Advanced Gas Reactor Fuel and its Behaviour During Drying

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Spent Nuclear Fuel Strategy

The current plan is to interim wet store the spent fuel pending a decision on final disposal.

To reduce the risk of corrosion the ponds are dosed to a pH of 11.4 [1].

Final disposal is expected to be to Geological Disposal Facility in 2075.

Dry storage is being investigated as an alternative storage method and as a prerequisite to disposal.

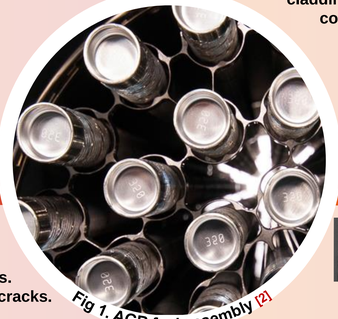


Fig 1. AGR fuel assembly [2]

Why Dry Spent Fuel?

For either dry interim storage or disposal, spent fuel must be dry to reduce the risk posed by radiolysis.

If fuel has failed then water could seep through cracks in the cladding during wet interim storage and come into contact with the fuel.

Radiolysis can produce H_2 and H_2O_2. H_2 is explosive while H_2O_2 is corrosive and will exacerbate the issue.

Research Objectives

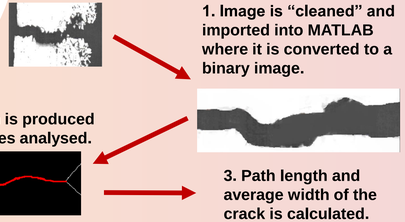
Experimental:

1. Produce representative cracks in stainless steel.
2. Measure the leak rate through pinhole defects.
3. Measure the flow rate of gasses through the cracks.
4. Validate the process model.

Computational:

1. Model the flow of gasses through the pinholes.
2. Model the flow through a crack network.
3. Characterise the cracks produced.
4. Validate the model using the drying rig.

Image Analysis



1. Image is "cleaned" and imported into MATLAB where it is converted to a binary image.
2. Skeleton is produced and triangles analysed.
3. Path length and average width of the crack is calculated.

Image Analysis Results

Sample	% Variation Length	% Variation Width
	0.04	4.98
	4.45	1.45
 [3]	13.34	4.54
 [4]	1.33	7.20

Process Model

After comparing approaches to experimental data the method by Beck et al (given below) was determined to be the most suitable [5].

$$0 = \frac{\rho u^2}{2}\left[N\left(1-\left(\frac{d_{eff}}{d}\right)^2\right)\right] + \frac{2u}{\rho}\left[\frac{12\mu l_{eff}}{d_{eff}^2}\right] - \Delta P$$

Drying Experiments

Initial validation of the process model has been performed with pinholes of various diameters.

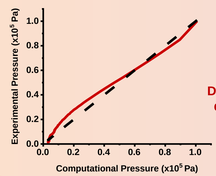


Fig 2. Test Piece

Producing Cracks

Adapted from a method to produce stress corrosion cracks in stainless steel for the marine and oil & gas industry [6,7].

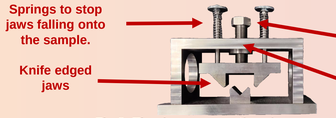


Fig 3: The drop evaporation rig

The sample is stressed, heated and then a chloride solution is dripped onto the sample to induce cracking.

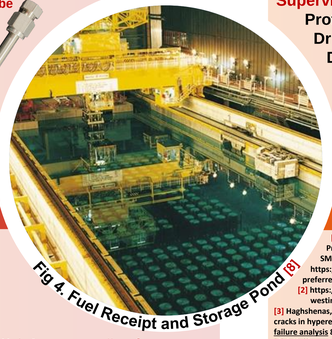


Fig 4. Fuel Receipt and Storage Pond [8]

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