Orbit Magazine

Throwback Thursday - Preloads

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the Orbit

Bently Nevada has a rich history of machinery condition monitoring experience and has always placed a high priority on educating and helping customers manage & maintain their equipment better. Every week, an article or Application Note that was published by Bently Nevada ‘back in the day’ will be highlighted. Although the format may be dated, the information is just as valid and informative as the original printing.

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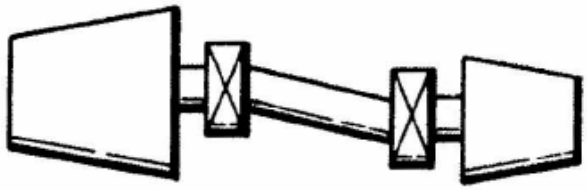
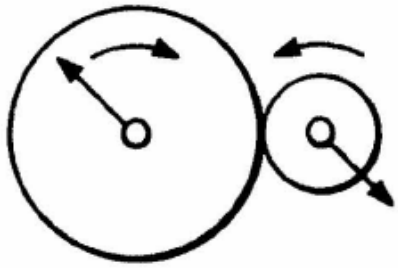
Preloads on rotating shafts are one of the most common, yet perhaps most misunderstood of the machine behavior categories. A preload is defined as a directional load or force applied to the rotating shaft. We can define preloads into two basic categories, external and internal.

EXTERNAL PRELOADS: Only one type of external preload exists. This is one whereby the directional force is applied to the rotating shaft through the coupling element. This is caused by angular or parallel misalignment, plus a stuck or partially stuck coupling. The magnitude of this preload is a function of the amount of misalignment as well as the type and condition of the coupling, the highest existing for a rigid shaft, and the lowest with diaphragm or other spring type couplings.



External Preload (Misalignment)

INTERNAL PRE LOADS: Internal Preloads are those forces generated internal to the rotating machine. Common examples of internal preloads are; torque reaction and pressure angle forces associated with gear boxes; elliptical or lemon type bearings where the clearance is reduced in one plane to provide a preloading action on the shaft, a cocked bearing due to thermal distortion, or installation misalignment. Horizontal mis-indexing of bearing shells will produce a preload. Internal misalignment on machines designed with three bearings will also produce a preload. Distortion of a machine casing may cause the internal seals to act as partial bearings preloading the shaft. Aerodynamic and Hydraulic forces can cause internal preloads.



Internal Preload (Gear Reaction Forces)

The immediate result of a preload is to force the shaft into one sector of a bearing. This results in a

non-linear restraint, in that the spring constant of the bearing is much higher opposing the preload than it is perpendicular to the preload. If the preload is increased this results in elliptical, then banana, then figure "8" shaped orbits. It is this non-linear restraint which produces the classical twice per turn frequency associated with misalignment. If one traces out the path of motion for a circular force input with the curvature of the bearing as a restraint, one will see that the shaft is pushed back toward the force twice per revolution. This is the primary cause of the twice per turn motion, not coupling friction forces.

Preloads do not necessarily cause a machine malfunction. In many cases they tend to stabilize the bearing. Gear forces, pressure dam bearings and gravity all provide additional stability of the rotor system in most machine designs.

Frequency components of the vibration signals may be utilized to provide an indication of a preload's presence. A strong indicator of the presence of a preload is provided by the use of proximity prot>es adjacent to the machine bearings. The DC probe gap voltage shows the shaft position in the bearing. The shape of the orbit shows the direction of the preload and the magnitude.

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