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Innovative and emerging melting technologies for fusion power plants wastes recycling

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To fully maintain the promise of energy production in clean, safe and environmentally responsible way, the nuclear fusion technology must include specific recycling and clearance techniques.

A number of options have been already proposed and investigated to recovery valuable elements, to separate radioactive species, to re-use materials in re-fabrication of components.

Melting based techniques, where materials after use are treated at high temperature and melted, are considered promising candidates, because the melt can be cast in a more compact volume for easier handling, disposal or for producing new components. The melt can be treated in appropriate conditions in order to remove undesired elements or to add species to recovery some specific characteristics, for further re-fabrication.

The most investigated melting options have been derived from well consolidated processes and plants widely applied in industrial sectors for mass production, such as steelmaking, glass, ceramic, foundry industries. The idea is to transfer these technologies taking advantage for the treatment and recycling of nuclear wastes. However the specific cases of radio-activated wastes expected from fusion power plant require significant and accurate re-design of technological solutions and operating conditions to make effective these options.

This paper presents and discusses examples of innovative technologies that could be fruitfully applied in melting processes for fusion power plant wastes treatment. The presented panorama includes technologies already applied at industrial level, in highly specialized, niche sectors, such as skull crucible technique, as well as laboratory and conceptual technology, such as magnetic levitation, still under development, but probably available when fusion power plant will be in service.

The aim of the paper is twofold: to enlarge the spectrum of melting technologies candidate for the needs of fusion power plant waste treatments: to help the individuation of necessary adaptation and improvement of these technologies for the specific case of radio-activated wastes.

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