VIBRATION IN MINERAL PROCESSING EQUIPMENT CAN BE COSTLY

CONDITION MONITORING OF MACHINERY BY WAY OF VIBRATION MEASUREMENT CAN FORESTALL EXPENSIVE, OTHERWISE UNFORESEEN BREAKDOWNS WITH CONSEQUENT LOSS OF PRODUCTION. **KEVIN SMITH** EXPLAINS.

There's the hoary saying "if it ain't broke – don't touch it." Plant engineers charged amongst other things, with maintenance, won't voice this in exactly those words as though it were a dictum.

Rather, they'll confirm the need for some form of regular maintenance as more or less a 'motherhood' statement.

However, motherhood statements don't get a ball mill motor going, nor fix motorised pulleys on belt drives, aerators on flotation tanks, etc. when these plant give up the ghost.

Excessive vibration often is the root cause for breakdowns and the trick is to devise some form of early warning that can indicate a 'go and inspect and check' flag so that an 'unscheduled breakdown' and associated loss of repair/replacement and production costs can be avoided.

The fact is that although such flags are a good idea, the practical aspects of measurement and analysis require the use of vibration data collection and software.

This article discusses methods of gathering data, data massaging and diagnosis to indicate likely problems and where they probably occur.

Vibration can be due to mechanical as well as electrical faults

Vibration in rotating equipment is invariably caused by out of balance conditions.

It can occur after an electric motor has been repaired, through misalignment of shafts, uneven wear of gears, electrical faults in motors, wear in bearings, etc.

In the real world of harsh environments, excessive vibration is the cause of early failure. It is also an ignored condition because noise (the audible part of vibration) is accepted as normal.

Without going into too much science, vibration energy is proportional to out of balance mass and square of the rotational speed, revs/minute, and can therefore exert high impact forces.

Regular maintenance, for example the 'shut' that some plants have on a yearly basis so that machinery can be inspected, repaired, or refurbished may catch some problems due to excessive vibration.

It is however, no safeguard. The challenge to initiating maintenance when required is in observing what constitutes excessive vibration.

In short, it can only be established in practical terms by comparison to 'normal' vibration patterns. Fortunately establishing the so-called 'normal' base is not nearly as difficult as it might sound.

Ideally, the normal levels would be established when plant is new. In practice that's not of much help since in many cases, machinery has already been in use for some years.

Irrespectively, the initiation of collection of vibration data is an excellent start to catching incipient breakdown conditions.

Analysis of vibration frequencies is the key to corrective action

Some investment in analytical equipment is necessary, but there is no need for highly specialised training. Although, it needs to be pointed out in fairness to specialist consulting companies, that the general field of vibration analysis as it relates to structures and very high speed engines, etc. is highly complex.

