Sound of silence

Bearing failure of any kind is not good news, but when it goes undetected, there's a price to pay. Mark Goodman looks at the power of ultrasonic technology

Ultrasonic tools are invaluable in detecting bearing failure, mostly because warnings appear well before any temperature rise or low frequency vibration can be seen. In fact, the technology recognises everything from early fatigue failure, through brinelling to lubricant problems.

Why? Because as the metal in the raceway, roller or ball bearing begins to fatigue, there's a subtle deformation, resulting in irregular surfaces that cause increases in ultrasonic emissions. These are best observed at 24–50kHz, as originally shown by NASA – which also found that, if the system can analyse modulations of resonant frequencies, it can detect very slight, early onset faults, such as pits or faults in the race surfaces. It can also detect brinelling of bearing surfaces, due to flattening of the balls, which results in a repetitive ringing.

Today, standard engineering practice recognises that a change in amplitude from an original reading is enough to indicate incipient failure. Then, when an ultrasonic reading exceeds any previous reading by 12–16dB, the bearing has entered failure mode. As for on-the-spot analysis, it helps if the ultrasonic signal is heterodyned (made audible). Engineers can quickly learn to recognise the difference between a good bearing, which produces a rushing or hissing noise, as opposed to a bearing in failure stage, which produces rough, crackling or clicking sounds.

A high intensity, uniform rough sound may indicate a damaged race or uniform ball damage. Rushing sounds above normal by 8–10dB normally indicate inadequate lubrication, while short duration increases in sound, with scratchy components, usually stem from a rolling element hitting a flat spot and sliding on the bearing surfaces, rather than rotating. If this condition is detected, more frequent examinations should be scheduled. However, if the sound is loud – similar to an electric hum – there's a bearing failure that can be confirmed, using a vibration analyser to reveal the fault frequency.

Best advice is to formalise monitoring, using comparative or historical testing – the latter enabling analysis of bearings over time, which makes wear patterns at particular ultrasonic frequencies very clear, and allows for early detection and correction. Beyond that, it's a matter of minimising the variables by selecting the same test sites, the same type bearings under similar load conditions and rotational speeds, the same frequency tuning on the test meter, and so on.

Pointers

- Modern ultrasonic tools are very good at detecting early onset bearing failures
- Equipment capable of analysing modulations can detect down to pits and microscopic faults in ball race surfaces
- Instruments providing audible outputs enable plant engineers to check bearing condition fastest
- These tools also enable in-depth lubricant checking
- There is no substitute for a formalised monitoring programme, whatever the measuring technology used

Detection protection

What isn't commonly known is that ultrasound can also be used with some slower speed bearings. Most of today's instruments have a wide sensitivity range and some have frequency tuning. With these features, it is possible to listen to bearings' acoustic qualities, although, if the speed is below 25rpm, it may be necessary to disregard the meter display and just listen to the bearing sound: large, slow-moving bearings are usually greased with high viscosity lubricant, which absorbs most of the acoustic energy. If a sound is heard, usually a crackling, it's an indication of deformity.

So much for detection: two key causes of failure are under- and over-lubrication. Normal bearing loads cause an elastic deformation of the elements in the contact area, providing a smooth elliptical distribution. But bearing surfaces are not smooth, and the contact area will have surface roughness.

If there's an adequate lubricant film on the bearing surface, it provides a dampening effect on the stress distribution and the acoustic energy released is low. But if lubrication is reduced to a point where the stress distribution is no longer present, microscopic deformities will make contact with the face surfaces and increase the acoustic energy, resulting in wear and possibly small fissures, leading to the pre-failure condition.

On the other hand, if there is too much lubricant, pressure builds and can lead to heat, which creates stress and deformity, or the bearing can simply break or pop its seal. Both conditions can be detected using ultrasonics, the trigger being around 8dB above or below baseline. PE

Bearing tests using ultrasonic instruments can detect very early onset failure conditions

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