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MATRIX EDDY CURRENT PROBES FOR MOLTEN METAL LEVEL MEASURING DURING CONTINUOUS CASTING IN SMALL SECTION MOLDS

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ABSTRACT. This paper demonstrates the application of matrix eddy current probe for molten metal level measuring during continuous casting in small section molds. The results do support the potential for replacing radioactive probes used in small section continuous casting molds by matrix eddy current probes.

Keywords: Eddy Current, Matrix Probe

The eddy current probe, which contains a single sensing coil and provides the amplitude and phase as output signals, unavoidably requires calibration. The matrix eddy current probe, which consists of a set of sensing coils, makes available a distribution of output signals over sensing coils. This allows us to identify the position of electro conductive objects by analyzing the form of this distribution. Because positional information is obtained in an inducted voltage distribution form, the probe calibration is unnecessary.

This paper demonstrates the application of matrix eddy current probe for molten metal level measuring during continuous casting in small section molds. Currently, for an estimation of metal level in small section molds, different radioactive probes are commonly used. But these probes are known as potentially dangerous and have slag sensitivity. The matrix eddy current probe is being developed to replace such probes.

The eddy current probe measures the molten metal level through a copper mold with a wall thickness of 8 – 20 mm (Fig. 1). Its measurement accuracy is approximately 5 mm. The heating of the copper mold during the steel casting process decreases the electrical conductivity of the cooper by more than two times. As a result, the signal (which can be obtained) from molten metal may be more than 30 times weaker than the maximal relative electrical conductivity change. In such a case, it is impossible to use a probe with a single sensing coil due to calibration problems; thus, a matrix probe must be used.

We have developed a computer electromagnetic field model of the matrix eddy current probe. In this model, we also considered the particularities of the temperature distribution in mold volume, which is depended on metal level. Furthermore, we developed special samples to study pertinent characteristics of the matrix probe in laboratory.

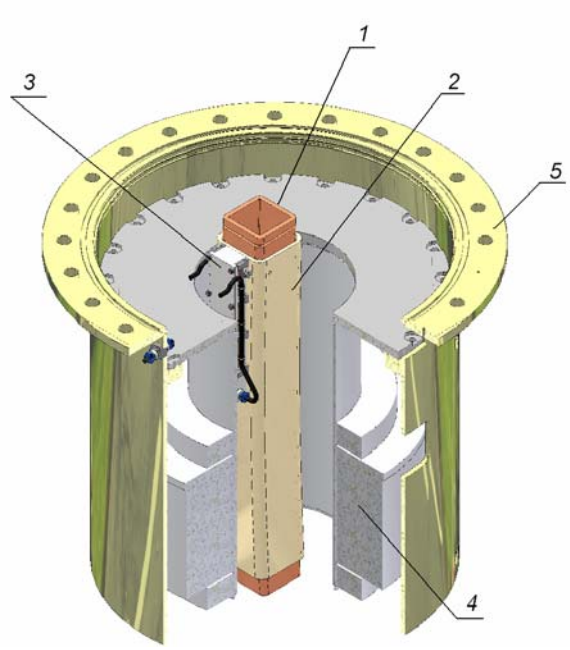

FIGURE 1. Small section casting mold: 1 – copper mold, 2 – stainless shell, 3 – eddy current probe, 4 – electromagnetic stirrer, 5 – casting molds frame

The experiments have been carried out in a 100 x 100 mm mold section, most commonly used in continuous casting. The dependence of output signals on metal level, excitation frequency, and other parameters has been studied (Fig. 2). Based on these results, an industrial model of the matrix probe was developed. This model has passed all necessary tests in working at the "Severstal" metallurgical plant.

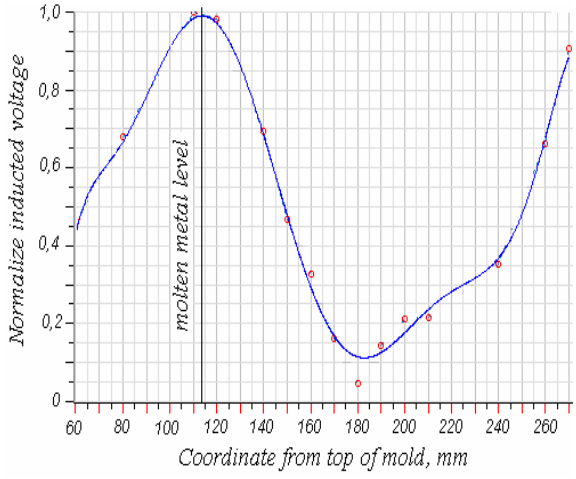

FIGURE 2. Matrix eddy current probe output signal (distribution of inducted voltage over coordinate)

Static and dynamic characteristics of the matrix eddy current probe have been determined during a series of tests. The test results have been used to validate and supplement the results of computer and laboratory simulation, helping to improve the operational capability of the matrix eddy current probe.

The tests demonstrated that basic technical characteristics of the matrix eddy current probe are comparable to those of the radioactive probe. Additionally, there is no slag influence on the matrix eddy current probe signal.

In over 50% of cases, the application of the matrix eddy current probe is limited by the use of electromagnetic stirrers during casting. Nevertheless, the results described in this article do support the potential for replacing radioactive probes used in small section continuous casting molds by matrix eddy current probes.

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