

Main Advantages of Non-Involute Spur Gears:

The Design of Non-Involute Spur Gears to Improve the
Condition of Contact

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American Gear Manufacturers Association



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ABSTRACT:

The main cause for the limitation of gear durability in highly loaded and high speed working gears is scuffing. The principal way to avoid scuffing of tooth flanks is an oil-film of sufficient thickness between the mating flanks. In the calculation rules for the oil-film thickness and surface durability, the curvature radius and sliding velocities affect decisively the forming of the oil-film between the flanks. Both the curvature radius and the sliding velocity depend on the shape of the tooth flanks. By shaping the line of action properly, better gear flank shapes can be achieved, thus implying improved durability. In this paper the tooth shapes, generated by a progressive crooked path of contact, will be shown and discussed.

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MAIN ADVANTAGES OF NON-INVOLUTE SPUR GEARS

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INTRODUCTION

There exist many types of non-involute gear shapes, but this paper will observe only such kind of non-involute gears where the path of contact is given in advance. Besides this it is also required that all types of gears, being of the same size of module, could be manufactured by the same tools and by the common types of gears manufacturing methods, of course, using adequate tool profiles.

According to previous research work we know that, by using a concave type of path of contact, we could manufacture gears where the tooth flanks fit better together (1). These kinds of gears prove theoretically much better tooth flanks contact conditions, better lubrication conditions, and a greater resistance to scuffing. We also attained some positive results for non-involute gears in working conditions practice.

MODE OF DEFINING THE TOOTH FLANKS IN CASE THAT THE PATH OF CONTACT IS DETERMINED IN ADVANCE

In spite of the fact that this procedure was published a long time ago (2), we will explain it shortly again.

For each spot "P" on a defined path of contact (Fig. 1), a radius of curvature of addendum ρ_E , a radius of curvature of dedendum ρ_F , and a radius of curvature of rack ρ_0 can be defined by using a special rule (3). The point Q means the pole of the velocity for a stick $\overline{PC}$, if one end (P) of it moves along the path of contact, and simultaneously the other end glides through the pitch point C.

Centers of curvatures S_H , S_F , and S_0 are determined by the intersection of straight line $\overline{PC} - \overline{O_1Q}$, $\overline{PC} - \overline{O_2Q}$, and $\overline{PC} - \overline{\infty Q}$. If all curvature centers are situated on the same side to the point P, a concave - convex shape of tooth flanks has to be done (see Fig. 1).

If we observe the two adjacent points on the path of contact, point P_i and P_{i+1} (Fig. 2a) we find out that to each of them belongs a radius of curvature ρ_{0i} and $\rho_{0(i+1)}$, and that these radii form an angle $\Delta\alpha_i$. We presume that point I_i on the tooth flank of the rack is known and the next point I_{i+1} could be found, if the involute of the tooth shape $S_{0i}S_{0i}^{i+1}$ is replaced by an arc. The radius of this arc could be calculated by the known length of the arc $\Delta s_0 = \rho_{0(i+1)} - \rho_{0i}$ and by the known angle $\Delta\alpha_i$. The center of curvature S_0^{i+1} is situated at the end of the arc Δs_0 . The next point of the rack I_{i+1} will be defined by the intersection of radius $\rho_{0(i+1)}$ and a parallel to the x-axis through P_{i+1} .

In a similar way we define the neighboring point on the dedendum (Fig. 2b). The angle of involute differs for minus $\Delta\varphi = \Delta x/R_{01}$ in this case. The neighboring point on the addendum (Fig. 2c) is defined in the same way, differing again in the angle of involute, which must be greater by $\Delta\varphi = \Delta x/R_{02}$, now.

Angle α_C , and the reduced radius of curvature at pitch point C could always be calculated (4). Starting from this point, we are able to define all points on the tooth flanks (addendum, dedendum and rack), relating to points P_i on the path of contact. For this procedure a computer program could be made.