The basic equipment for industrial

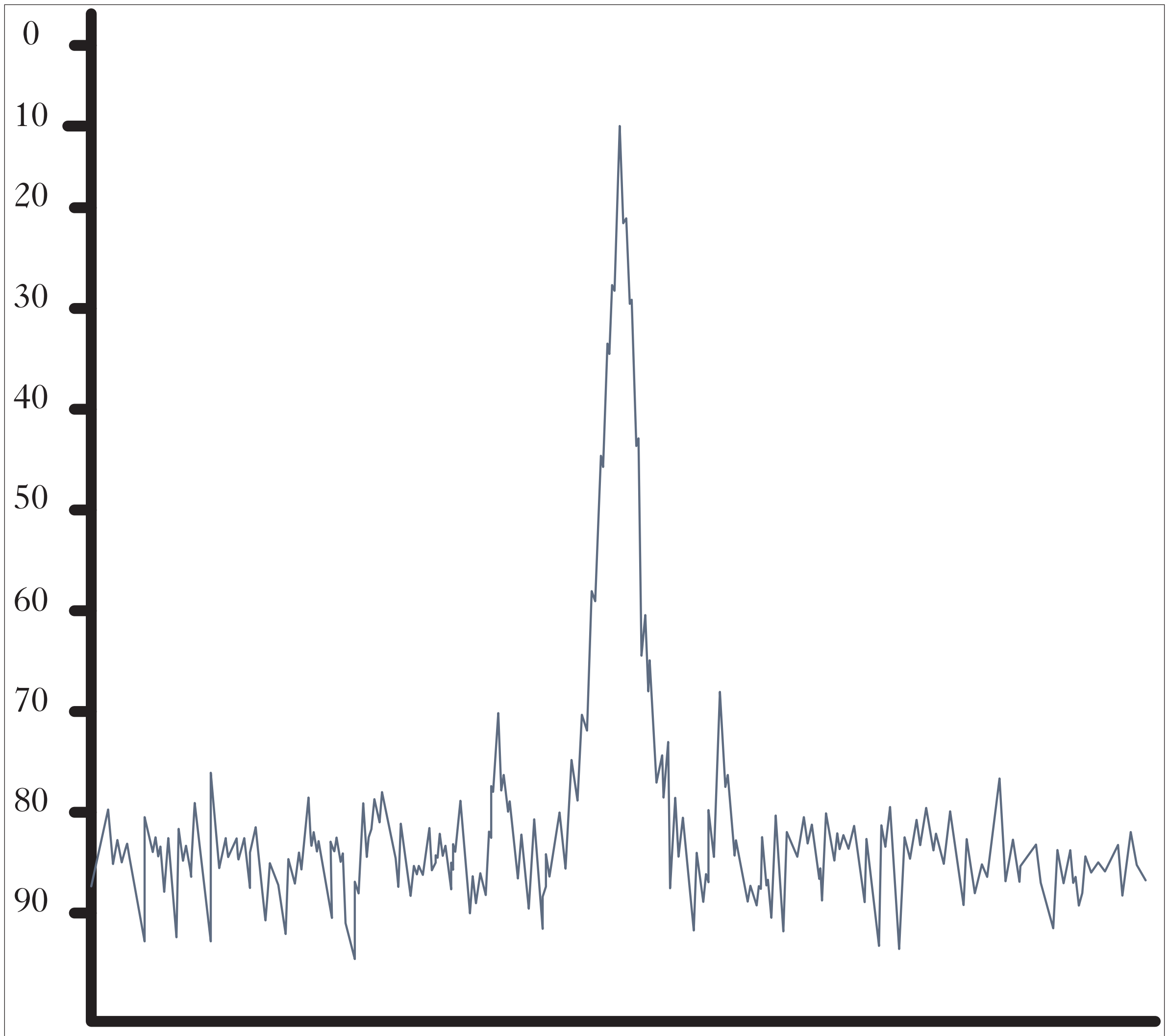

Fig 1

purposes comprises of accelerometers and high-speed digital recorders, capable of showing time and frequency variation of vibration.

Accelerometers are the primary vibration sensors that can be easily mounted on housings, pillow blocks, bearing casings, etc. They can be magnetically fixed, or by means of adhesives, or mechanically (screws, bolts).

In general, accelerometers are designed to be easily transferred, making them suitable for industrial environments.

Although there are other forms of vibration sensors, the accelerometer is best suited to the task because of its wide frequency range (note: a motor might be running say at 1500 rpm (25 cycles/sec), or close to that, but incipient failures might well be indicated by much higher frequency components).

The output signals from the accelerometer are analysed by the high-speed digital recorder, which will have FFT (fast Fourier transform) software for frequency analysis. FFT is a frequently-used analysis package and provides a frequency spectrum in decibels (dB), as shown in the accompanying graph (fig 1). The waveform function is useful for looking at time variations (as in fig 2), indicating a condition of excessive force caused by shaft slapping.

Interpretation of vibration spectra is aided by comparison with 'normal' data

In practical terms, vibration analysis is useless as an indicator of incipient failure unless we can establish what a normal level is. A practical example might be a large rated induction motor (refer to fig 1).

Unsurprisingly the main peak in the frequency spectrum is at the motor speed, but to be noted are two, so called 'side bands' with one below the motor speed and one above it.

At 50 dB below the main peak for the side bands there's nothing noteworthy, but if on a subsequent monitoring occasion, they show at 40 dB, there is a clear case for motor inspection.

The notion of comparison of vibration signatures is important because signatures in themselves are only capable of suggesting a problem area. The spectrum in fig 1 indicates a 'rotating' vibration, in other words due to the rotor of the induction motor.

At low levels, as already indicated, there is no concern. At the 40 dB level, likely problem areas are high resistance joints in rotor end rings, or broken rotor bars.

Alternately eccentricity of the rotor may be indicated, or loose laminations in the rotor.

On the other hand, a frequency peak at twice line frequency, i.e. 100 cycles/sec, is an example of a stationary vibration pointing therefore to the stator of the motor.

