PASSENGER

FOR SUSTAINABLE AND EFFICIENT RE-FREE MAGNETS

FACT SHEET

Rare Earth free permanent magnets: a game changer for a greener tomorrow

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Key facts

- Permanent magnets, crucial in energy, transport, robotics, and medicine, are typically based on rare earth elements (RE), classified as critical raw materials by the European Union due to their high economic importance and supply risk.
- RE mining has a huge environmental and human health impact. Around 98% of these elements used for the European economy come from China, which owns the monopoly and defines the market rules.
- Life cycle assessment shows that RE-free magnets, like sintered ferrite and Mn–Al–C magnets, offer significant environmental advantages over RE-based magnets, including a 95% reduction in impact categories, such as climate change, resource depletion, and human health.
- The comparison of environmental impacts between RE-free magnets (ferrite and Mn–Al–C) and Nd–Fe–B magnets shows potential emission savings of 93% and 87%, respectively, in the category of climate change.
- Social aspects, including health and safety at work, favor the usage of RE-free magnets, with the potential for a 3-12 times decrease in worker accidents (both lethal and nonlethal) compared to RE-based magnets.
- RE-free magnets are a promising option for applications such as electric vehicles, power tools, and appliances, emphasizing the need for continued research and technological development to enhance their properties and applications for a sustainable transition.

Overview

Permanent magnets are an essential part of many modern technologies, including electric cars, wind turbines, and hard drives. However, the process of manufacturing these magnets can be harmful to the environment.

Research performed within the European-funded project PASSENGER (Pilot Action for Securing a Sustainable European Next Generation of Efficient RE-free magnets) in collaboration with the project e.THROUGH, has shown that Rare Earth-free magnets, can be produced with a much lower environmental impact than traditional magnets, because they are made from different materials that don't require as much mining or processing. This means that they can be produced with a smaller carbon footprint.

The study found that RE-free magnets can be produced with a 95% reduction in greenhouse gas emissions. This is a significant improvement over traditional magnets, which can produce up to 69 kg of CO_2-eq per kilogram of magnets. Indeed, the estimation showed that the manufacturing of 1 kg of ferrite and Mn–Al–C magnets causes impacts around 5.1 - 8.2 kg CO_2-eq, if performed in Europe, and 9.7 - 10.1 CO_2-eq, if performed in China, compared to the 69 kg CO_2-eq for each kg of Chinese Nd–Fe–B magnet (baseline scenario).

The researchers also found that RE-free magnets can be produced with a smaller environmental impact in terms of resource depletion and human health.

The study's findings have the potential to significantly impact on the manufacturing of e-vehicles. As the demand for related technologies grows, it is important to find ways to produce them more sustainably. RE-free magnets could be a key part of this solution.

Sustainability & applications

The study proved that the substitution of RE-rich permanent magnets with RE-free magnets (in technologies where it is possible) could not only respond to the raw material supply risk but also represent an environmental and social gain and contribute to global sustainability. The LCA analysis quantified an advantage of both conventional sintered ferrite and prototype Mn–Al–C magnets that demonstrate 95% improvement, compared to Nd–Fe–B magnets, in many environmental categories irrespective of the geographical area where it takes place.

It is evident that this substitution suggested may not be applicable across all fields and applications, given the superior performance of RE magnets. However, **ferrite and Mn–Al–C magnets could serve as the best option for less energy-intensive applications, such as power window/seats in vehicles, switches, fans, blowers in appliances, certain power tools, and loudspeakers and buzzers in electro-acoustic devices**. Additionally, they may prove suitable for the motors of some e-vehicles (e-scooter, e-bike, and e-motorbike) by taking advantage of the possibility of an easy implementation of redesigns.

PASSENGER, which is working on both improved Sr-ferrite and Mn-Al-C magnets as substitutes of RE-magnets, focuses on several applications. The project identified five core products where the RE-free magnets could penetrate the market, particularly e-bikes, e-motorbikes, e-cars, e-scooters, and pump drives. The positive effect that these conversions could have on the market is highlighted by the growing market for these products. The forecasts indicate a growth of 60% for the e-bike market, 50% for the e-motorbike market, 70% for the e-car market, and 25% for the e-scooter market between 2021-2031. Regarding pump drives, the estimations report around a 7.6% annual growth rate in the same decade.

What can we expect in the future?

With rare earth elements facing supply challenges and environmental concerns, finding greener alternatives becomes not just a choice but a necessity. RE-free magnets could offer a promising solution to the environmental challenges associated with traditional magnet production. As research continues in this area, we can expect to see even more environmentally friendly ways to produce these important technologies.

Can you imagine your next electric vehicle or home appliance powered by magnets that not only perform incredibly well but also contribute to a cleaner, safer world?

Where can I learn more?

This factsheet is based on the research article:

Life Cycle Assessment of Rare Earth Elements-Free Permanent Magnet Alternatives: Sintered Ferrite and Mn–Al–C

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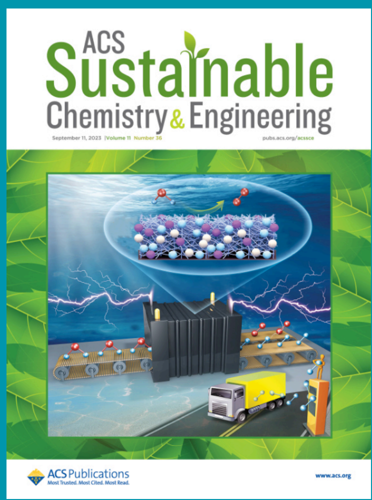

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