Int J Adv Manuf Technol (2004) 24: 789–793
DOI 10.1007/s00170-003-1741-8

ORIGINAL ARTICLE

Feng Xianying · Wang Aiqun · Linda Lee

Study on the design principle of the LogiX gear tooth profile and the selection of its inherent basic parameters

Received: 2 January 2003 / Accepted: 3 March 2003 / Published online: 3 November 2004

Abstract The development of scientific technology and productivity has called for increasingly higher requirements of gear transmission performance. The key factor influencing dynamic gear performance is the form of the meshed gear tooth profile. To improve a gear's transmission performance, a new type of gear called the *LogiX* gear was developed in the early 1990s. However, for this special kind of gear there remain many unknown theoretical and practical problems to be solved. In this paper, the design principle of this new type of gear is further studied and the mathematical module of its tooth profile deduced. The influence on the form of this type of tooth profile and its mesh performance by its inherent basic parameters is discussed, and reasonable selections for LogiX gear parameters are provided. Thus the theoretical system information about the LogiX gear are developed and enriched. This study impacts most significantly the improvement of load capacity, miniaturisation and durability of modern kinetic transmission products.

Keywords Basic parameter · Design principle · LogiX gear · Minute involute · Tooth profile

1 Introduction

In order to improve gear transmission performance and satisfy some special requirements, a new type of gear [1] was put forward; it was named "LogiX" in order to improve some demerits of W-N (Wildhaver-Novikov) and involute gears.

Besides having the advantages of both kinds of gears mentioned above, the new type of gear has some other excellent characteristics. On this new tooth profile, the continuous concave/convex contact is carried out from its dedendum to its addendum, where the engagements with a relative curvature of zero are assured at many points. Here, this kind of point is called the null-point (N-P). The presence of many N-Ps during the mesh process of LogiX gears can result in a smaller sliding coefficient, and the mesh transmission performance becomes almost rolling friction accordingly. Thus this new type of gear has many advantages such as higher contact intensity, longer life and a larger transmission-ratio power transfer than the standard involute gear. Experimental results showed that, given a certain number of N-Ps between two meshed LogiX gears, the contact fatigue strength is 3 times and the bend fatigue strength 2.5 times larger than those of the standard involute gear. Moreover, the minimum tooth number can also be decreased to 3, much smaller than that of the standard involute gear.

The LogiX gear, regarded as a new type of gear, still presents some unsolved problems. The development of computer numerical controlling (CNC) technology must also be taken into consideration new high-efficiency methods to cut this new type of gear. Therefore, further study of this new type of gear most significantly impacts the acceleration of its broad and practical application. This paper has the potential to usher in a new era in the history of gear mesh theory and application.

F. Xianying (✉) · W. Aiqun
School of Mechanical Engineering,
Shandong University,
P.R. China
E-mail: FXYing@sdu.edu.cn
Tel.: +86-531-8395852(0)

L. Lee
School of Mechanical & Manufacturing Engineering,
Singapore Polytechnic,
Singapore

2 Design principle of LogiX tooth profile

According to gear mesh and manufacturing theories, in order to simplify problem analysis, generally a gear's basic rack is begun with some studies [2]. So here let us discuss the basic rack of the LogiX gear first. Figure 1 shows the design principle of divided involute curves of the LogiX rack. In Fig. 1, $P.L$ represents a pitch line of the LogiX rack. One point O_1 is selected to form the angle $\bullet n_0 O_1 N_1 = \alpha_0$, $P.L \bullet O_1 N_1$. The points of intersection by two radials $O_1 n_0$ and $O_1 N_1$ and the pitch line $P.L$ are N_1 and n_0. Let $O_1 n_0 = G_1$, extend $O_1 n_0$ to $O_1^{'}$, and make two tangent basic circles whose centres are O_1, $O_1^{'}$ and radii are equal to G_1.. The point of intersection between circle O_1 and pitch line

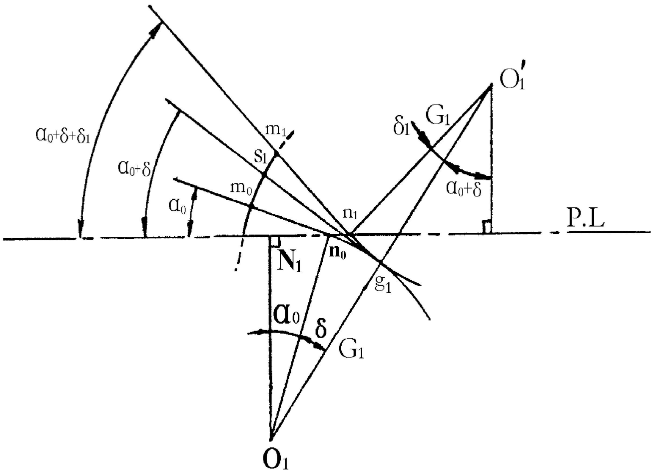


Fig. 1. Design principle of LogiX rack tooth profile

$P.L$ is n_0. The point of intersection between circle O_2 and pitch line $P.L$ is n_1. Make the common tangent g_1s_1 of basic circle O_1 and O_1', then generate two minute involute curves m_0s_1 and s_1m_1 whose basic circle centres are O_1 and O_1'. The radii of curvature at points m_0 and m_1 on the tooth profile should be: $\rho_{m0} = m_0n_0$, $\rho_{m1} = m_1n_1$, and the centres are met on the pitch line.

