Mechanism and Machine Theory 126 (2018) 491–513

Contents lists available at ScienceDirect

Mechanism and Machine Theory

journal homepage: www.elsevier.com/locate/mechmachtheory

Research paper

Evolution of balanced root stress and tribological properties in high contact ratio spur gear drive

R. Ravivarman[a,*], K. Palaniradja[a], R. Prabhu Sekar[b]

[a] Department of Mechanical Engineering, Pondicherry Engineering College, Puducherry 605 014, India
[b] Department of Mechanical Engineering, Motilal Nehru National Institute of Technology Allahabad, Allahabad, Uttar Pradesh 211004, India

ARTICLE INFO

Article history:
Received 14 December 2017
Revised 7 March 2018
Accepted 4 April 2018

Keywords:
Contact stress
EHL film thickness
Non-standard HCR
Rack cutter tooth thickness
Root stress
Tooth wear

ABSTRACT

Tooth bending and surface wear are the two major causes of failure modes which occur due to inadequate bending and contact strength. In a gear drive, when the gear ratio is more than one the bending strength of the pinion and gear it is different. Consequently gear drive with an equivalent bending strength in the gear and pinion is called as a balanced gear drive. This can be attained by providing non-standard tooth thickness at the pitch circle in High Contact Ratio (HCR) spur gears. Non-standard HCR spur gear drive is one in which the tooth thickness at the pitch circle of the gear and pinion is not same. In the present study, tooth wear over the contacting surfaces for non-standard HCR spur gear drive is probed numerically through finite element analysis (FEA). In addition, the tooth load, contact stress, film thickness and sliding distance are also estimated for a balanced non-standard HCR spur gear drive. Also the effect of different gear parameters like pinion teeth number, pressure angle, addendum height and gear ratio on tooth wear along the line of action on non-standard HCR spur gear has been evaluated and discussed.
© 2018 Elsevier Ltd. All rights reserved.

1. Introduction

In power transmission, gears are most essential parts of a machine for many applications in aerospace, automobiles and industrial machineries. In the transmission of power, spur gears are used to transfer power among the parallel shafts. The modern power transmission drives demand high load transport capacity, high strength to weightiness ratio, reduced noise and vibration with compactness in size. Due to this competitive industrial market HCR gears have high reputation. Employing the HCR gear is a substantial method of reducing vibration, shock and noise, thereby improving the performance [1,2]. The effectiveness of these extremely efficient machine drives depend upon the working of the tooth gearings. Performance criteria for tooth gearings are based on the bending strength, contact strength, scoring and tooth wear of operational surfaces. The wear is termed as a loss of tooth material in the form of particles from the surfaces which are in contact at the time of engagement. Gradual increase in teeth wear results in rubbing of surfaces [3] which are in contact while meshing with each other [4]. The varying rolling-sliding action will result in non-uniform wear in the gear flanks [5]. Excessive wear

Abbreviations: BTEP, beginning of teeth engagement point; BFDTEP, beginning of first double tooth engagement point; BSDTEP, beginning of second double tooth engagement point; EFDTEP, ending of first double tooth engagement point; EHL, elasto hydrodynamic Lubrication; ESDTEP, ending of second double tooth engagement point; ETEP, ending of tooth engagement point; FEA, finite element analysis; FEM, finite element model; HCR, high contact ratio; NCR, normal contact ratio.

* Corresponding author.
E-mail addresses: varman92@pec.edu (R. Ravivarman), palaniradja72@pec.edu (K. Palaniradja), rprabhusekar@mnnit.ac.in (R.P. Sekar).

https://doi.org/10.1016/j.mechmachtheory.2018.04.025
0094-114X/© 2018 Elsevier Ltd. All rights reserved.

Nomenclature

AF	length of line of action in mm
E	modulus of rigidity in GPa
F	load in N
G	material parameter
H	material hardness
J	wear coefficient
K	ellipticity factor
L	load parameter
N	speed in rpm
R	radius of curvature in mm
S	RMS composite roughness factor
SR	slide to roll ratio
T	input torque in Nm
U	speed parameter
V	volume of the worn out material in m^3
X	distance between the engagement point and pitch point in mm
a_o	center distance in mm
a_i	semi contact width at any instant engagement point in mm
b	face width in mm
h	height in mm
i	gear ratio
k	tooth thickness factor
m	module in mm
p	pitch in mm
r	radius in mm
s	sliding distance in mm
t	tooth thickness in mm
v	velocity in m/s
w	tooth wear in mm
z	number of teeth

Symbols

γ_o	absolute viscosity of the lubricant in Pa s
θ	angle of half tooth thickness in pinion in degree
ω	angular velocity in rad/s
ε	contact ratio
σ_s	contact stress in MPa
φ_L	EHL film thickness in m
μ	friction coefficient
ν	Poission's ratio
α	pressure angle in degree
ρ	pressure viscosity coefficient of the lubricant in (1/Pa)

Subscripts

N	normal direction of tooth surface
a	addendum
ar	addendum rack cutter
b	base circle
c	cutter tip
e	entraining
f	dedendum
fr	dedendum rack cutter
g	gear
gr	rack cutter for gear
i	instant engagement point
max	maximum
n	number of meshing cycle

Download English Version:

https://daneshyari.com/en/article/7179108

Download Persian Version:

https://daneshyari.com/article/7179108

Daneshyari.com