Likely problems are inter-turn shorts in windings, and/or loose stator laminations. Peaking of frequency in the range of 0.42-0.48 of machinery or motor rpm can indicate whirling in sleeve bearings (whirling is a vibration effect due to bearing oil forming a wedge between the shaft and bearing lining).

Roller and ball bearings (the latter are mainly found in lower rated motors, and smaller load bearing axles) have characteristic vibration patterns.

Nicks in cages, and inner and outer races cause the patterns to display additional frequency peaks.

Spectrum analysis is superior to other forms of vibration monitoring

It is easy to oversimplify the use of vibration analysis because without a good comparison base, the figuring out as to whether to take a machine out of action or not is made difficult, if not impossible.

The alternative to analysis, in other words the use of simple vibration monitors which indicate a gross vibration energy level over a wide frequency range, only provides some information when things are coming to a head – hardly useful for incipient problem detection.

Investing in vibration analysis equipment, as outlined, provides the basis for facts-based maintenance programs.

These, as opposed to scheduled maintenance, allow for more up-time of equipment – and importantly, in as much as taking equipment out of service always poses a risk of introducing faults, will likely extend equipment life. AM

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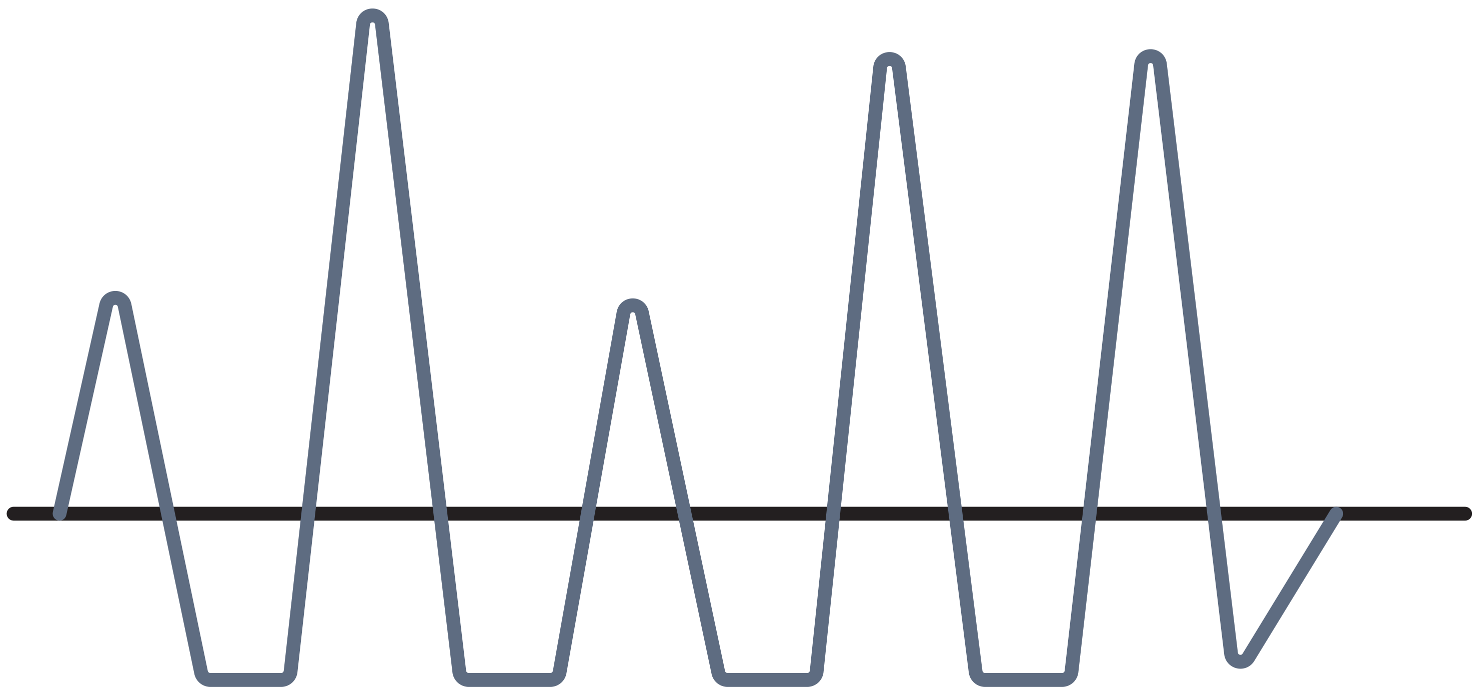

Fig 2