

Reliability and Service Life

Introduction

The purpose of this Technical Memo is to provide users with the data and an understanding of the necessary terms used to predict reliability and service life of a REXA actuator.

Reliability

The reliability of an actuator is the probability that it will function within specified limits for at least a specified period of time under specified environmental conditions. The REXA actuator is an extremely reliable piece of equipment and on average, reliability is in excess of:

98.7% for a continuous year of operation

This number can be increased to a value greater than 99.9% with our redundant construction option, reference PM10. This reliability should be used as a guide since each installation is unique and the specified variables that make up a typical reliability number vary. The best way to determine the time period between maintenance, thus eliminating failures, is collecting data during normal operation. Later in this document you will find guidelines that should be used as a starting point in predicting actuator maintenance and service life.

Mean Time Between Failure

A common term used in specifying and marketing products for reliability is Mean Time Between Failure (MTBF). This is a vastly misunderstood and often misused term. MTBF only applies when the reliability distribution has a constant failure rate. Because the primary failure mode for mechanical parts is wear, they **DO NOT** exhibit a constant failure rate. Preventative maintenance will insure worn components will not result in failures. For this reason, MTBF is not an appropriate calculation for the mechanical components of the actuator.

Electronic components, on the other hand, do have a reasonably constant failure rate that can be approximated. For sophisticated electronics, such as those used in the Xpac, the commonly accepted method for determining MTBF is through large scale data collection. Using our data base and extensive unit history, the MTBF for the electronics is:

685,000 hours

MTBF is equal to the inverse of the failure rate. The calculation to determine the failure rate of the electronics follows:

MTBF = 1 / failure rate

Failure rate = 1 / MTBF = 1 / 685000 hours

Failure rate = 0.0000014599 failures / hour

Failure rate = 1.28% / year

It is logical that a device can have a MTBF that is much greater than its expected mechanical wear time because MTBF is only a projection of the normal lifetime failures within 64% of the normal distribution of failure times. Most, if not all, devices will have experienced mechanical wear long before the MTBF time. Without proper preventive maintenance, mechanical wear will result in a failure of some degree.

Design Life

Each REXA actuator is made up of sub-systems, and it makes most sense to look at each sub-system in terms of its unique design life. The first sub-system is the power module; this is the hydraulic pumping system which includes the bidirectional gear pump and the Flow Matching Valve. The design life of the power module is:

***5,000,000 full stroke cycles or
50,000,000 dither cycles (<1% stroke)***

The second sub-system is the hydraulic cylinders that can be broken out into two categories based on type; rotary and linear. When dealing with the gearboxes found in the rotary or drive units, the design life is dictated by the stresses on the rack and pinion gears. Life expectancy testing performed by the cylinder manufacturer assumes a constant load throughout the stroke and in both directions. Most applications of our units do not apply the full rated load for the full 90° of stroke. In general, the maximum load is typically applied only at the end of stroke in one direction. For this reason, REXA bases our cylinder life expectancy on our experience with actual installations, rather than the cylinder manufacturer's ratings. Linear cylinders on the other hand are more subjective to side load damage than wear damage. Typically the bushing will wear out depending on the degree of side load that is introduced into the system. If the bushings are replaced before damage occurs, linear cylinders will last as long as rotary cylinders. While some applications will result in even longer design life, it is reasonable to expect a design life of:

***5,000,000 full stroke cycles or
50,000,000 dither cycles (<1% stroke)***

Maintenance Schedule

Items such as seals, o-rings, wear bands, bushings, seats and valves will from time to time need to be replaced. Since factors such as pressure, actuator travel, contaminants, temperature and output all play a role in determining how frequently preventive maintenance is required, this document should only be used as a guide. Actual maintenance history logs for the specific application should be generated for a better indicator of when preventive maintenance is required.

For example, a linear cylinder seal for a 2000 lb thrust actuator will wear out three times faster if the cycle stroke is six inches vs. two inches and, conversely, will last four times longer if the stroke is half inch vs. two inches. Seal life is also dictated by the pressure the seal is holding. As the pressure increases, so do the forces between the seals and the rods and bores they are sealing. As these forces increase so do the friction forces between these components causing a seal under pressure to exhibit more wear than one under less pressure. It is important to understand the application and its influence on the actuators' components when determining the frequency of preventive maintenance for each unit. The soft goods—or seals—in each REXA actuator have been selected to provide a design life of at least:

1,000,000 cycles or 10,000,000 dither cycles

This equates to four years of service in a typical process control system. Seal design life estimates are based on the following assumptions: The actuator will only be loaded to its full output during 5% of its total travel—this is the case in 90% of control applications when the actuator is seating a valve. If the full load of the actuator is required over a greater percentage of the stroke, then required maintenance will be increased. Excessive loads—such as those exhibited when a cylinder "dead ends"—can cause excessive stress and premature wear.