

DEFECTOMAT DS + FERROMAT

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The application and features of the FERROMAT channel with the DEFECTOMAT DS are explained in detail in the following report.

1. Application

The FERROMAT is designed to detect ferrous inclusions in non-ferrous metals. The detection is based on the principle of magnetic induction. The main field of application is in the production of copper wire rods.

Especially in the continuous casting lines of Southwire, USA (SCR), Continuus Properzi, Italy (CCR), Outokumpu, Finland (upward casting) and MDS, Germany (Contirod), the combined testing of Cu wire rods with eddy currents and magnetic induction is truly state-of-the-art.

The eddy-current testing detects surface faults such as stress cracks, which may occur during the casting process, and faults such as scaling and laminations, which are caused in the rolling process. The magnetic induction test, on the other hand, detects ferrous inclusions on and under the surface, which originate from the rolling process and nowadays sometimes even from the melting process due to increased scrap inserts.

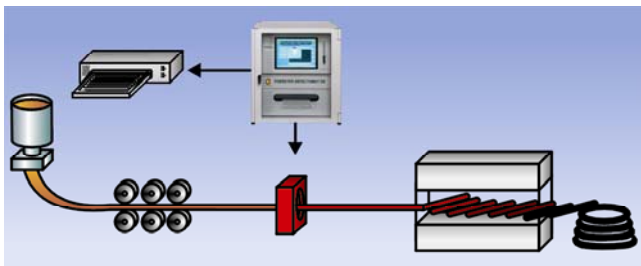
According to our information, there are currently approx. 200 continuous casting lines operating world-wide.

The major advantage of the combined testing method is the use of the same sensor system. Magnetisation is necessary to gain the optimal induction effect. Depending on the layout of the rolling line, the wire rods are either tested hot with the P 40 T ahead of the cooling section or with the P 40 or P 12 after the cooling section.

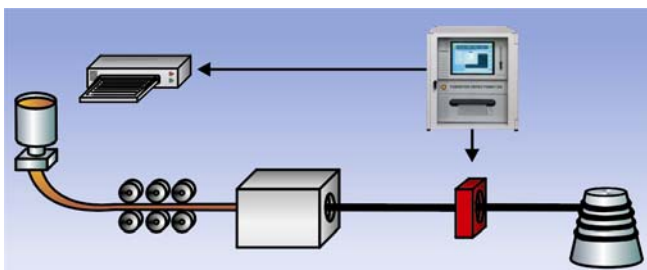


The two diagrams below show the installation location in schematic form.

Test ahead of the cooling bed with P 40 T



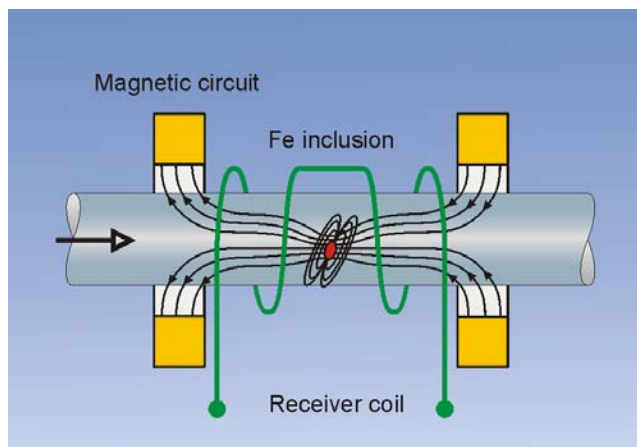
Test after the cooling section with P 40 / P 12



Integration in the line

2. FERROMAT procedure

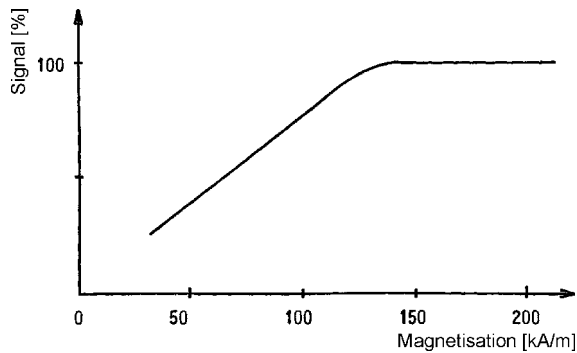
The FERROMAT works on the induction principle and detects minimal ferrous inclusions in the wire, as shown in the sketch.



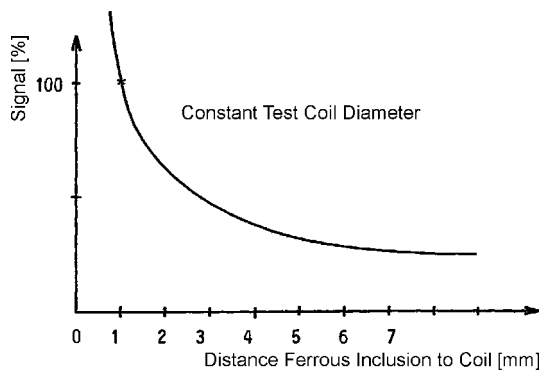
Method

The induction effect depends on a variety of parameters:

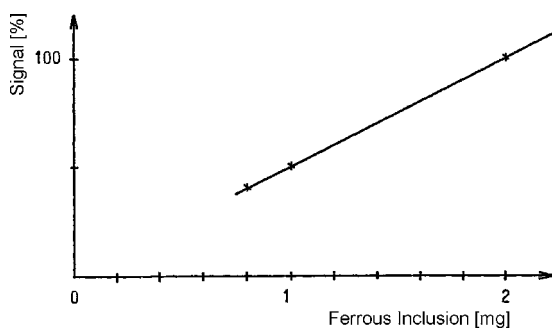
- DC field strength, which is generated sufficiently using the P-yokes.



