Crest factor

- Is defined as
  \[
  \text{Crest factor} = \frac{\text{peak value}}{\text{RMS}}
  \]

- CF for a gaussian signal
  \( \text{CF} \approx 3.5 \)

- CF for a deterministic sinusoidal signal
  \( \text{CF} = \frac{1}{0.707} = 1.414 \)

Application of CF

- CF of more than 3.5 may indicate a rare event superimposed on background random vibration (applications?)
- Detection of faults in rolling-element (ball or rolling) bearings
- The rationale
  - The vibration produced by a healthy new bearing is low in level and looks like random noise (CF appr. 3.5)
  - In a faulty bearing every time a rolling element encounters a discontinuity in its path, a pulse of vibration results (CF significantly higher than the one expected for random noise)
Rolling-element bearing

Unexpected breakdown of a rolling-element bearing, like that above, can cause injury, damage or lost production. Faulty rolling-element bearings can be detected long before breakdown by monitoring machine-vibration.

Machine condition monitoring

- Vibration Level
- Time
**MCM - crest factor principle (B&K)**

Crest factor = Peak RMS

Peak grows as fault grows

Crest factor

RMS grows as number of faults grows

Initial Peak

Initial RMS

Crest factor

Time

**More ideas**

- The resulting pulses repeat periodically at a rate determined by the location of the discontinuity and by the bearing geometry
Machine condition monitoring

Formulae for calculating rolling-element bearing frequencies

Contact Angle $\beta$

Ball Dia. (BD)

Pitch Dia. (PD)

Impact Rates ($f$ Hz) (assuming pure rolling motion)

For an outer race defect:

$$f (Hz) = \frac{n}{2} f_r \left[1 - \frac{BD}{PD} \cos \beta \right]$$

For an inner race defect:

$$f (Hz) = \frac{n}{2} f_r \left[1 + \frac{BD}{PD} \cos \beta \right]$$

For a ball defect:

$$f (Hz) = \frac{PD}{BD} f_r \left[1 - \left(\frac{0.85}{BD} \cos \beta \right)^2 \right]$$

For a cage defect:

$$f (Hz) = \frac{1}{2} f_r \left[1 - \frac{BD}{PD} \cos \beta \right]$$

$n$ = number of balls or rollers

$f_r$ = relative rev./s between inner and outer races