



12. Energy and Maintenance

Motor System Optimisation

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Energy & Maintenance - Contents

- Approaches to maintenance
- Motor reliability
- Condition Monitoring techniques

Approaches to Maintenance

- Four levels of maintenance operating practices
 - *Lowest Level:* fix it when it breaks, few maintenance records or spare parts, lack of training/capabilities
 - *Third Level:* short range fixes, better maintenance records, some spare parts maintained
 - *Second Level:* planned preventive maintenance, routine inspections, lubrication and adjustments made, good maintenance records, input from operations and engineering for maintenance problem solving
 - *Top Level:* predictive maintenance techniques used (vibration, thermography), problems are anticipated, computerized maintenance management system fully utilized

Why maintenance matters – the costs of failure

Industry	Typical financial loss per stoppage
Computer centre	\$825,000 (Euros 750,000) per event
Financial trading	\$6,600,000 (Euros 6,000,000) per hour
Glass industry	\$275,000 (Euros 250,000) per event
Semiconductor production	\$4,180,000 (Euros 3,800,000) per event
Steel works	\$386,000 (Euros 350,000) per event
Telecommunications	\$33,000 (Euros 30,000) per minute

Source: European Copper Institute 2001



Where better maintenance saves energy

- Shaft alignment
- Lubrication
- Dirt removal
- Voltage balance

The Energy costs of plant failure

Effect of unplanned breakdown	Related energy cost
Temporary reduction of output during breakdowns	Core or background energy needed to maintain essential services is spread across less output, and so the specific energy consumption rises.
Start up losses	A lot of energy is lost during the warm up time of high temperature processes
Alternative methods for re-gaining production used	Less efficient methods of production may be used, perhaps using older equipment or involving additional transport costs
Loss of product during warm up time	Some processes have to produce scrapped product while they are “warming up”.
Energy used in part processing the product is lost	Much energy may have been expended in getting a product to near the end of a production process, and this energy will be wasted.
Disposal of damaged product	There may be energy costs involved in the physical disposal of scrap product.
Emergency repairs made to re-start plant ASAP	Maintenance staff will do what ever is quickest to get the plant running, with speed taking priority over getting the optimum quality repair or looking for the most efficient spare part or replacement kit.
Rework costs	Additional energy used in re-working spoiled product.
Time lost for less urgent work	Time that could have been spent on energy saving work is lost

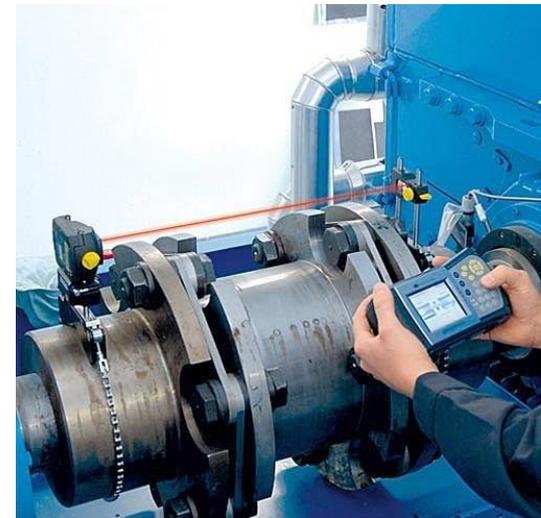
Linking Energy and Maintenance

- Maintenance problems represent an energy loss – *and are an indicator of a saving opportunity.*
- Regular maintenance checks also yield information on energy efficiency.
- Can you use the maintenance database for storing energy use information on?
- Maintenance projects always get priority over energy saving projects!

Installation and commissioning

Accurate shaft alignment will reduce bearing and seal wear.

Modern laser alignment equipment is convenient, but traditional alignment methods are also quite adequate if undertaken by an experienced fitter.



Direct Industry . com

Finding savings with motor systems

Maintenance considerations

Brief check list of things to look out for:

- Make sure motors, VSDs and related equipment are clean, free from dust & debris and adequate cooling can take place.
- Examine motor & equipment mountings - check these are tight, & equipment correctly aligned.
- Examine drive belts, check for:
 - Wear, correct seating on pulleys
 - Alignment of belts & pulleys
 - Correct tension
- Make lubrication checks – check for sufficient lubrication, no leaks.
- Listen to noise – listen for tell tale sounds of problems (*operators will recognise changes from the norm*).
- Electrical supply - check voltages are within tolerance, and phases are balanced.

