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M3Or1A-01: Design and test of the HTS magnet of the robust and low maintenance magnetic billet heater "RoWaMag"

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In the manufacture of semi-finished metal products, metal billets need to be annealed at temperatures up to 1100℃ in order to soften the materials for further forming. The annealing process can be performed in conventional furnaces using fossil fuels or by induction heating. The advantage of induction heating is a higher efficiency, shorter heating times and a better temperature homogeneity in the metal billet. However, in conventional induction heaters, where an AC coil surrounds the metal billet, losses are high due to the required AC operation mode. This limits the maximum efficiency to about 50 - 60 %. Magnetic billet heaters with superconducting DC magnets achieve higher efficiencies of 70 - 80 % by rotating a metal billet in a DC magnetic field.

In the framework of the German project „RoWaMag", a robust, low-maintenance magnetic billet heater with a DC magnet on the basis of 2G REBCO coated conductors is being built. The conduction-cooled magnet with an iron yoke is designed to generate a magnetic field of 600 - 700 mT at the center of the heating axis of metal billets with a maximum length of 750 mm and a diameter up to 225 mm. At the ends of the billet, a magnetic field of 500 –550 mT is required. The HTS magnet consists of three rectangular double pancake coils made of 3110 m Theva tape and has outer dimensions of 1179 mm x 1041 mm x 35 mm. The operating current is 505 A.

In first tests of the magnet and cryogenic system, the magnet reached temperatures below 25 K. Stable magnet operation was observed for several days for currents up to 250 A, however, during a further current increase the REBCO part of the current leads burnt due to underestimation of magnetic field and Lorentz forces. In a new design with higher current carrying capability, the current leads were mechanically stabilized and the thermal contact between the warm end and the first stage of the cryocooler was improved.

In this paper we present the design and construction of the HTS magnet, the HTS current leads and the cryogenic system of the magnetic billet heater. We present test results for the magnet and the cryogenic system and give an outlook to the final project stage with integration and operation of the magnet in the billet heater.

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