Temperature Effects On Rubber Belt Operations

PA NOTE

Many questions have been received concerning the effects of extreme ambient temperatures on rubber belt operations and on the temperature limitations for satisfactory belt performance. This PA Note will include a general discussion directed toward answering these two questions.

There are no well defined temperature limitations providing a distinct area of satisfactory belt performance. Many variables influence the life of a rubber belt application at any temperature, and perhaps are even more critical in extremely high or low temperature operations. Factors such as proper drive design, alignment and tensioning are always important. The ambient temperature, time of exposure, duty cycle, amount of ventilation or air circulation in the vicinity of the drive, as well as the drive design, all influence the internal belt temperature which is a very important factor in affecting belt life. The ultimate consideration when designing an extreme temperature application is: What constitutes satisfactory service for the customer? One recent application required a rubber synchronous belt to transport molded glass at 270 °F; a short service life was satisfactory to the customer in this case.

When a rubber belt operates with extremely high internal temperatures, the rubber properties begin to break down with resulting premature belt failure. A rule of thumb is that an increase of 18 °F in internal belt temperature will reduce the belt life by 50%. High internal belt temperatures are normally associated with high ambient temperatures but that condition is not necessarily true. As a rule, internal belt temperatures rise 1 degree for every 2 degrees increase in ambient temperature. The internal temperatures also increase because of heat generated through the drive operation itself. Poor tensioning, (causing increased slippage), excessive loading or misalignment (causing greater friction between the belt and groove sidewall), and use of subminimal sheave sizes (creating increased bending stresses) are conditions which also generate higher belt temperatures.

There are steps that can be taken to reduce belt degradation in overly high temperature applications. If high ambient temperature is the problem, increasing the air circulation around the drive will aid in heat dissipation and reduce belt temperature. In the case where high temperatures are generated through drive friction, the drive should first be checked for proper design, tensioning, and alignment. Loads per belt can be reduced with a subsequent reduction of internal belt temperature by redesigning the drive using an increased service factor which will reflect the severity of the high temperature condition. After this re-evaluation, steps such as using finned sheaves and using forced ventilation will help dissipate heat. Both of these procedures have proven to be significant steps toward increasing belt life in severely high temperature operations. If slippage is creating the problem, correct tensioning is a quick resolution for properly designed drives.

In extremely low temperature operations, the rubber material in V-belts becomes stiff. At sufficiently low temperatures, it will actually reach a glass point, where (as the name implies) the rubber is hard and will shatter like glass if it is bent. This is an extreme condition but approaching this state the rubber will go through various degrees of stiffness. As long as a drive is in operation, the heat generated through drive friction and bending will increase the internal belt temperature and maintain belt flexibility in temperatures well below the normally accepted minimum operating temperature. Trying to immediately transmit a load through a belt which has taken a cold set can cause belt failure because the belt is too rigid to bend.
There are a few procedures which can be used to reduce the effects of a cold operating environment. Keep the drive idle-time to a minimum; ideally, keep the drive operating continuously. If the drive sits idle for an extended period of time, use minimum torque or no load condition when starting the drive and until flexibility is returned to the rubber. Preheating the belt or removing it from the drive to store in a warmer environment when not in use are two helpful alternatives.

There is generally an accepted temperature range in which the above stated conditions are considered to be negligible and standard industrial life can be expected. These limits are from -30 °F to 160 °F. [An RMA Bulletin states 140 °F.] Special V-belts can be produced to operate satisfactorily down to -65 °F (Automotive Mil Spec MIL-B-110440-D) but the upper limit of operating temperature is reduced proportionately. Likewise, belts can be produced to perform in a 200 °F environment but they are not well suited for low temperature applications.

Once again, a satisfactory rubber belt application is ultimately determined by the belt life desired by the user. A 200 hour life might be normal for a household appliance but would be totally unacceptable in an industrial application where reliability is important.

If you have an application that is to operate in a questionable environment, contact Denver Product Application for our evaluation and recommendations.