Conditions that can effect motor performance/reliability

- Frequent starts and stops
 - Can cause premature motor failure
- Voltage unbalance or under/over voltage
 - Creates additional heat
 - Increases motor internal losses
 - Motor is derated for high voltage unbalance
- Environmental conditions
 - Poor cooling due to high ambient temperatures
 - Partially clogged motor vents
 - Dirty/wet application
- Application of variable speed drives
 - To be discussed in more detail
- Operating in the service factor
 - NEMA recommends that motors should be derated when operating in the service factor

Motor improvements

- Determine existing condition of motors
 - Electrical measurements
 - Motor circuit analysis, infrared thermography
 - Efficiency
- Plan ahead for repair/replace options
 - Have a Motor Management Policy
 - Application of variable speed drive will impact new motor type
- Evaluate how pump upgrades may effect the motor
 - Opportunity to resize the motor
 - Effect of variable speed drive
 - Impact on motor service factor
- Determine how motor upgrades will impact pump performance
 - Higher rpms for premium efficiency motors may increase pump capacity and power

Motor Derating based on Voltage Unbalance

For a 100 kW motor with a voltage unbalance of 3.5%, would result in the motor being derated to 85 kW.

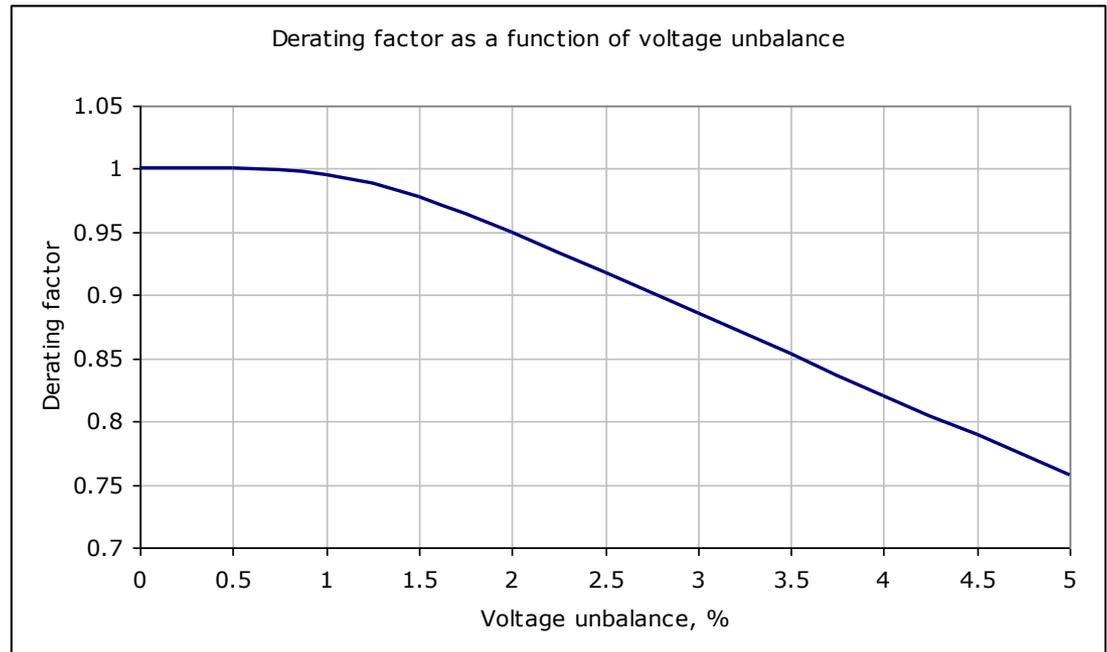


Figure Courtesy of Diagnostic Solutions

Condition Monitoring techniques

Common Techniques

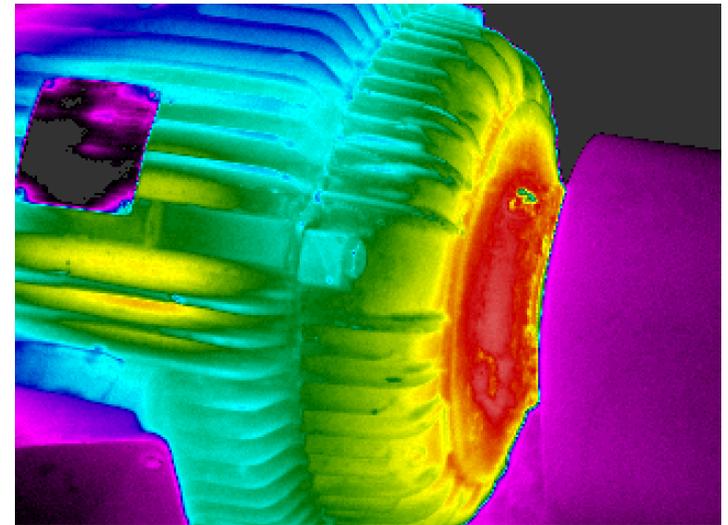
- Thermal Imaging
- Vibration analysis
- Shock Pulse Analysis

What are acceptable limits?

