Circular economy measures for NdFeB magnets: Development of an eco-labelling and grading system for traceability and better recycling in theory and practice

C. Burkhardt, B. Podmiljsak, S. Kobe

Magnets are one of the most crucial materials necessary for modern Europe, as they are integral to energy conversion across the renewable energy and electric mobility sectors [1]. Unfortunately, even though the alloying constituents of NdFeB magnets have been classified as EU Critical Raw Materials and 90% are produced outside of the EU, there is still no circular economy to reuse and capture value for these types of materials [2].

With the prediction that the need for RE magnets will double in the next 10 years [3,4], this problem becomes even more urgent. At present, the only way to recover end of life (EOL) magnets from waste streams of electric and electronic equipment is by shredding and recycling by chemicals and pyrometallurgical routes, which is expensive and energy intensive [5].

Another problem is that the quality of the recollected materials varies significantly, especially with respect to alloying constituents and state of corrosion and employed corrosion protection, with no classification system for recyclate grades of EOL NdFeB magnets.

To enable a circular economy ecosystem for NdFeB magnets, a whole range of measures is necessary:

a) the development of an eco-labelling system for newly produced RE permanent magnets to clearly identify different magnets types and qualities in order to categorise the EOL NdFeB magnets by technical pre-processing requirements,

b) using the highly effective HPMS process (Hydrogen Processing of Magnetic Scrap) for re-processing extracted materials directly from NdFeB alloy,

c) better treatments to eliminate pre-processing residue which contaminates the HPMS process,

d) upgrading the magnetic properties of EOL NdFeB magnets by tailoring the microstructure, phase ratio and phase composition, and

e) developing industrial up-scalability, including thorough life cycle assessments.

The feasibility of the above proposed measures will be discussed and related to actual results generated in the EU-funded projects Maxycle and SUSMAGPRO, which will have a great impact by overcoming existing low recycling rates due to poor collection, high leakages of collected materials into non-suitable channels, and inappropriate interface management between logistics, mechanical pre-processing and metallurgical metals recovery.

[1] http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_en

[2] Sprecher, B., Xiao, Y.,Walton, A., Speight, J.D., Harris, I.R., Kleijn, R., Visser, G., Kramer, G.J.; Life Cycle Inventory of the Production of Rare Earths and the Subsequent Production of

Nd-Fe-B Rare Earth Permanent Magnets. Environmental Science and Technology (2014) 3951-3958.

[3] Constantinides, S.; Market Outlook for Ferrite, Rare Earth and other Permanent Magnets. International Forum on Magnetic Applications, Technologies & Materials. 21-22 January 2016, Jacksonville, USA

[4]International Energy Agency. Energy, Climate Change & Environment: 2016 Insights

[5] DOI: 10.1021/es404596q