

Barkhausen Noise inspection

Detection of thermal damage on chrome plated HSLA steel parts

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SPL/CF1
Process,
Material &
Equipment
Development

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Contents

- Background information to investigate the potential to use Barkhausen Noise.
- Fundamentals of Barkhausen Noise inspection.
- Implementation of Barkhausen Noise inspection at KLM Engineering & Maintenance.

Background information

- In 2010, an incident occurred with a HSLA steel part.
- HSLA – High Strength, Low Alloy steels (> 200 ksi, $\Rightarrow 1400$ N/mm²). Also known as HHT (High Heat Treated).
- This type of steel obtained its strength by several heat treatments and the strength will be effected when exposed to high temperatures.
- HSLA parts are: Landing gears, Flap carriage assies, Fan mid shaft, cargo door hinges.

Background information

- Failure of part was caused by abusive grinding. Abusive grinding results in excessive (local) heat input.
 - Softening of the base material (sub) surface
 - Reduction of compressive residual stresses (which are applied by shot peening)

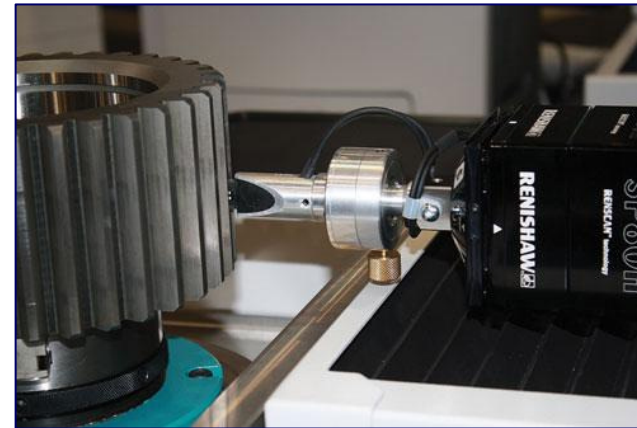
Background information

- HSLA parts are grinded twice during overhaul.
 1. Pregrinding → removing defects such as scratches, indents and corrosion.
 2. Grinding of the applied chrome plating
- Quality is assured after pre-grinding by nital etch inspection.
- After chrome grinding, no inspection is prescribed in the manuals in order to assure acceptable quality.

KLM introduced Barkhausen Noise inspection to detect thermal damage caused by abusive grinding on chrome plated HSLA steel.

Background information

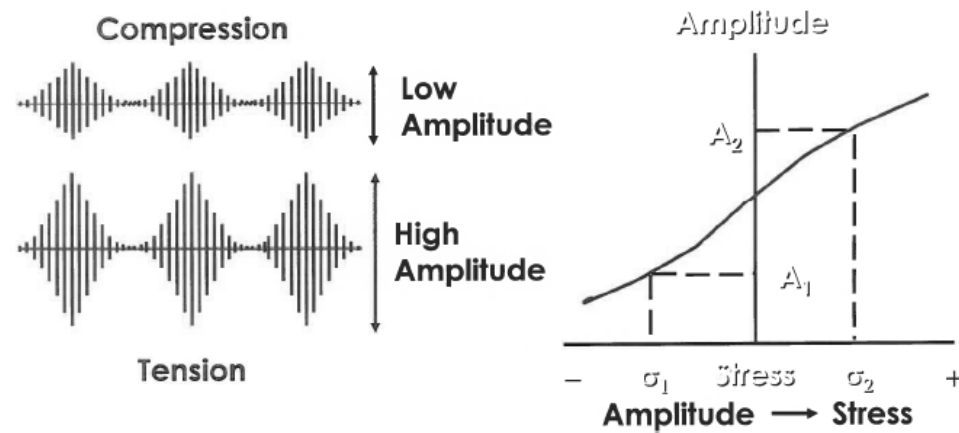
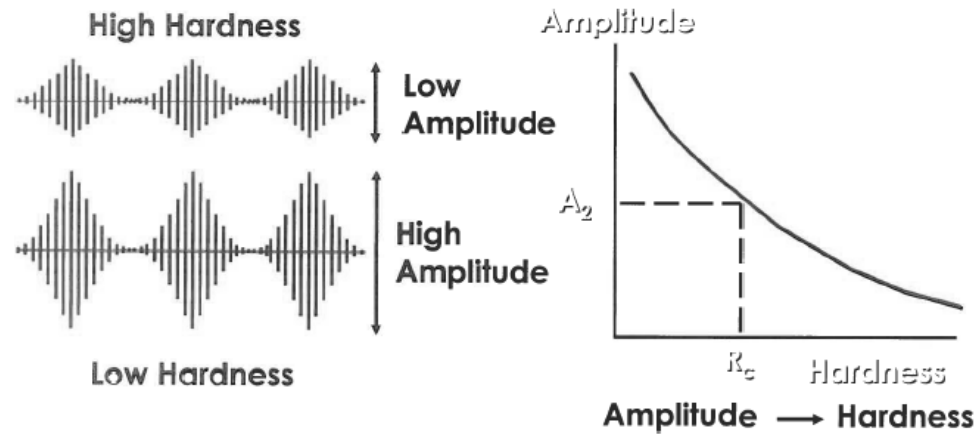
- Barkhausen Noise inspection is currently used as inspection method after grinding processes.
- **SCANIA** – inspection of more than 100000 camshaft at Scania Heavy engines, yearly.
- **Messier-Dowty** - Service Bulletin to inspect for thermal damage on landing gear.



