Planetary Gear Sets Power Loss Modeling: Application to Wind Turbines

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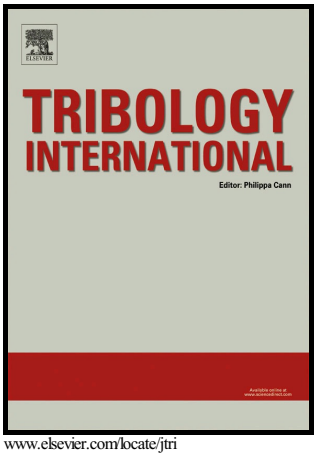

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Title: **Planetary Gear Sets Power Loss Modeling: Application to Wind Turbines**

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Abstract

Power losses in any geared-transmission can be attributed to gear-mesh and bearing-contact frictional effects and the interaction of rolling element bearings and gears with the lubricating medium. In this paper, a composite power loss model combining a non-uniform load distribution model with a local friction coefficient at any point of contact and oil drag formulations has been developed. A design sensitivity study has been carried out that examines how the design parameters of planetary gear sets and bearings and lubricant properties influence performance. The accuracy of these models was assessed by comparing predicted results to published measured values taken from planetary gear sets and parallel axis gear set experiments.

Keywords: Planetary gears, non-uniform load, power loss, wind turbine lubricant

Nomenclature

A	Area, mm^2
B	Bearing width, mm
b_i	Face width of gear, mm
d	Bearing inner diameter, mm
D	Bearing outer diameter, mm
d_m	Bearing mean diameter, mm
Er	Modulus of elasticity, MPa
F_r	Radial load, N
F_a	Axial load, N
F_n	Normal load, N
$\tilde{F}_r$	Elemental isothermal rolling force, N
F_{bt}	Circumferential force on base circle, N
$\tilde{G}$	Material parameter (-)
G_{rr}	Rolling friction variable, (-)
G_{sl}	Sliding friction variable, (-)
l_c	Instantaneous line of contact, mm
$l_{\min}$	Minimum length of the contact, mm
M_{jet}	Frictional moment due to jet lubrication, N mm
M_{sump}	Frictional moment due to oil bath lubrication, N mm
n	Rotational speed, 1/mm
P_{ch}	Power losses, W