

Gearbox Field Performance from a Rebuilder's Perspective

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American Gear Manufacturers Association



TECHNICAL PAPER

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Charles D. Schultz, Pittsburgh Gear Company

[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

AGMA Standards have traditionally focused on rated capacity and allowable stress levels. Design life is addressed in various calculations and occasional comments are made concerning component design. The focus of this paper is the actual field performance of over 2,000 different gearboxes that have been repaired over the last 15 years.

The information presented consists of a statistical review of the types of gearboxes repaired and the typical failure modes. Among the problems described are tooth breakage, tooth wear, housing bore damage, seal wear, and lube system failures. Photographs are included along with suggested design practice changes and a proposal for extended life service classes.

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Introduction

The major focus of the American Gear Manufacturers' Association standards activity has been the accurate determination a gearbox's ability to transmit a specified amount of power for a given amount of time. The need for a "level playing field" in this critical arena was one of the reasons the association was formed in the first place. Over the past 85 years AGMA committees have spent countless hours "discussing" the best ways to calculate the rating of a gearset, often arguing vigorously over factors that varied the resulting answers by fractions of a percentage point. While all this "science" was being debated in test labs and conference rooms all over the country, our customers were conducting their own experiments through the daily operation of gear driven equipment of all types.

Unfortunately the results of these "test programs" are usually unavailable to the design engineer unless failure occurs during the relatively short warranty period offered on new equipment. My employer, the Pittsburgh Gear Company, has been engaged in the repair, rebuilding, and field servicing of gearboxes for many years. The record of this activity provides some interesting insight into what happens to gearboxes long after the warranty runs out. [See Appendix A] While the majority of our customers are in the steel business, equipment from the chemical, mining, and rock quarrying industries has also been repaired. At one time or another products from most domestic and foreign suppliers have been serviced. The gearboxes cover much of AGMA's history and include most of the designs popular today. One of the drives operated by a local customer was put on-line in 1921 and hasn't missed a day of work yet. This type of performance is exceptional, of course, but it certainly inspires respect for the designers who labored in our trade long before the advent of the computer.

It is in deference to those creative engineers that I encourage today's gear designers to avail themselves of any opportunity to study long term performance. Having spent most of the last 25 years engaged in gearbox design and development, exposure to the far less glamorous side of the business has been extremely beneficial to my design work. In this paper I'll try to share some of the things I've learned and how they've affected my design philosophy.

Failure Definition

Our customers have their own definition of "gear failure" and it has nothing to do with bending stress or durability rating. The average mill superintendent cares about only one thing: Can the equipment work today? If a little pitting or a small crack appears the user couldn't care less if production can continue. While some of the more sophisticated plants are rapidly moving towards a "predictive maintenance" environment, the vast majority of mills react only to catastrophic breakdowns. We've seen some incredible performances by gearboxes run completely without oil for months or missing sizable tooth fragments due to bearing related misalignment. We have seen very few "failures" caused by over rating or misapplication, although overloads due to process line "crashes" and field modifications remain a significant problem. AGMA's standards writers and the application engineers can be justifiably proud of their work.

The same pride cannot be shared by the plant maintenance crews, however. The most common causes of failure recorded in our data base are lack of lubrication, poor lubricant quality, and debris damage. Tooth breakage is rarely seen unless bearing damage, extreme tooth wear, or debris are involved. Pitted teeth are usually left un-treated until the drive becomes noisy enough to attract attention or someone becomes alarmed at the metal seen