and the involute tooth line.

Any tangent to the base cylinder diameter  $d_b$  is normal to the involute tooth line section of the spiral face gear presenting a straight flank gear rack (see Figure 1, Section A-A). The spiral face gear tooth parameters and its root fillet profile can be optimized using Direct Gear Design optimization technique [1] to amplify load capacity by increasing tooth surface durability and minimizing bending stress concentration.

## Involute spiral face machining

Since any normal to the involute tooth line section of the spiral face gear presents a straight flank gear rack, a gear hob can be used in manufacturing. Thus a spiral face gear per this design can be hobbled with the same accuracy as spur and helical gears utilizing conventional hobbing equipment.

Schematics of spiral face gear hobbing are shown in Figures 2 and 3.

Hobbing center distance “a” is:

$$a = \frac{d_b}{2 \cos(\beta)} \cos(\beta \pm \gamma) \quad (2)$$

Where the “+” sign if the spiral gear and hob have opposite hands left-right (Figure 2) or right-left, the “-” sign if the spiral gear and hob have the same hands right-right (Figure 3) or left-left.

The normal section of the spiral gear tooth profile is an impression of the hob tooth profile in normal section (Figure 2, Section A-A).