OPEN TECHNOLOGICAL QUESTIONS OF THE BACK-END OF THE FUSION MATERIALS CYCLE

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Within the framework of the International Energy Agency (IEA), an international collaborative study on fusion radioactive waste has been carried out over the past several years to examine the back-end of the materials cycle. This activity is important to maximize the environmental benefits of fusion as a source of energy. Fusion devices have certain characteristics that make them environmentally friendly devices, such as the potential for recycling all low-level wastes that fusion generates and the avoidance (or minimisation) of long-lived waste that presents a burden for future generations.
In previous studies [1], an integrated approach to the management of fusion materials back-end was proposed, starting from the removal of components from the power plant, to the reuse of materials through recycling and clearance, or the disposal of the low-level waste in geological repositories.
Recycling and clearance procedures, necessary for the spent materials management, pose many open technical questions. The following important technology-related issues were identified:

- Definition of undesirable alloying elements for advanced tungsten alloys – candidate structural alloys for high performance divertors.
- Assessment of radioactivity build-up by repeated reuse of structural materials.
- Dismantling and separation of different materials from complex components: different steps to follow and impact on design requirements.
- Processes for the production of material suitable for recycling (e.g. melting in ingots): re-use the materials in fusion, in fission, in waste management or for other purposes.
- Fabrication of complex components using recycled materials by remote handling and related design approach.
- Study of Li-Pb breeder refurbishment by chemical process for reuse. Recycling processes for non metallic materials (e.g. ceramics) and for high melting temperature materials (e.g. Be and W-rich alloys).
- Activated material storage facilities characteristics and capacity.
- Production of secondary waste during recycling/refurbishing.
- Acceptable limits for radioactive materials in foundries. The current experiences on this aspect are considered.
- Processes to recycle materials that are above the foundries acceptable limit.

The paper discusses these issues, presents a research program for their further development, and the short-term solutions are addressed in more detail. Preliminary results are presented and discussed for selected topics.

[1] M. Zucchetti et al., Fusion Science and Technology, 52, No. 2 (2009) 109-139.