Multiple different minute involutes consisting of a LogiX profile should be arranged for a proper sequence. The pressure angle of the next minute involute curve m_1m_2 should have an increment comparable to its last segment m_0m_1. The centres of curvature at extreme points m_1, m_2, etc. should be on the pitch line, and the radius of the basic circle is a function of pressure [1] – it varies from G_1 to G_2. The condition for joining front and rear curves is that the radius of curvature at point m_1 must be equal to the radius of curvature just after point m_1, and the radius of curvature at point m_2 must be equal to the radius of curvature just after point m_2. Figure 2 shows the connection and process of generating minute involute curves. According to the above discussion, the whole tooth profile can be formed.

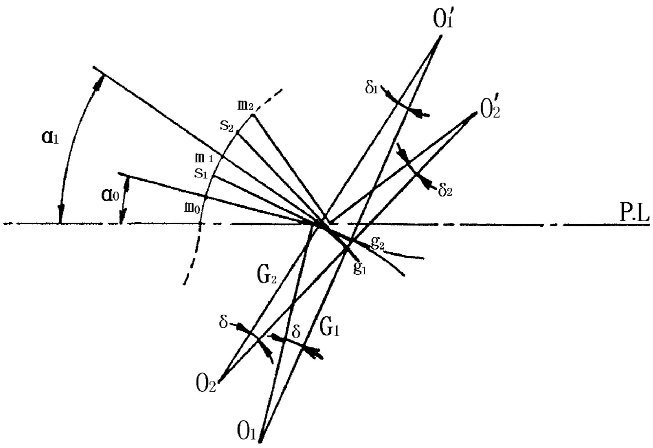


Fig. 2. Connection of minute involute curves

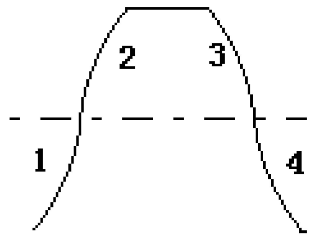
3 Mathematic module of LogiX tooth profile

3.1 Mathematic module of the basic LogiX rack

According to the above-mentioned design principle, the curvature centre of every finely divided profile curve should be located at the rack pitch line, and the value of the relative curvature at every point connecting different minute involute curves should be zero. The design of the tooth profile is symmetrical with respect to the pitch line, and the addendum is convex while the dedendum is concave. Thus for the whole LogiX tooth profile, it can be dealt with by dividing it into four parts, as shown in Fig. 3. Set up the coordinates as shown in Fig. 4, where the origin of the coordinates O coincides with the point of intersection m_0 between rack pitch line $P.L$ and the initial divided minute involute curve.

According to the coordinates set up in Fig. 4, the formation of initial minute involute curve m_0m_1 is shown in Fig. 5.

Fig. 3. LogiX rack tooth profile



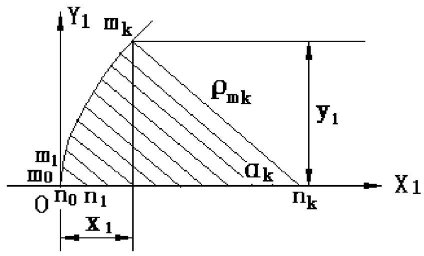


Fig. 4. Set-up of coordinates

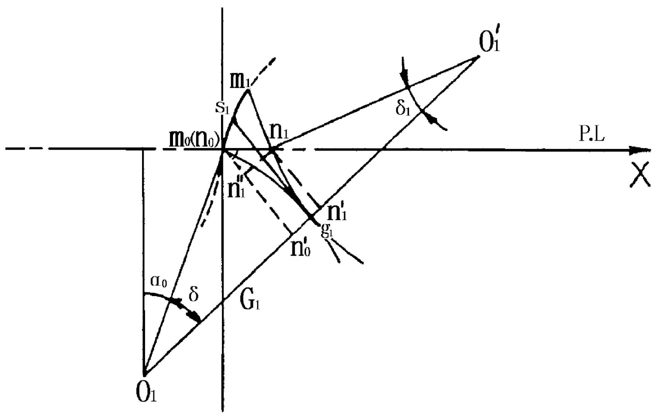


Fig. 5. Formation process of initial minute involute curve m_0m_1