Innovative Simultaneous Harmonic Analysis (iSHA) Eddy Current Testing

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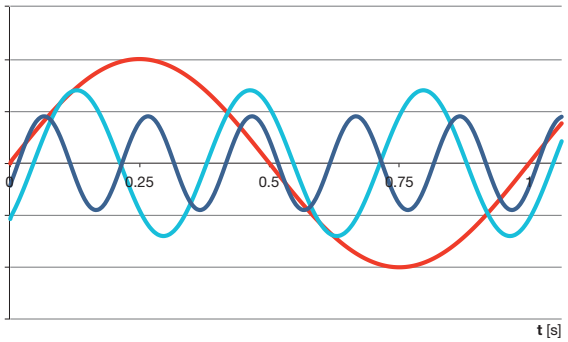
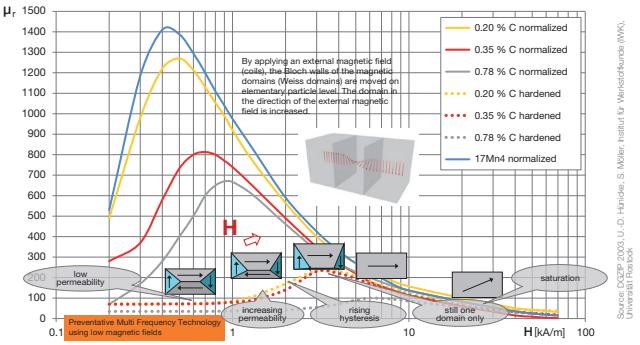
Eddy Current Technology

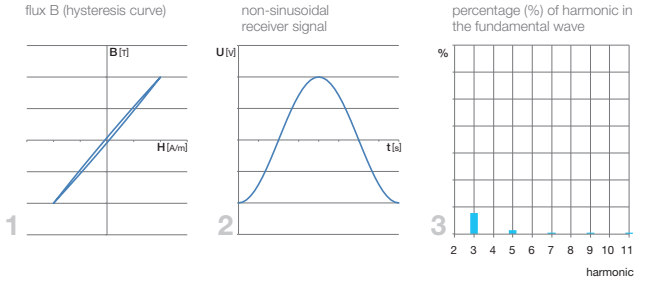


What are harmonics?
Sinusoidal signals with differing amplitudes 1 Hz, 3 Hz and 5 Hz Frequency.
The 3 Hz and 5 Hz signals are the 3rd and 5th Harmonic of 1 Hz.



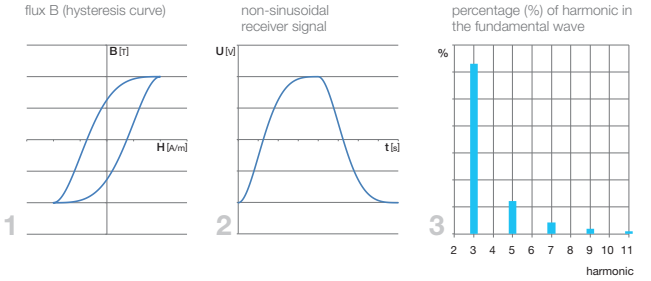
Relative permeability [μr] is strongly influenced by heat treatment. Hardened structures have lower permeability than soft structures. As ibg's Preventive Multi-Frequency Technology (PMFT) uses small magnetic fields one moves within the initial permeability. It is moreover horizontal at hardened parts and thus creates no harmonics. Soft structures, however, show a steep permeability rise already at low field strengths with corresponding strong harmonic generation.

Harmonics of a hardened OK part



Harmonics arise by each hysteresis of the magnetisation curve of the test part in the coil arrangement. The sinusoidal current in the exciting coil causes a sinusoidal field strength (1) which triggers a magnetic flux B in the test part. The magnetic flux observed over the time, however, is (depending on permeability) not sinusoidal anymore. Thus the magnetic flux over the time induces a distorted voltage differing from the pure sine in the receiver coil even at small field strength (2).

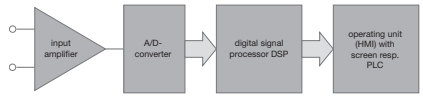
Harmonics of a soft NG part



Fourier analysis of the distorted signal reveals harmonics of the 3rd, 5th, 7th or 9th order (3). Analyses of these harmonics (4) give an accurate picture of the magnetic properties of the test part, thereby providing detailed information of its metallurgical structure. In addition, iSHA offers significant advantages in suppressing interferences like batch scattering, parts geometry and temperature or positioning effects.

