Heavy Truck Friction & Wear Reduction Technologies

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Project ID #

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Project ID/Agreement ID	Program Structure	Sub-Program Element	R&D Phase	Date
DE-FC26-04NT42263 / A000	Vehicle Systems	HV Systems Optimization	Exploratory Research	05/19/09

Project Overview

Timeline

- Start - Oct 2004
- Finish - Sep 2009
- 88% Complete

Budget

- Total project funding
  - DOE - $ 2,090 K
  - Contractor - $ 2,500 K
- Funding received in BP3 (Yr 4)
  - $ 418 K
- Funding received in BP4 (Yr 5)
  - $ 212 K of $ 418 K

Barriers

- Gear coating life
- Risk of gear and bearing damage with low fill sump
- Dissolution of low friction oils

Target

Improved fuel efficiency of 2 to 4 mpg

Partners

- Eaton
- Caterpillar
- Northwestern University
- Argonne National Laboratory

Project Objectives

Overall Objective

Reduce friction and parasitic energy loss by 30-50% in transmissions and axles used in class 3-8 trucks without compromising performance or durability

Years 1-3

- Develop computer simulation tools for various contact geometries to predict friction, interface temperatures, wear, and other performance parameters for gears, bearings, seals, and oil churning losses
- Calibrate and validate simulation tools utilizing coupon fixture testing and component bench testing
- Identify commercialization strategies for efficiency improvement methods in truck transmissions and axles

Years 4-5 (2009 is Year 5)

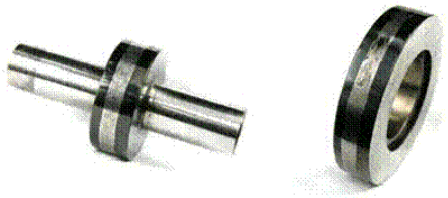
- Conduct dynamometer tests to measure efficiency improvements
- Prepare for commercial implementation of these technologies in on-highway/ off-highway truck transmissions and drive axles.

Project Approach

Implementation Strategy

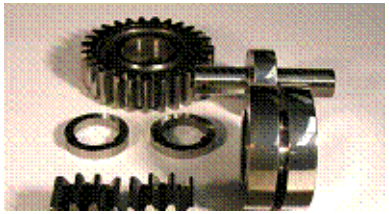
The strategy identifies specific technical factors that can reduce friction and parasitic losses in transmission and axles and, in turn, that can be exploited to reduce the US consumption of petroleum by trucks. Among the technical factors are the following:

- Lubrication
- Surface Roughness
- Textures
- Churning
- Coatings



Implementation Approach

- Screening with bench top and fixture tests
- Low friction oil with solid lubricants
- Super finishing of gears
- Dynamometer tests
- Low fill sump and spray tubes
- Diamond Like Carbon (DLC) and AlMgB coatings applied on gears by PVD/CVD



Technical Accomplishments

Reduced gear wear and lower friction by replacement of Eaton Roadranger CD50 Revision 6 transmission fluid with commercially available Roadranger SAE 50 Revision 7

Experimental SKQ5 low friction oil with coefficient of friction 50% lower than the commercially available Eaton Roadranger SAE 50 Revision 7

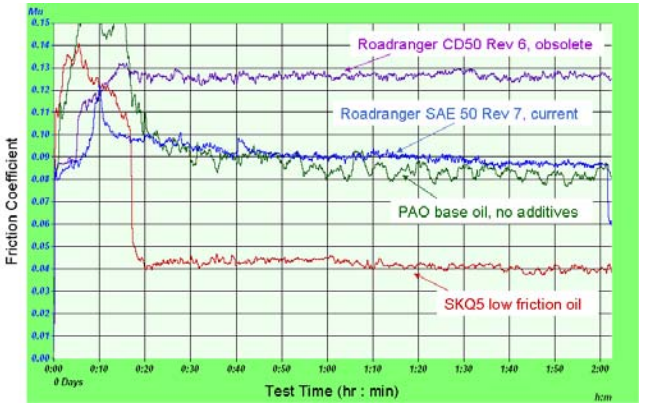
Low fill sump designs for transmission and drive axles

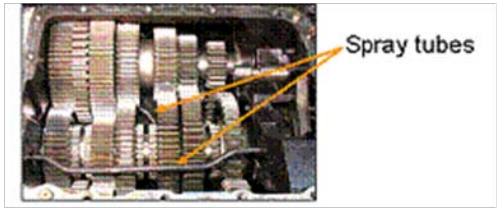
Oil spray tubes with modulating valves for added efficiency

Improved PVD/CVD gear coatings including Diamond-Like Coatings (DLC) and AlMgB for high durability and low friction

Improved PVD bond coats to handle high contact stress

Documentation of reduction in friction coefficient with increasing wear for components with high initial surface roughness





Future Work

- Developments in lubrication, the low fill sump and gear coatings are to be reviewed for incorporation in commercial truck transmissions and drive axles
- A final summary report will be prepared at project end September 30, 2009
- Findings of this project and associated literature point out the opportunity for combining the individual efficiency technologies synergistically for maximum benefit in a single vehicle, the ***Super Truck***. Among the individual efficiency technologies are aerodynamic fairings, shore power units, auxiliary power units, reduced frontage radiators, hybrid power units, wide single wheels, and higher strength steel gears

Project Summary

- Traditionally transmissions and axles have been designed for 750,000 mile durability; not for efficiency
- Factors contributing to friction and parasitic energy loss in transmissions and drive axles include high surface roughness on gears, lubricant churning and high viscosity lubricants contributing to high friction coefficients
- High initial surface roughness results in excessive friction, excessive wear putting hard particle debris into the system and excessive noise from gear profile error. Super finishing gears reduces friction, minimizes wear and debris and reduces noise
- Dry (low fill) sumps minimize churning loss and allow the lubricant to run at a lower operating temperature. The heat exchanger can be eliminated. Risk of gear and bearing damage has limited the use of dry sumps in heavy trucks. Spray tubes overcome the risk. Advanced CPU regulated lubrication systems are coming
- High viscosity lubricants protect gears and bearings but rob efficiency. New lubricants will offer low viscosity and low friction from heavy loading with friction modifiers, solid lubricants and anti-wear agents