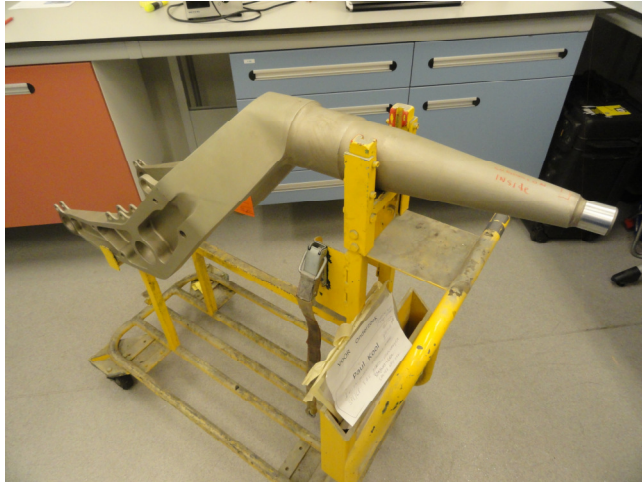
Barkhausen noise inspection

- Barkhausen Noise is a sound emitted by material when it is magnetized by AC. This noise is created by moving magnetic domains (clustered group of atoms with similar magnetic poles).
- The magnitude of this noise is depending on microstructural material properties; mainly hardness and residual stresses.

Barkhausen noise inspection



Barkhausen noise inspection



Reference material

- Barkhausen Noise signal is known
 - Residual stress state is known
 - Hardness is known
- > Acceptance criteria determined by experiments.



Part to be inspected material

- Barkhausen Noise signal is measured over the surface and inspection results are compared to reference material results.
- If part signal $>$ reference signal \rightarrow Reject
-If part signal $<$ reference signal \rightarrow Accept

Barkhausen noise inspection

- Advantage:
 - Non destructive inspection method.
 - No need for surface preparation.
 - No need for consumables, such as acoustic couplant.
 - Fast en easy inspection method.
 - Capability to obtain quantitative measurements.
 - works only on ferromagnetic materials.
- Disadvantage:
 - Comparative inspection method which requires extensive research to determine acceptance criteria for each material type.
 - Barkhausen noise signal cannot show relation stress – hardness.

Implementation of Barkhausen Noise inspection

- Rejection when the compressive residual stress is below 450 MPa. This corresponds to minor burn according Boeing (BAC 5653).
- Rejection limit is determined by experiments. Several test rings are grinded abusively and afterwards investigated on hardness, residual stress state and Barkhausen noise.

Implementation of Barkhausen noise inspection

- Barkhausen noise inspection is a non-destructive testing method, where no NDT level is required. (Boeing)
- At KLM, personnel are allowed to perform Barkhausen noise inspection after completing:
 - HSLA course
To create awareness of thermal damage on HSLA steel parts.
 - Theoretical Barkhausen noise course
Get understanding how the Barkhausen noise is affected by hardness and residual stress and how the several forms of thermal damage can be detected.
 - 'On-the-Job-Training' (OJT)
Get experience with the machine, the sensors, the procedure and the interpretation of inspection results.

Barkhausen Noise Inspection @ KLM

- Barkhausen Noise inspection assures acceptable quality for chrome plated and grinded HSLA steel parts.
- KLM Engineering & Maintenance is the first airline which implemented Barkhausen Noise to inspect for thermal damage on chrome plated and grinded parts in production environment.
- At this moment, only one type of part is inspected. In the future, maybe more parts.

Any questions?

