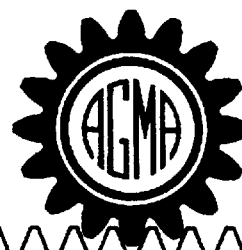


95FTM10

Efficiency of High Contact Ratio Planetary Gear Trains

by: John Colbourne, University of Alberta

American Gear Manufacturers Association



TECHNICAL PAPER

AVA Documents
Document Sharing Hub

Efficiency of High Contact Ratio Planetary Gear Trains

John Colbourne, University of Alberta

[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

A method is described for calculating the efficiency of planetary gear trains, and as an example the method is applied to the case of a fixed differential gear train.

Copyright © 1995

American Gear Manufacturers Association
1500 King Street, Suite 201
Alexandria, Virginia, 22314

October, 1995

ISBN: 1-55589-659-6

EFFICIENCY OF HIGH CONTACT RATIO PLANETARY GEAR TRAINS

John R. Colbourne
Department of Mechanical Engineering
University of Alberta
Edmonton, Alberta, Canada T6G 2G8

Abstract

A method is described for calculating the efficiency of planetary gear trains, and as an example the method is applied to the case of a fixed differential gear train.

Introduction

Efficiency calculations for planetary gear trains fall into two parts. First, we find the tooth meshing efficiency of gear pairs with fixed centers. Next, these efficiencies are used in the calculation of the overall efficiency of the planetary gear train. In this paper, a small improvement is suggested in the commonly used method for calculating the tooth meshing efficiency. An alternative method is described for gear pairs with high contact ratios, which will be discussed later in the paper. Then a method is presented for calculating the efficiency of planetary gear trains, based on the dynamic equilibrium of the planet, and taking into account the frictional tooth force components.

Coefficient of Friction

It is generally agreed that the effect of friction in meshing gears can be approximated by using a constant coefficient of friction. The value of the coefficient depends on the oil viscosity, the load intensity and the pitch line velocity. Expressions are given in AGMA 6023-A88 [1] for

calculating the coefficient of friction, and these give values that range from 0.02 at low load intensity and high pitch line velocity, to 0.06 at high load intensity and low pitch line velocity. In Chapter 12 of Dudley's Gear Handbook [2], Shipley presents a table of coefficient of friction values measured by Ohlendorf and Winter [3]. The values range from 0.03 to 0.07, and Shipley uses the value 0.05 for his examples.

Efficiency of Gear Pairs with Fixed Centers

The method described by Shipley for calculating the efficiency of a gear pair with fixed centers is the same method used earlier by Buckingham [4] and Tuplin [5]. The path of contact shown in Figure 1 extends from point T2 to T1. We use a coordinate s measured along the contact path from the pitch point, so that points above and below the line of centers have positive and negative coordinate values, and the length of the path of contact is then $(s^{T1} - s^{T2})$. If we assume a constant tooth force W , the useful work done by one meshing tooth pair is equal to the force multiplied by the distance through which it acts,

$$\text{Work} = W (s^{T1} - s^{T2}) \quad (1)$$

The sliding velocity v_s [6] is given by

$$v_s = s (\omega_1 - \omega_2) \quad (2)$$