Strategy for environmentally and socially attractive fusion tritium system

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This paper poses some strategic considerations for fusion energy to be deployed in the future as environmentally and socially attractive option, from safety and resource aspects that could be potential constraints if adequate attentions would not be paid.

While environmental and biological behaviour of tritium is being understood, those knowledge have not been reflected well to the technical design of fusion plants. It is pointed out that tritium emission from fusion plant comes from normal operation and thus chronically accumulates in the environment. Fusion plants are thus suggested to locate off-shore sites such as artificial islands or “mega-floats”. Exhausts are to be released from lower stack, preferably through water to take maximum advantage of isotopic dilution of water form, and avoid possible oxidation by soil bacteria. In the case of off-normal spill, washing with water is expected to be effective, particularly high pressure helium that does not condense is selected as coolant. In order to evaluate the acceptable tritium level, that would reach human body is more essential than the concentration at the boundary. So far tritium recovery and removal systems are designed to meet the regulation guidelines at the plant outlet as a point source. Particularly with generation plants large amount of final coolant would be the essential pathway. The authors suggest use of fusion heat for endothermic chemical reaction to produce hydrogen or fuel could be a potentially attractive fusion market. In this application, tritium to be released with coolant is negligible, and the hydrogen containing product that would spread in the market exhibits quite different environmental behaviour.

Fuel resource provides some specific feature of fusion as energy source. Initial tritium loading is a necessary criteria to consider fusion plant. The authors have suggested that the plant, possibly with specially designed low heat load, high TBR blanket can effectively produce initial tritium during the preparatory DD operations of the plant. Liquid blankets have some advantage for precise control of TBR, but use of He-3 or D_2O in the coolant may also be effective. Deuterium supply could be a concern despite of the natural abundance, because the providers are rather limited in the world. However a fusion plant with water detritiation systems with sufficiently large throughput is operated, it can be shown that no additional deuterium supply is needed by the function of the water detritiation.

Thus when fusion plants are regarded as an energy system as a whole, some interesting and attractive features can be identified, that could effectively be taken into account in the process design. This paper suggests that information exchange between environmental/biological and technical, and social researches on tritium are important.