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NEW PROPOSAL

CFD-Machine Learning Gear and Coupling Power Loss Software

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INTRODUCTION

Sliding power loss is defined as the power loss due to the friction between the gears' teeth. The power loss will cause heating inside the gear material. From experience, the high-speed effects become significant at pitch line velocities above 10,000 ft/min (50.8m/s). Coupling guard heating and pressure distribution within the coupling guard are closely associated with windage effects. According to the latest edition of **API 671**, the maximum coupling guard temperature should not exceed 60 °C (140°F), the investigation of windage is therefore of practical significance.

In this project, a CFD, machine learning model, and experimental rigs will be developed to predict coupling guard temperature and gearbox sliding power loss. The development of the code is based on extensive simulations in ANSYS CFX, Fluent, and MATLAB. Parametric studies of factors influencing coupling guard temperature and gearbox sliding power loss will be conducted. Guidelines on designing a coupling guard and gearbox to mitigate windage power loss will also be provided.

PROPOSED WORK

Couplings

1) Build CFD models for new coupling designs like (Beam coupling, Bellows Couplings, Chain Couplings…etc.)
2) Make machine learning, and regression codes for new coupling designs like (Beam coupling, Bellows Couplings, Chain Couplings…etc.)to predict the power loss and guard's peak temperature.

Gears

3) Build an experimental rig to validate the FEM of the high contact ratio gears.
4) Build a FEM to simulate the sliding power loss for the helical gear system.
5) Use the results of the FEM to build prediction models for the sliding power loss in helical gears.
6) Compare the fatigue life between the standard contact and high contact gear system.
7) Simulate different features for the gears like crowned gear tooth.
8) Provide additional tutorials on coupling and gearbox and heating modeling with CFX.

DELIVERABLES

Couplings

1) Modeling methodology and worked examples for predicting coupling guard and gearbox temperature and power loss using simulations software;

Gears

2) Software using mixed lubricant between gears teeth to investigate the effect of gear material and surface finish on gearbox efficiency and temperature;
3) Standalone software package based on machine learning optimization models for tested gear problems like gear heating and power loss. Also, recommended optimal gear designs based on the solutions;
4) Finite element model with machine learning prediction based software can be used at any computer for recommended solutions for power loss and high temperature in gear system;

STATUS OF CURRENT WORK

Couplings

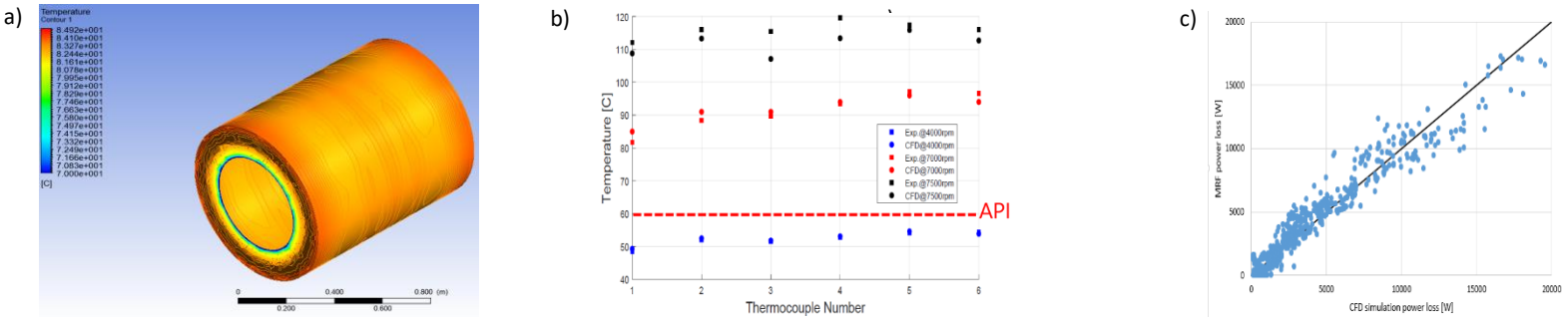
1. CFD model simulates the power loss in diaphragm coupling.
2. CFD model simulates the temperature of different guard designs like (Mailbox, cylindrical, and cylindrical with ports for cooling).
3. Machine learning model and formula to predict the power loss in coupling.

