
Contribution ID: **266** Type: **not specified**

# Hydrogen isotope permeation experiment - design and first results

*Monday, 17 September 2018 11:00 (2 hours)*

Following the decommissioning of JET, and other future fusion reactors, there will be large amounts of tritiated waste requiring disposal. An appropriate containment strategy is required for storage of this waste. Studies have so far demonstrated that stainless steel appears to be the most promising containment material, but little is known about the permeation of hydrogen isotopes through stainless steel in waste relevant conditions. It is essential that this process is understood prior to the decommissioning of JET and start-up of ITER and DEMO.

An experiment has been designed to replicate waste storage relevant conditions and allow for the study of hydrogen isotope permeation under these conditions. The effect of temperature, humidity and surface uniformity of the steel are being studied for protium, deuterium and tritium.

This unique experimental rig has been built at UKAEA, to support JET decommissioning research funded by the UK Nuclear Decommissioning Authority, and is now carrying out testing with deuterium. The first results have been extremely surprising, with deuterium permeation significantly lower than expected for unbaked stainless-steel samples. This phenomenon is being further investigated to determine the cause, but is currently thought to be due to the protium content of the steel preventing diffusion of other hydrogen isotopes. This theory is supported by further experimental results indicating that baking the samples at 400℃ to remove protium prior to commencing experimental work increases the permeation dramatically, to be in line with computational models. X-ray photoelectron spectroscopy and thermal desorption spectroscopy are being conducted to further understand the nature of the samples and rule out surface contamination or other unexpected effects.

The outcomes of this work are entirely unexpected; no published literature appears to have investigated this phenomenon. The results are expected to have wide-ranging consequences for the storage and containment of tritium and tritiated waste worldwide.

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**Session Classification:** P1