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P3.177 Test facility for the measurement of tritium permeation through fusion power plant materials

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A DEMO fusion reactor will need to be self-sufficient in tritium fuel, with breeding planned within blankets surrounding the vessel. However, at the high temperatures within the breeding blanket region, tritium will readily permeate into the coolant through most materials of construction, causing a loss of this valuable commodity and contamination of the coolant stream. Special coatings have therefore been developed to minimise tritium loss.

A system has been designed and constructed at UKAEA to measure the efficacy of these coatings by direct measurement of tritium permeation at DEMO-relevant temperatures of around 800 K. This presentation explains the novel experimental design, driven by overcoming the challenges of handling a radioactive and explosive gas under such conditions.

High temperature components of the system are constructed from tungsten coated internally with beta-silicon carbide, due to its low tritium permeability at these temperatures. Detection is by a variety of methods to fully sample a range of sensitivities, and hence variations in material permeability. These include pressure rise into a known volume with residual gas analysis measurement, ionisation chambers, and beta-induced x-ray emission from a gold substrate on a beryllium window. A series of containment vessels allows any tritium permeated from the primary containment to be recovered.

The experiment allows an easily-mounted sample to be placed within its housing, with minimal intervention over the duration of a test, estimated to be up to several weeks for the most resistant samples. The system could easily be adapted to measure permeation of any hydrogen isotope through morphologically flat samples at temperatures between ambient and 800 K. Additional detection mechanisms, such as liquid scintillation counting, may be required at lower temperatures for low-permeation materials.

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