1.13.14. INDUSTRIAL FLAW DETECTION OF METAL PRODUCTS AT HIGH TEMPERATURES

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Nowadays a continuous casting of metal is widely applied and the use of the continuous casting-rolling technology is growing.

The increase of economic efficiency of these technologies requires the solution of some problems of non-destructive on-line testing of hot (up to +1200°C) metallurgical semiproducts quality.

This report is devoted to some issues of creation of NDT equipment of continuous casting metal products at temperatures up to +1200°C.

The development of NDT equipment of hot continuous casting metal requires the overcoming of influence of a few hindering factors, such as:

- high temperature;
- hostile vaporizations;
- considerable surface irregularities of ingots;
- presence of different types of scale on the surface of ingots;
- important natural heterogeneity of the ingot conditioned by arborescent structure of crystallized metal;
- important random changes of the ingot position;
- necessity of NDT equipment design matching with the construction of the existing casting-rolling process equipment.

Several options of engineering realization of methods NDT of hot ingots testing were examined:

- acoustics methods:
- ultrasonic probing waves excite by air shockwave and ultrasound is receiving by the microphone through air (echo and echo-shaded testing scheme);
- ultrasonic probing waves excite by air shockwave and ultrasound is receiving by EMAT (echo and echo-shaded testing scheme);
- ultrasonic probing waves excite by a laser radiation and ultrasound is receiving by laser ultrasonic receiver (echo and echo-shaded testing scheme);
- ultrasonic probing waves excite by a laser radiation and ultrasound is receiving by EMAT (echo, echo-shaded and diffraction testing scheme);
- eddy-current methods:
- absolute multifrequency testing;
- differential single- and multifrequency testing;
- testing by "far field" with separate emitting coils and receiving coils.

All examined methods are noncontact and also allow implementing testing at different size of an air gap between sensors and surface of the ingot under test.

Acoustic diffraction testing method with exciting of an ultrasonics by a laser radiation and reception of ultrasonics with EMAT receiver was recognized as most effective and eligible for industrial application by the aggregate amount of technical-economical indexes.

The industrial multichannel water-cooled EMA receiver for the Laser-EMA defectoscope is designed. The sensor cell is separated from the ingot surface by ceramic plate and by layer of water in the receiver case. The total thickness of protective layer (ceramic + + water) is 8 mms.

The long-time operation of the designed EMA receiver is guaranteed at the temperature of metal up to +1200°C. The developed receiver is used in the Laser-EMA defectoscope of the surface layer of the continuous casting slabs.

Laser in the defectoscope is solid-state Q-switch YAG:Nd laser with flexible fiber output waveguide.

Also, the Laser-EMA technology and industrial system of metering of real position of border of a liquid phase well in an ingot in time of casting were designed.

The designed system allows to catch the moment of formation of a solid frame of an ingot and to estimate a ratio of liquid and solid phase in cross-section of an ingot.

The system is intended for joint use with the equipment of soft-reduction of continuous casting ingots.