Technical Document

Why can Turbo gears show higher than Normal Vibrations Levels during Startup & Shutdown

Usually one of the following two scenarios are the source of high vibration levels at start-up:

1. A common phenomena in speed increasers operating under no load may result in pinion vibration recordings that exhibit higher vibration levels than the allowable limits set in API 613/5, Para 2.6.6.5. These vibration values of the pinion vary within a certain range. The above mentioned behavior is due to a slight instability of one of the rotors which can occur when the tangential force (driven torque) is equal to the pinion rotor shaft weight. Once there is load on the gear unit (< approx. 10%), there will be a defined force, which will move the pinion to its normal defined operating position (upward and out). At this point the instability will immediately disappear and the amplitude of the vibration will drop below the maximum allowable values.

   In this case the energy associated with the start-up is low enough whereby no harm can occur. Temporarily overriding the controls to a limit just outside of the maximum level seen would be acceptable.

   In speed reducers this condition is less likely to occur since the low speed element is heavier and will likely dampen the forces attempting to excite the rotor. However it is possible to occur as well particularly in short ratio gear units.

2. Another phenomena commonly experienced in these type gear units higher than normal vibration on hot starts. In this case higher vibration levels may be experienced on both rotors after a brief shutdown (hot start). When the gearbox is shut down lube oil continues to spray into the local area of the outgoing mesh (now idle). The cooling effect of the oil brings the localized gear toothing temperature down causing a thermal retraction of the steel in a localized area relative to the rest of the rotors gear teeth. This cooled area temporarily generates a thermally induced relative transient transmission error of rather major proportion causing the load reaction point to shift during rotation through the hot zone to the cooled zone and back to the hot zone. This behavior will continue for a short while gradually diminishing in manner until the rotors are thermally stable to the appropriate uniform load. This is a greater problem on double helical gears versus single helical gears. In double helical gears, the load shift coupled with the higher total contact ratio over two helices really destabilizes the rotor forcing the operators to either wait for a time period for cool down or override the shutdown vibration points on startup.

   This condition can be avoided if a cool down period is permissible; i.e. one to on and a half hours. Double helical gears may require two to two and one half hours. Allowing more time for the rotor temperatures to stabilize prior to start-up is encouraged. Extending the time out periods between start-ups is the best solution.

   These scenarios will generally apply to all high-speed turbo gears.