Measurement of the ferrite content with the FERITSCOPE® FMP30

Chemical, utility and other processing plants are often exposed to heat, aggressive media and high pressure. These circumstances require corrosion and acid resistant steel that is mechanically resilient even at high temperatures. If the ferrite content is too low, the weld is susceptible to cracking under heat, if the ferrite content is too high, the weld loses its toughness and ductility. For duplex steel, a lack of ferrite in the area of the weld seam is an indicator of susceptibility to cracking under tension or vibration.

The FERITSCOPE® measures the ferrite content in austenitic and duplex steel according to the magnetic induction method. All magnetic components of the otherwise non-magnetic structure are recognized, that is, in addition to delta ferrite and other ferritic components transformation martensite is also recognized. The instrument is suitable for measurements according to the Basler Standard or according to DIN 32514-1. Areas of application are on-site measurements, e.g., of austenitic claddings as well as weld seams in stainless steel pipes, containers, boilers or other products made of austenitic or duplex steel.

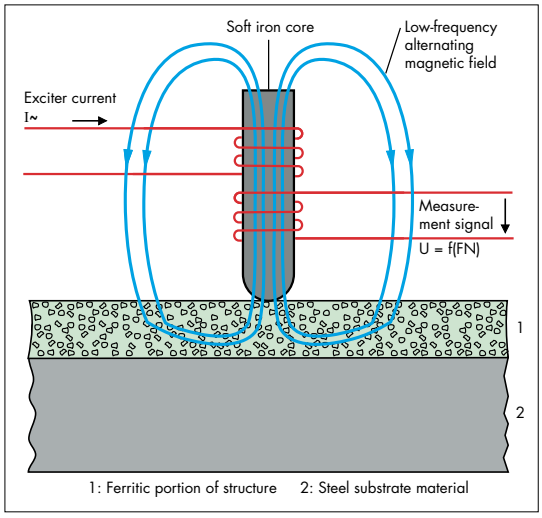
Determination of the ferrite content in the area of weld seams using the FERITSCOPE® FMP30

Characteristic features:

- Non-destructive measurement of the ferrite content in a range of 0.1 to 110 FN or 0.1 to 80% Fe in austenitic and duplex steel
- User-friendly instrument operation
- Large display, rich in contrast with 240x160 pixels
- USB port for data transfer to PC or printer
- Mechanical sliders to cover keys not required for the measurement operation
- Ready to make measurements right after power-up
- Measurement automatic upon probe placement through external trigger via instrument button or PC
- Automatic probe recognition
- Audible signal at measurement acquisition
- Only one calibration required for the entire practically relevant measurement range from 0.1 to about 90 FN. Measurement accuracy according to ANSI/AWS A4.2M/A4.2:1997 standard
- Calibration with standards traceable to TWI secondary standards or with customer-specific standards
- Adjustable instrument switch-off or continuous operation
- Lockable keyboard/restricted operating mode
- Various status displays (e.g., warning message when battery voltage drops)
- Various language settings
- Measurement units selectable between WRC-FN and %Fe
- Memory for up to 20,000 readings
- Up to 100 applications for measuring application specific calibrations
- Capability of allocating readings into up to 4,000 blocks
- Date and time stamp for blocks
- Display of statistical common characteristic values such as mean value, standard deviation, min, max, range in the block and final results. Output of characteristic variance-analytical values
- Graphical measurement display as a histogram with a Gaussian plot
- Capability of entering process tolerance limits and computation of the associated process capability indices c_p and c_{pk}
- Audible and visual warning when tolerance limits are exceeded
- Free-running display with additional presentation of the reading as an analog bar between the tolerance limits
- Matrix measuring mode for connected multi-point measurements, e. g., in a pre-defined surface array
- Capability of averaging measurement data: Only the mean value of several readings will be stored
- Measurement acquisition through area measurement possible: Only single readings until probe lift-off are captured and averaged
- Capability to measure continuously with the probe placed on the specimen
- Outlier rejection for the automatic elimination of erroneous measurements
- Overwriting of erroneous and already stored readings through overwriting
- Application linking mode: Ability for common normalization/calibration of applications
- Designations for applications through the optional PC program MP-Name
- Data transfer to a PC into an Excel spreadsheet with the optional PC program PC-Datex
- Data transfer to a PC into an Access database with the optional PC program PC-Datacc
- Battery and line power operation (AC adapter optional accessory)

Magnetic induction method

The FERITSCOPE® FMP30 measures according to the magnetic induction method. A magnetic field generated by a coil interacts with the magnetic components of the specimen. The changes in the magnetic field induce a voltage proportional to the ferrite content in a second coil. This voltage is then evaluated. All magnetic components of the otherwise non-magnetic structure are recognized, that is, in addition to delta ferrite and other ferritic components transformation martensite is also recognized. One particular advantage of the magnetic induction method for the ferrite content measurement is that a sigma phase, i.e., a Fe-Cr deposit, which may have formed due to excessive ferrite contents and unfavorable cool down conditions, is recognized correctly as a non-ferritic structural constituent. In a metallographic section, on the other hand, it is not easily possible to distinguish a sigma phase from a ferritic structure, which may lead to an erroneous evaluation of the ferrite content.



Basic operation of the magnetic induction measurement method, using the example of an austenitic plating

Application example

Increasingly, the chemical and petrochemical industries use duplex steel, e.g., for a container made of high corrosion resistant duplex stainless steel shown in figures 1 and 2. A ferrite deficiency in the weld beam may lead to cracks under the influence of tension or vibration. However, when welding duplex steel, it is easy to bring the ferrite content in the welding area to unfavourable values, either because of unsuitable welding additives or through wrong heat application or removal. Only a measurement on site can ensure that the processing steps did not change the optimal ferrite content resulting in a decrease of the mechanical or corrosion resistant properties.

Figure 1: Container made of highly corrosion resistant duplex stainless steel

Calibration/Standards

To obtain comparable results, the instruments must be calibrated with standards that are traceable to internationally accepted secondary standards. For this reason, the IIW (International Institute of Welding, UK) developed secondary standards that have been established by TWI (The Welding Institute, UK) according to methods described in DIN EN ISO 8249 and ANSI/AWS A4.2. Helmut Fischer offers certified calibration standards for the corrective and master calibration that are traceable to the TWI secondary standards. The standards in the Fischer calibration standards sets carry both the ferrite numbers FN and the %Fe values. Influences of the component geometry (strong curvature, thickness of ferrite-containing coating, etc.) can be taken into account through corrective calibrations with customer-specific calibration standards or with correction factors (included with shipment). Normalization and corrective calibration are stored application-specific in the respective application memory of the instrument.

Fischer calibration standard set with certificate

TWI secondary standard set

Figure 2: Measurement of the ferrite content at a weld seam