Superconducting Magnetic Density Separation

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We discuss the design challenges and the envisaged solutions that are encountered in the demonstration and implementation of superconducting magnetic density separation (SMDS), a new and potentially wide-spread application area for superconductors.

MDS is a relatively new technique that allows to separate mixed product streams (e.g. shredded waste) based on the mass density of its constituent materials. In contrast to earlier magnetic separation methods, which rely directly on magnetic- or Lorentz-type of forces on the particles, its application is not limited to magnetic or conducting materials. Instead, a product stream is fed in a ferro-fluid that flows through a magnetic field with a high vertical gradient. The balance between the magnetic force that acts on the fluid and gravity that acts on the particles causes the latter to float on a well-defined depth, depending on their density. This technology was pioneered at the University of Delft and is meanwhile commercially available and successfully used with several types of product stream.

State-of-the-art MDS relies on rare-earth-based permanent magnets (PM) to provide the magnetic field gradient. Compared to PM, superconducting electromagnets offer higher flux densities and a more flexible design space, which allow for 5-10 times higher gradients (i.e. separation resolution), smoother field profiles and an about 5 times deeper fluid bed (throughput). Therefore, a consortium of Dutch universities, component manufacturers and end-users is developing a superconducting MDS demonstrator and - in a later stage - prototype system. Key issues in the design of such a SMDS system are economic competitiveness, user-friendliness and reliability. The prototype seeks to meet these requirements with a GM-powered conduction-cooled MgB_2-based system of racetrack coils.

The presentation introduces the principles behind MDS; reviews its application areas; discusses the desired magnetic field profile together with its optimal practical implementation; and finally focusses on the ensuing challenges in terms of the thermal and mechanical housekeeping of an SMDS system.

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