Examination of High-Speed Helical Gear Mesh Efficiency and Influences

Martin Buerkle

Doctor of Engineering in Manufacturing Oral Defense

Will be held on
Monday May 23, 2005
Beginning at 9:30 a.m.
1515 HH Dow Building

If you plan to attend Martin's Oral Defense, please let Kathy Bishar at kbishar@umich.edu know by Wednesday, May 18.

Co-chair: Stacy Birmingham (Bike) (Grove City College)
Co-chair: Volker Sick
Committee Member: Huei Peng
Committee Member: Jonathan Luntz
Committee Member: Thomas Asmus
Committee Member: David Wright

The economic pressures of rising fuel prices and increased power requirements for automotive transmissions have pushed for new innovations and efficiencies in transmission design. Gear scuffing and failure is a complex process involving many factors, particularly gear speed. This thesis investigates the benefits of synthetic lubricants over mineral lubricants for transmission applications, as well as the feasibility of automotive high speed gear meshes that reduce scuffing. Several key areas of an automotive gear mesh application were investigated, including EHD contact, gear manufacturing, power loss, as well as both lubricant and lubrication influences.

The method involved a four-square test bench with a high speed helical gear mesh, which tested the real gear mesh of a production transmission with various torques and surface pressures. Tests were also run on a mini-traction machine (MTM) and the test bench results were compared with MTM traction curves. Three transmission lubricants were run in the four-square test bench gear mesh as well as on the MTM, at various temperatures. Post-test SEM failure analysis was conducted using a Wyko machine which measured non-contacting surface replicas of scuffed and non-scuffed gear teeth.

Gear surface topologies, bearing ratios, and manufacturing methods were analyzed, to improve total gear lifetime cost. Other areas investigated were power loss and heat removal to improve mechanical efficiency.

In addition, the thesis explores the relationship between drag loss and base stock viscosities, with respect to elastohydrodynamic gear tooth contact velocities. Comparisons were made between the base oil composition, molecular structure, additives, and VII of the three lubricants and their test performance.

The above research addresses friction power loss for the gear mesh; related base oil molecular structure and oil temperature issues; as well as surface pressure, gear mesh velocities, manufactured gear surfaces, and surface topologies for this application.