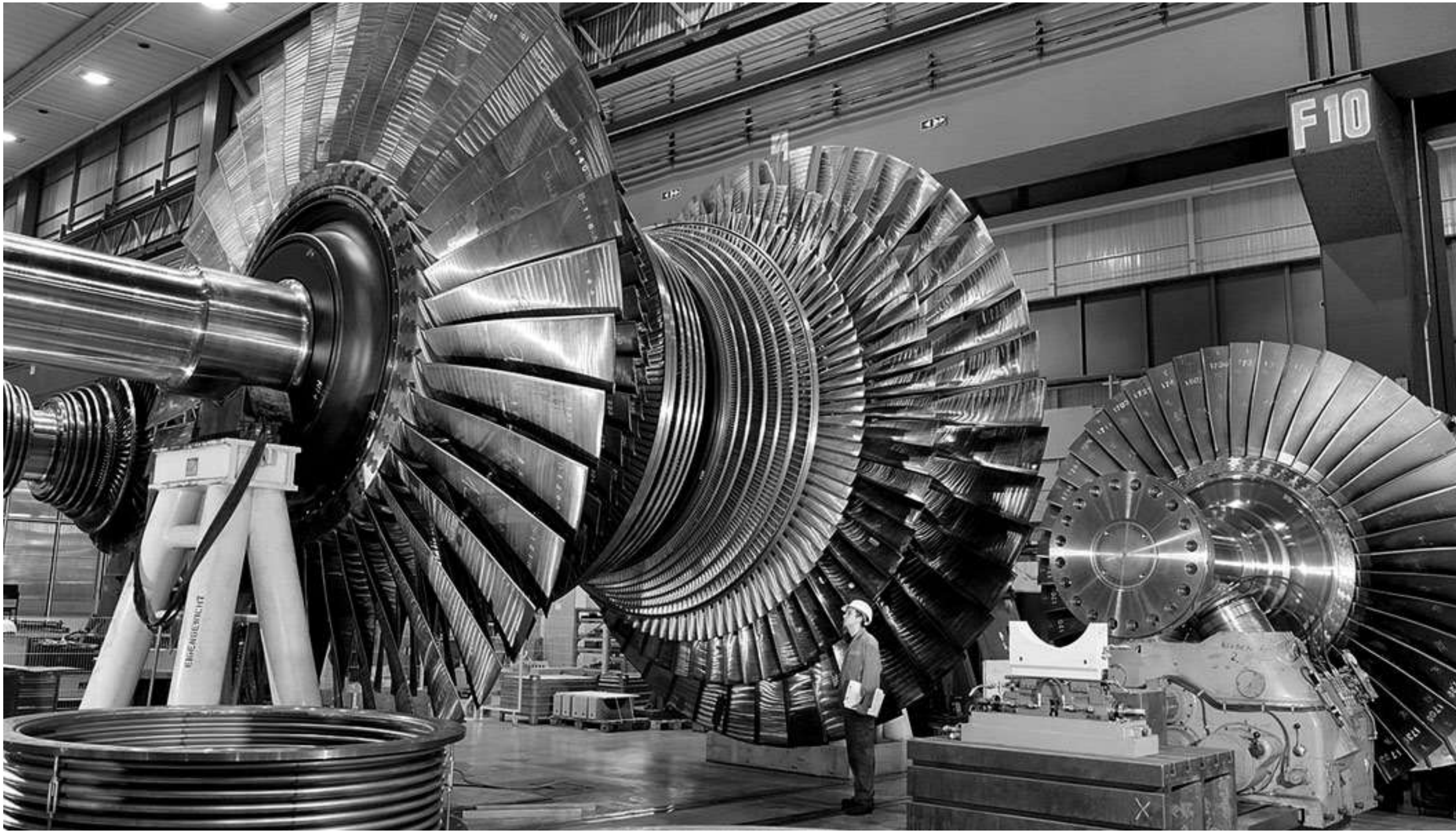

Vibration product training

Gearbox tutorial

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Wilcoxon
SENSING TECHNOLOGIES

Introduction

- Transducers come in two basic types
  - Contact - which measure the absolute movement of the casing
  - Noncontact - which measure the relative movement of the shaft versus the casing. Noncontact probes are specified in API Standard 613, but as we will see later, these are inadequate for monitoring all aspects of gear boxes. Of the three types of contact sensors (velocity, acceleration and displacement) only acceleration is adequate. This is because the transducers must be able to measure up to the third harmonic of the gear mesh. The accelerometer is the only sensor that can cover the wide frequency required for most gearbox analysis.

Resonance

- Many experts advise taking vibration readings only up to half of the resonance frequency mount. But many of the high frequency vibrations that must be measured for gear analysis are well above the mount resonance frequency.
- Can vibration measurement made above resonance frequencies be useful, even though they may have deviations of 20-30%?
  - Most gear analysis is based on change, not on absolute values.
  - The most important thing is to be consistent in the way the readings are taken: stay with the same mounting and transducer combination each time readings are taken.

Location for transducers

- The vibration sensors should be mounted so they avoid any gear casing resonances.
- The top of a horizontal gearbox may only be a flimsy (not on FALK equipment) cover and have many drumhead frequencies that are not directly related to the gear set.
- Transducers are best mounted on the gear shaft bearing caps or the
- case split line flange. These are the most rigid portions of the case and will be the least affected by extraneous resonances.

Nonsymmetric readings

- Gears may respond in a very different manner than the driver or driven equipment.
- The gears' movement is dominated by the torque acting on the gear mesh, and this force tends to restrain the gears in the direction perpendicular to a line between the gears' principle axis of rotation. As a result, the gears' response may be very nonsymmetric, i.e., the horizontal, vertical, and axial components of vibration may differ considerably in amplitude.

Gear mesh frequency

- Gear mesh frequency is often the dominant feature in a gearbox spectrum. This is easily calculated by multiplying the number of teeth on a gear by the rotating speed of the gear. Because a gear set has a constant, fixed ratio, the mesh frequency is the same for the bull gear and pinion. A set of precision gears smoothly meshing will generate very low vibration amplitudes. If the gear mesh amplitude increases without any corresponding change in speed or load, this indicates a problem is developing in the gearbox.
- Large amplitudes at the mesh frequency may indicate poor surface finish on the teeth or bad contact pattern between the mating gears.
- Increased amplitude can also be caused by bottoming of the gear due to improper backlash or severe pitch line runout.

Gearbox vibration limits

- Be careful not to jump to conclusions too soon, here are no general standards for acceptable vibration levels in gearboxes in service.
- For new gearboxes, AGMA 426 and API 613 sets an overall level at 2 mils max. or square root (1200/rpm), whichever is less, on the test stand with NO load.
- Most general purpose gearboxes are not built to that standard. The amount of vibration measured is dependent on the magnitude of the dynamic forces causing the vibration and the stiffness of the gear casing. Given the same force, a stiffer gear case will vibrate less.

Condition monitoring

- Condition monitoring requires that you know your equipment and understand what is normal for it.
- Establish good baseline data and know how the machines respond to the load and speed changes.
- When you find a unusual change in the vibration signature, analysis will indicate what areas to investigate.
- Other predictive maintenance techniques
  - Oil analysis should check viscosity, additives, contaminants.
  - Wear particles analysis should check number, size, and if there is an increase in number, alloy.

Wilcoxon Sensing Technologies

✆ +1 (301) 330 8811
✉ info@wilcoxon.com
💻 www.wilcoxon.com