



AGMA Technical Paper

A Case Study in a Practical Application of Smart Gearbox Technology

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[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

In many different industries, the gearbox is a very critical component in each individual operation. Regardless of what the specific application is, from coal mining to moving an airline traveler's baggage, the conveyors rely on the gearboxes to convert speed and torque into motion. In this day and age where technology is being used to make our lives easier in many different aspects, the power transmission industry seems to be lagging behind in this trend. The gearbox in its simplest form has not seen many technological changes in the last 20 years.

Many end-users rely heavily on the gearboxes in their applications. They also want it to last as long as possible, but still pay a minimal cost for the same product and lifespan. However, without proper maintenance, regardless of the gearbox design, the useable life of the gearbox could be significantly shorter than desired. In some cases, the end-users fully understand that maintenance is a requirement for long life of the equipment. They just do not have: a) adequate staffing in their maintenance departments; b) the funds to support a maintenance program; or c) the time to devote to maintenance.

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Introduction

In many different industries, the gearbox is a very critical component in each individual operation. Regardless of what the specific application is, from coal mining to moving an airline traveler's baggage, the conveyors rely on the gearboxes to convert speed and torque into motion. In this day and age where technology is being used to make our lives easier in many different aspects, the power transmission industry seems to be lagging behind in this trend. The gearbox in its simplest form has not seen many technological changes in the last 20 years.

Many end-users rely heavily on the gearboxes in their applications. They also want it to last as long as possible, but still pay a minimal cost for the same product and lifespan. However, without proper maintenance, regardless of the gearbox design, the useable life of the gearbox could be significantly shorter than desired. In some cases, the end-users fully understand that maintenance is a requirement for long life of the equipment. They just do not have:

- a) Adequate staffing in their maintenance departments;
- b) The funds to support a maintenance program, or
- c) The time to devote to maintenance.

This provides a new opportunity to develop gearbox technology that essentially advises when the maintenance is needed and can help get the most life possible out of the reducer. This "smart gearbox" technology will provide a system that alerts users as to when a gearbox could potentially be failing could be the next major technological advance in power transmission. It allows users to essentially put a status on reducers' condition, and could use real-time data instead of the many varying opinions of many maintenance technicians to determine how the gearbox is operating.

The concept of condition monitoring gearboxes is not necessarily a new concept. There are many different "Off the shelf" systems that are available in the market today. However, due to the uniqueness of the Sumitomo Cyclo Reducer (Figure 1), the concepts previously used for standard, involute gearing do not apply. The eccentric cam and Cyclo disc arrangement is inherently imbalanced by design. The design incorporates ways to minimize the imbalance but they are used for more industrial applications versus precision applications. There will always be some imbalance, which manifests itself as vibration.

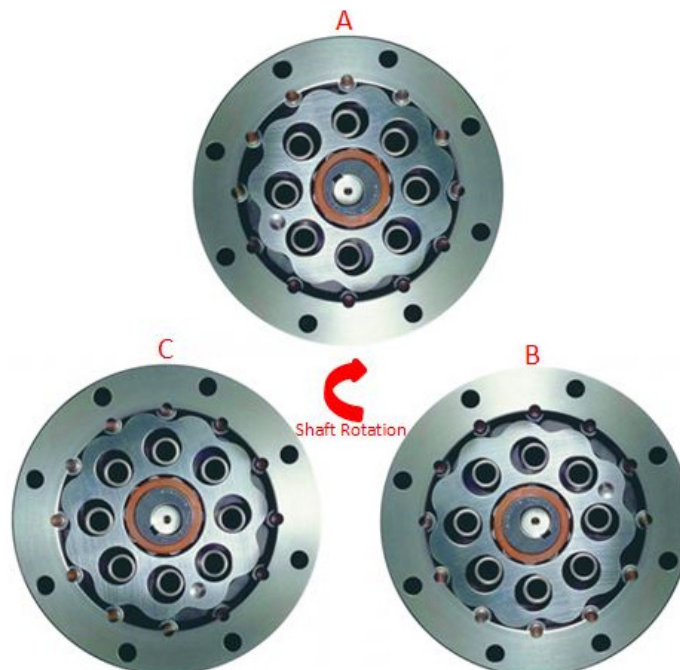


Figure 1. Cyclo Speed Reducer

The facility used for this case study, has a very large installed base of Sumitomo Cyclo based products at around 300 units. Of the 300, there are roughly 20 “unique” units that are the same Cyclo frame size. Each one of these, are installed in applications that vary greatly in regards to loading criteria, run time, duty cycle, etc. Although all of the reducers are of the same cycloidal design, all of the factors that affect the vibration and temperature measurements of a gearbox vary greatly between each unit. This fact is what makes creating a monitoring system for the Cyclo reducer a difficult task.

The purpose of the paper is to discuss the development of this technology using real-world application testing and data analysis, while keeping in mind the needs of the end-user in order to assist them in developing their monitoring system. It will describe the previous maintenance methodologies used and how the ever-changing needs of the industry require them to introduce a proactive maintenance system rather than a typically reactive approach.

It will explain the testing performed at the user's facility which helps gather the data that cannot be duplicated on a test system (Figure 2). It will then explain how after all the data is reviewed and analyzed, how it is then relayed back to the user so it can be implemented by their maintenance departments. It will discuss reviewing the data of a failed gearbox during testing and how looking at the data can give a glimpse of how to understand what the data is telling us in regards to the end goal of the project.

Background

In years past, the need for maintenance of mechanical systems has not changed very much. No matter how expensive or inexpensive the equipment is, maintenance is something that cannot be avoided.

The end-user in this case study sorts packages in the material handling industry, and down time is critical. Spanning the U.S and many other countries, they have many gearboxes that need maintenance of some kind. In the case of the gearbox, we normally focus on lubrication and how it should be changed periodically depending on how severe the loading conditions are in the application.

In the past, maintenance methods consisted of a set schedule for changing the gearbox oil. The schedule was set that every six (6) months, regardless of age of the unit, all gearboxes are drained, and the units be refilled with new lubricant.

From a gearbox manufacturer's standpoint, this methodology is one of the best ways to get the longest life out of the unit. The lubrication generally is the first item of the gearbox assembly that will start to break down and fail. Once the lubrications starts failing, it can no longer lubricate the rolling components of the gearbox. This causes an increase in friction, which leads to an unwanted temperature rise, ultimately leading to the failure of the gearbox. Therefore, having new lubrication inside the unit as much as possible will help its lifespan immensely.



Figure 2. Test unit