Plasma separation for rare earth elements recycling

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Owing to the great upside potential of plasma separation for nuclear waste cleanup [1] and nuclear spent fuel reprocessing [2], the last decade has seen a renewed interest in plasmas for the purpose of separating elements (see, *e. g.*, Refs. [3, 4] and references therein). For these applications, the mass difference between elements to be separated is typically tens of atomic mass or more, and large throughput processing is highly desirable. This is in contrast with plasma isotope separation techniques developed since the 1970s' [5], which aim at separating elements separated by at most a few atomic mass and typically have a limited throughput. New plasma separation mechanisms are thus called for.

In an effort to address this new need, a suite of plasma configurations offering mass differential confinement properties has been identified in recent years [3, 4]. These concepts rely on a variety of separation mechanisms (*e. g.* gyro-orbit, ion drift, mobility) which are each effective for a particular range of plasma parameters such as magnetization, collisionality and ionization fraction. It is therefore anticipated that these different concepts will display different performances with respect to purification and throughput for a given input stream composition.

Yet another promising application for plasma separation is rare earth elements (REEs) recycling [6]. Indeed, it has recently been shown that separating in a plasma the various atoms found in neodymium - iron - boron (NdFeB) magnets with respect to a threshold atomic mass $m_c = 100$ amu could in principle allow recovering REEs at a cost comparable to the current market price of these elements (Nd, Dy). In this talk, we evaluate how different plasma mass separation concepts proposed to date perform relatively to one another for the particular case of NdFeB magnets recycling and discuss possible pathways for optimization.

References

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