LORENTZ FORCE SIGMOMETRY: A NOVEL TECHNIQUE FOR MEASURING THERMO-PHYSICAL PROPERTIES OF MOLTEN METALS

ALKHALIL[1] S., THESS[1] A., FROHLICH[2] T., KOLESNIKOV[1] YU.
[1] Ilmenau University of Technology / Institut für Thermo - und Fluiddynamik, Germany
[2] Ilmenau University of Technology, Institute for Process Measurement and Sensor Technology, Germany
E-mail: shatha.alkhalil@tu-ilmenau.de

The precise measurement of the thermo-physical properties of molten metals such as electrical conductivity, density, and viscosity are of great importance for industrial applications, in particular, for MHD flow control in high-tech production processes. We term the technique “Lorentz force sigmometry” as deriving from the Greek letter sigma often used to denote the electrical conductivity. In previous measurements techniques a resistance of vessel with two electrodes for measuring electrical conductivity of molten metal has been used [1]. For chemically aggressive hot liquids, there is no suitable material for electrodes. In our technique, we apply non-homogeneous magnetic field acting on a moving conducting fluid in which according to Ohm’s law the eddy currents are induced. These eddy currents produce a secondary magnetic field. In consequence, the interaction of the applied magnetic field with induced eddy currents generates a Lorentz force that breaks the motion of the fluid. At the interaction of secondary and applied magnetic fields, the same force acts on magnet system [2]. By measured this force and the mass of fluid flowing through the magnetic system we calculate the electrical conductivity of the fluid. The results of two series of measurements are presented, one with solid bars made of copper and aluminum to find the calibration factor of the setup then we use this calibration factor to calculate the electrical conductivity of a third solid bar made of brass. Our results compared with working of a commercial device, called by SigmaTest, give the error less than 0.5%. The other measurements are with liquid metal alloy in the composition of Ga67In20.5Sn12.5 at room temperature in order to find the calibration factor which will be used to measure the electrical conductivity of ferrous and non-ferrous molten metals at high temperature in industrial conditions.

References

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