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Detailed analysis of conduction-cooled MgB₂ for use in superconducting magnetic density separation

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Superconducting MgB₂ wire is characterized to analyze the optimum working point of a magnet system for magnetic density separation (MDS) in terms of the magnetic field and operating temperature. MDS is an innovative recycling technology that selectively separates particles in a waste stream based on their mass density by suspending them in a ferro-fluid that flows through a strong vertical magnetic field gradient. Application of superconducting MDS on an industrial scale will require a user-friendly conduction-cooled magnet system. With its relatively high critical temperature and relatively low cost, MgB₂ is a prime candidate material to realize such a magnet. Since the separation forces depend on the product of the magnetic field and the ferro-fluid magnetization, the optimal design of a superconducting MDS system has to balance magnet cost (CAPEX, higher field implies a more expensive magnet) against the ferro-fluid price (OPEX, higher field allows for a more dilute fluid) and cooling requirements (OPEX, lower temperature implies higher power consumption). To be able to achieve this optimal balance, the critical surface of MgB₂ wire produced by Columbus Superconductors SpA is measured in detail and used as starting point to calculate the most adequate operating point of an MgB₂-based MDS system. This work is part of the research programme “Innovative Magnetic Density Separation for the optimal use of resources and energy” with project number P14-07, which is (partly) financed by the Netherlands Organisation for Scientific Research (NWO).

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