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Development of a tritium-compatible electrolyzer for water detritiation

The radioactive hydrogen isotope tritium is becoming increasingly important in research and industry. Since tritium has a very low availability, a closed tritium cycle is essential for applications on a technical scale, e.g. electricity generation from nuclear fusion. The physical properties of tritium present a particular challenge for safe handling. These include its (i) good permeability through pipe walls, (ii) high corrosivity, and (iii) difficult detection due to low decay energy.

A closed tritium cycle is being operated for over 25 years at Tritium Laboratory Karlsruhe (TLK) [1] to test and develop technologies for safe handling and containment of tritium. The various experiments or decontamination carried out at TLK produce tritiated water (HTO), from which tritium needs to be recovered. One possibility for this is the Combined Electrolysis Catalytic Exchange Process, which was implemented on a technical scale with the TRENTA-facility at TLK [2].

A central element of TRENTA is the electrolyzer, which splits HTO into oxygen and hydrogen isotopologues. Initially, commercial electrolysis units were used as a proof of concept. However, they were not designed for tritium operation and subsequently showed significant deficiencies during operation [3]. For that reason, a dedicated electrolyzer plant was designed specifically for tritium operation. This electrolyzer is based on Proton Exchange Membrane (PEM) Electrolysis and fulfills both (i) the process requirements, which serve the fulfillment of operation parameters and component protection, and (ii) safety-related requirements for radiation protection. Because the plant will be setup in a glove box, emphasis was given to good accessibility, sufficient space for maintenance and a compact construction design.

In this poster, we will present our implementation of a tritium-compatible electrolyzer. The focus lies on the compliance of process and safety requirements for tritium operation, as well as designing a facility with good handleability and easy maintenance.

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