- Machinery specification will give some idea.
- Better to trend measurements over time – predictive maintenance.
- Machine to machine comparison is a good technique

Thermal Imaging

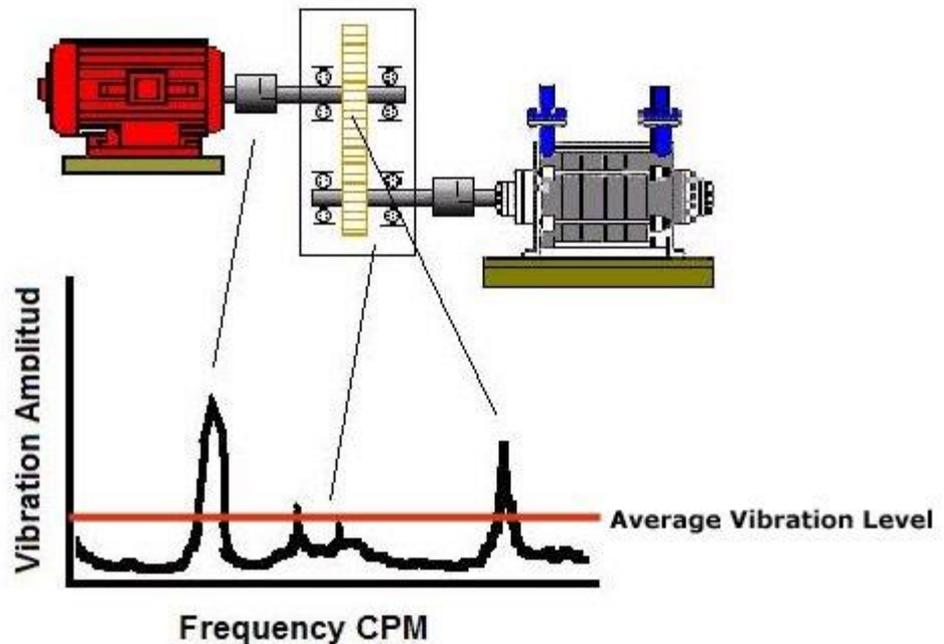
- Look for hot spots in windings
- Spot over-heated bearings
- Identify over-heated connections
- *Needs care in interpreting results*
- Basic fault finding can be done in house, but for more precise work, outside experts will be required.
- Budget for \$US5-10k, but you can pay a lot more or less.



Island Thermal Imaging

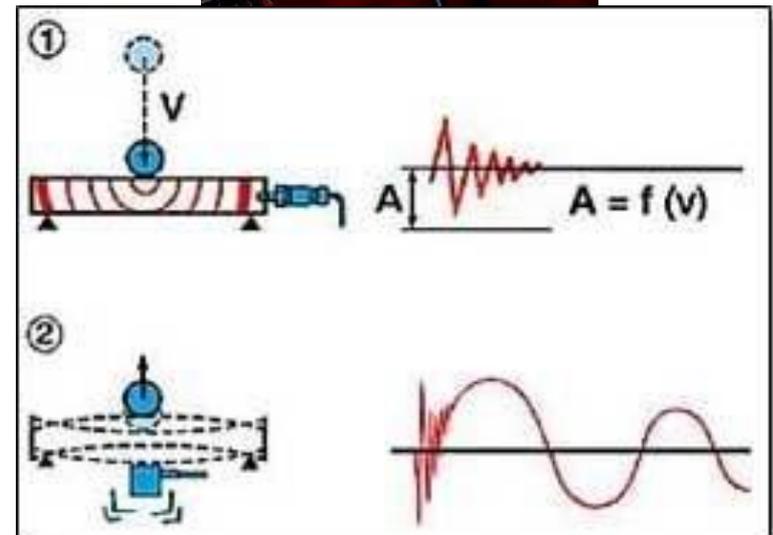
Vibration Analysis

- Identify different components by their frequency
- For SMEs, call in outside help



Shock Pulse Vibration

- Ideal for condition monitoring of bearings
- Can measure **lubrication** (regular or “carpet” level) and
- **Damage** (peak values) – like hitting a pothole.
- Rpm should be entered in order to adjust for speed.
- Budget \$3-5kUS. Its best for looking at changes over time.
- Can be done in house.

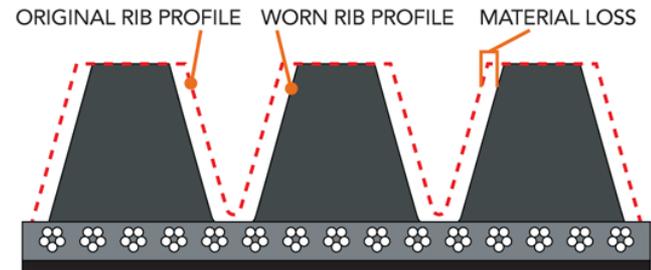


Transmission Checks

Checking Drive belts

Check for drive belt wear, and replace pulleys if needed.

Check for belt tension use tension meter and belt wear using simple profile gauges.



Enlarged Rib Cross-section



Chain checks

Detect chain “stretch”
before you damage the
gears





Discussion:

-What are your examples of good or bad maintenance practice?

-And what is the cost of a critical motor failing at your plant?