MT 26
International Conference on Magnet Technology
Vancouver, Canada | 2019

Contribution ID: **1306** Type: **Poster Presentation**

Tue-Af-Po2.25-05 [116]: Effect of the iron core air gap structure of superconducting DC induction heater on the heating of aluminium billet

Tuesday, 24 September 2019 14:00 (2 hours)

In aluminium manufacturing plants typical billets having 200 mm diameter and 1000 mm height are pre-heated to a temperature of 723.15–773.15 K in order to soften the metal before it is pressed through the extruder. Due to the similar physical properties of aluminium and copper the efficiency of these heaters is in the order of 50%. In order to improve the efficiency superconducting DC induction heating has been proposed. The idea is to force the billet to rotate in a static magnetic field produced by a DC superconducting magnet with iron core. Since a static superconducting magnet has no losses, the efficiency of the system is the efficiency of the motor used. The magnetic field profile generated by different core air gap structures with a same DC superconducting magnet is different. The heating time and temperature uniformity for the same rotating speed will be different when the aluminium billet is heated to a certain temperature. Therefore, it is necessary to study the influence of different air gap structures on the heating of the aluminium billet.
In this work, the temperature distributions arising from the magnetic field profile produced by a given superconducting magnet under different air gap structure of iron core are reported. The heating time and temperature uniformity vary with the rotational speed are investigated. The two end faces of the iron core are trapezoidal and semi-circular. The radius and length of aluminium billet are 100 mm and 1000 mm respectively. Considering the cryogenic system and the thermal insulation, the distance d between the inner surface of the coils and iron yoke is 85 mm and the distance between the surface of the aluminium billet and iron yoke is 50 mm. Finally we discuss our results in terms of the effect of core air gap structure on heating of aluminium billet and design optimization method of core air gap structure.

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Session Classification: Tue-Af-Po2.25 - Novel and Other Applications III