Inline integration of electromagnetic NDT methods using 3MA

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In the late 70-ties, Fraunhofer IZFP started research on electromagnetic methods (EM), in order to develop microstructure sensitive NDT techniques for German reactor safety applications [1]. Fraunhofer IZFP has investigated different classical electromagnetic techniques such as Barkhausen noise, eddy current and more exotic ones such as incremental permeability and analysis of upper harmonics in tangential magnetic field.

Later, these first investigations led to a combination of 4 different testing methods with focus on the development and design of robust sensors. This merging offers a multi-parametric characterization (output of 41 magnetic measuring quantities) and allows studying the tested material in different depths. This approach avoids calibration problems linked to measuring disturbances.

Meanwhile a broad range of applications on different parts and components has been reported. Several equipment variants and a wide range of sensors like MicroMach, 3MA-II [2], 3MA-X8 [3], Magnus, Magnetic Flux Leakage, EMAT, etc. were successfully developed and used to determine quantitative or qualitative technological parameters and to characterize defects [3-4].

The application of EM NDT technology is linked to the inspection situation and to the targets to be determined. The target quantities can be local or global values as well as microscopic or meso-macroscopic information. The use of such EM NDT devices is not only dedicated to the laboratory inspection, furthermore they can also be adapted into the production environment.

The challenge of EM inline integration is two-fold; material characterization but furthermore process monitoring and control. The design and the signal processing of these sensors have to fulfill a series of requirements, defined by the inline environment and the machining process data. Generally, electronic devices and especially probe heads have to be designed in a robust way, to be applicable in an industrial manner. In contrast to laboratory conditions, in production facilities disturbances are always present and have to be identified, described quantitatively and compensated regarding their influences on the NDT measuring techniques. The sensors have to be able to withstand conditions in harsh environment like for example in steel plants: elevated temperature, lift off, vibrations, roller stress (see figure 1).

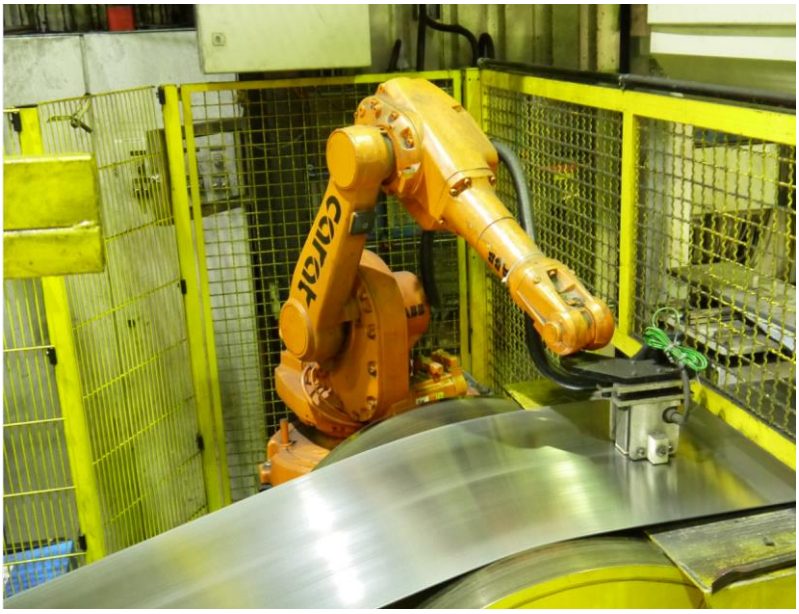

Figure 1: 3MA NDT probe head integrated in line production

In order to anticipate to these environmental behaviors, laboratory tests are processed. To guarantee stable characterization and calibration, the variation of 3MA outputs and signals are assessed. In this work, a complete inline protocol investigation will be described in detail.

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