- Position of the ferrous particle in the wire. The effect decreases with increasing distance of the Fe particle from the coil winding. Guide value: decrease in the amplitude by a factor of approx. 20 up to the coil centre (worst case).



- Volume of the iron particle. Experience has shown that, in best case, iron particles with a mass of only 0.1 mg can be detected.



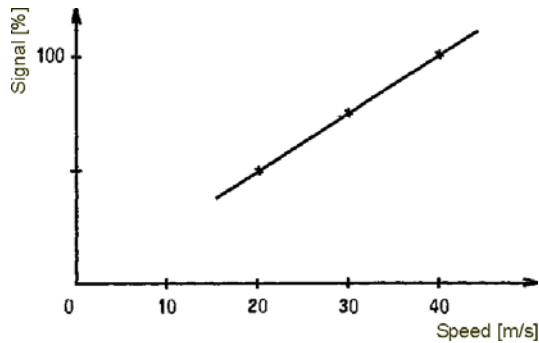
Parameters

Magnetisation

Position

Volume

- Test speed: with increasing speed, the induction effect increases in linear fashion. For instance, in the case of the continuous casting lines, the speed lies between 10 and 30 m/s, depending on the system type.



Speed

$d\phi/dt$

Applications

3. Other applications of the FERROMAT channel

When drawing copper wire to the finest possible dimensions, high quality is absolutely crucial. Therefore it is logical to carry out checks during the various drawing stages, especially for ferrous inclusions, in order to decide whether the wire quality is still suitable for the next drawing step, without risking a wire break. In the production of insulation wires, too, good surface quality is the most important prerequisite for coating purposes.

It is now also planned to use the FERROMAT in the production of copper tubes, and especially of finned heat exchanger tubes, as a supplement to the conventional eddy-current test.

4. Test sensitivity

The following table lists guideline values for some coil diameters, which have been extrapolated from measured values under the following prerequisites:

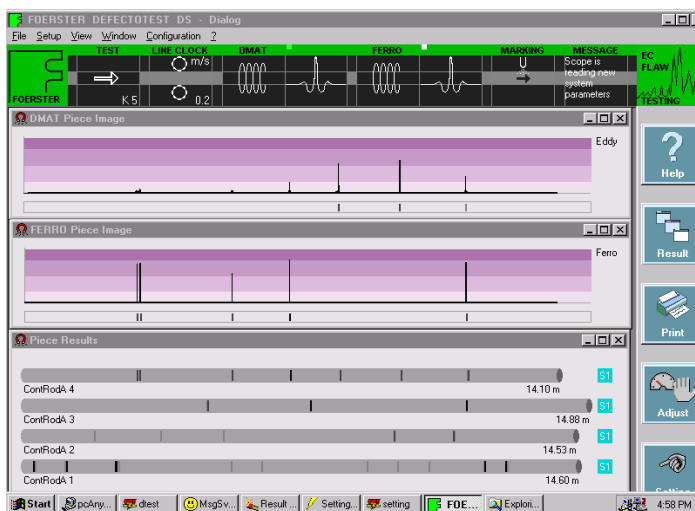
- Magnetisation in the P 40 or P 12
- Speed 10 m/s (can be converted to other speeds in inverse proportion)
- Position of the Fe particle in the test coil:
 - Best case: at the wire surface
 - Worst case: in the wire core
- Specification of the mass of the Fe particle in mg and converted to a corresponding spherical diameter.

Sensitivity

Test coil	Worst case		Best case	
	mg	mm	mg	mm
0,6 mm	0,025	0,138	0,0013	0,067
1,0 mm	0,07	0,257	0,0035	0,095
2,0 mm	0,20	0,365	0,01	0,134
2,6 mm	0,40	0,46	0,02	0,17
7 mm	1,2	0,66	0,06	0,244
9 mm	1,8	0,76	0,09	0,28
11 mm	3,0	0,90	0,15	0,33
13 mm	3,6	0,96	0,18	0,36

5. New features of the FERROMAT

- The basic sensitivity of the FERROMAT DS is approx. 10 dB higher than in the preceding model. Even more sensitive testing is therefore possible, depending on the ambient conditions.
- The effect of the low-pass filter has been improved with more effective filters, now 120 dB/decade. This leads to better suppression of residual carrier frequency.
- There is a new option of working with a speed-dependent HP filter, if an external speed pulse is available.
- The two test channels “Eddy current” and “FERROMAT” are evaluated entirely independently, practically as if they were two separate stations; this gives the user the maximum possible flexibility for assessing the results.



Detectability

Features