4. Machine learning model and formula to predict the peak temperature of the guard.

Gears

5. FEM to simulate the sliding power loss in high contact spur gear.
6. FEM to simulate the temperature distribution and thermal deformations in high contact spur gear.
7. Machine learning prediction model to predict the sliding power loss in the high contact gear system.

*All the models could be programmed to be stand-alone software able to be used by TRC members.



a) Sample of coupling guard temperature simulation result b) CFD validation with experimental results c) Machine learning prediction accuracy

8. Prediction model for coupling guard temperature and power loss

Machine learning, neural network, and mathematical model were developed based on validated CFD simulation results. It is a standalone software that gives output parameters (Peak guard's temperature and power loss) based on your design.

9. Gearbox temperature and power loss

A simulation model has been developed using machine learning to evaluate the power loss in the gear system. The model has been validated with other researches. The model can predict the power loss along the line of action for the gear system, also the model able to visualize the temperature distribution in the gear system for the High and standard contact system.

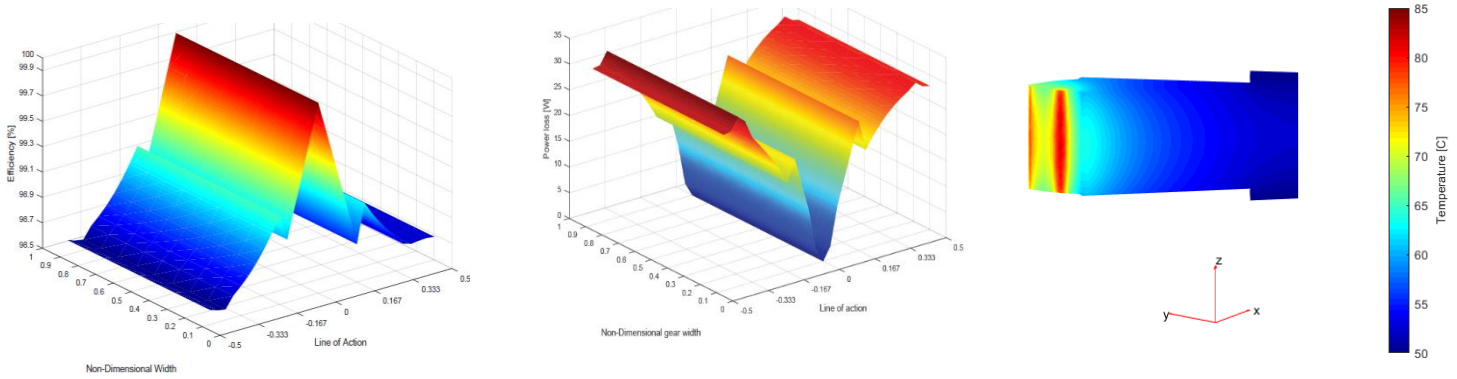


Figure 2: Gear sliding power loss, gear efficiency, and gear tooth temperature

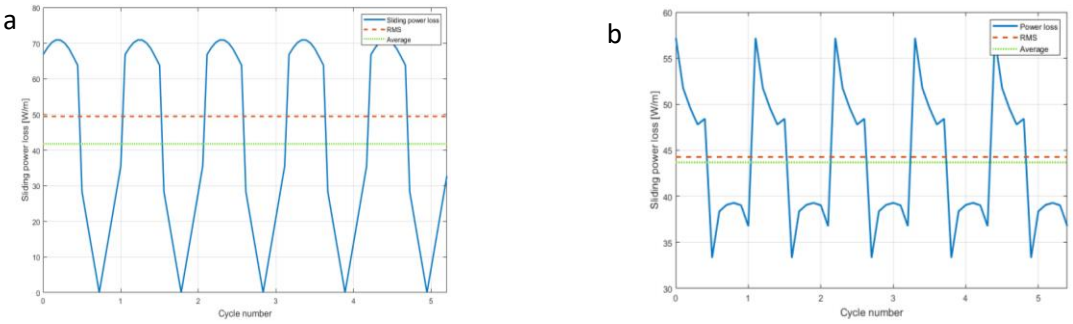


Figure 3: Total sliding power loss for standard and high contact gears (a)Standard contact (b) High contact.

COSTS $2,000 monthly salary for a graduate student, $3,000 for insurance and fringe benefits, $17,000 for tuition and fees, and $6,000 for equipment and supplies. The total cost is ***$50,000***.