ON THE FLOW PATTERNS DRIVEN BY A HELICAL PERMANENT MAGNETIC STIRRER

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Magnetic fields and electromagnetic forces have long been used to control the flow of a solidifying melt. Recently, low-frequency modulated traveling or rotating magnetic fields attracted more and more attentions because they could efficiently interference solute rejection process of metallic alloy elements during solidifying process, and the study may have a potential to improve macrosegregation. In this study, we construct a helical magnetic field using permanent magnets, namely a series of small pieces permanent magnets magnetizing in their own radii's direction are piled along Archimedes's spiral.

Such helical magnetic field can be considered as the superposition of traveling and rotating magnetic field, and consequently the liquid metal flow driven by such rotating stirrer is three dimensional, to understand the physical underlying is essential for certain electromagnetic process of materials.

The azimuthal and meridian velocity profiles of liquid GaInSn alloy was quantitatively measured using an Ultrasonic Doppler Velocimetry (UDV), which exhibits different flow patterns either secondary flow or global axial vortices in the meridian direction depending on the several key experimental parameters, which include the helical magnetic structure, the ratio of radius of magnetic stirrer and radius of the liquid metal bulk etc. Figure 1 show the schematic of this Archimedes's permanent magnetic field.

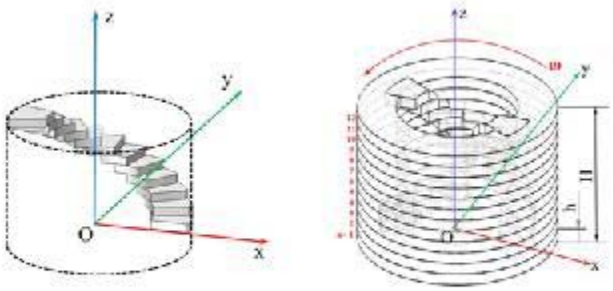

Figure: Schematic of an electromagnetic stirrer constructed on the permanent magnets along Archimedes spiral.