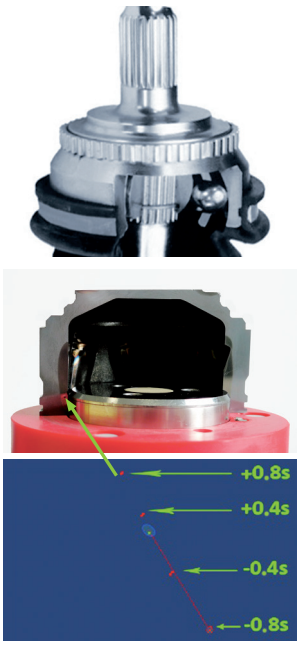
Simultaneous Harmonic Analysis iSHA

The signals of the harmonics are very small and a significant electronic effort is required to separate these small signals from the noise. ibg's new and ground-breaking feature of the digital eddyvisor instrument family is the digitalisation of the signal directly after the input amplifier and fast processing in the DSP.



ibg's innovative iSHA-technology (ibg's Simultaneous Harmonic Analysis) together with PMFT (Preventive Multi-Frequency Technology) guarantees high test sensitivity for decades to come. The eddyvisor family of instruments digitises the test signal immediately after the input amplifier. The digitised signal is sent to the Digital Signal Processor (DSP) for simultaneous calculation of vectors for the fundamental frequency and two harmonics for up to eight test frequencies. Without adding to the total test time, iSHA is able to use higher test frequencies and their harmonics for better resolution of the smallest microstructure difference. iSHA substantially expands the testing capabilities of ibg's proven Preventive Multi-Frequency Technology.

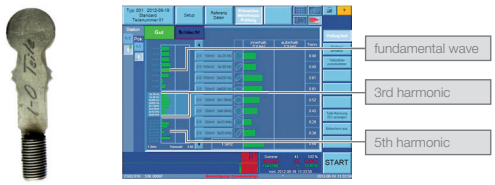
Application: case depth and position of hardening zone



Display of the 3rd harmonic of 1.2 kHz.
The measuring results show a good correlation to different induction hardening times.

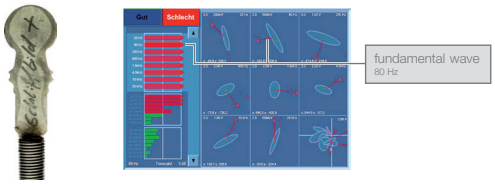
Application case depth

eddyvisor S digital in structure test mode 4



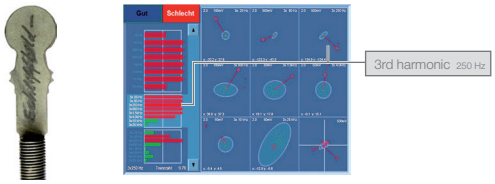
hardness profile of an OK part

display of OK part



hardness profile with too deep case depth

display of NG part „too deep case depth"
best separation at 80 Hz fundamental wave



hardness profile with too shallow case depth

display of NG part „too shallow case depth"
best separation at 3rd harmonic of 250 Hz

Innovative Simultaneous Harmonic Analysis (iSHA) in Eddy Current Testing

Harmonic analysis used with traditional eddy current testing for the detection of microstructure, case depth, hardness and other metallurgical differences has been known since the 1960's. However, it was rarely used, despite significant advantages in suppressing interferences such as batch to batch variation, part geometry, temperature or position. The mistaken assumption that harmonics are generated using strong magnetic fields at low frequencies and the limited technology of the time limited the broad use of harmonic analysis.

Harmonics are created through the hysteresis of the magnetisation curve of a part inside a test coil. The sinusoidal current of the excitation coil results in an alternating magnetic field, which in turn, causes magnetic flux (B) in the test part. Depending on permeability of the test part, the magnetic flux induces a distorted signal in the receiver coil. Fourier analysis of the distorted signal reveals harmonics of the 3^{rd}, 5^{th}, 7^{th} or 9^{th} order. Analyses of these harmonics give an accurate picture of the magnetic properties of the test part, thereby providing detailed information of its metallurgical structure. The signals of the harmonics are very small and a significant electronic effort is required to separate these small signals from the noise.

ibg introduces the new and ground-breaking digital eddyvisor instruments with iSHA-Technology. The innovative iSHA-technology (ibg's Simultaneous Harmonic Analysis) together with time tested Preventative Multi-Frequency Technology (PMFT) guarantees the highest test resolution available on the market. The digital eddyvisor S family of instruments digitises the test signal immediately after the input amplifier. The digitised signal is sent to the Digital Signal Processor (DSP) for simultaneous calculation of vectors for the fundamental frequency and two harmonics for up to eight test frequencies. Without adding to the total test time, iSHA is able to use higher test frequencies and their harmonics for better resolution of the smallest microstructure difference. iSHA substantially expands the testing capabilities of ibg's proven Preventative Multi-Frequency Technology.