Development of Grid Cell Size Test System with Pin Gage in Hot Cell

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1. Introduction

The spacer grids supporting the fuel rods absorb vibration impacts due to the reactor coolant flow, and grid spring force decreases under irradiation [1,2]. This reduction of contact force might cause grid-to-rod fretting wear. Thus, it is important to understand the characteristics of cell spring behavior and the change in size of grid cells for an irradiated spacer grid.

Test set-up using camera and motor driven x-y-z axis was installed and used for the dimensional measurement of the irradiated material in a hot cell. This dimensional measuring equipment has the flexibility by employing a camera and this allows the operator to measure an irradiated material with variable shape in a hot cell. The measuring result can be varied depending on the alignment status between the camera and the material on the table, but there is a limit of alignment because of the hot cell operation.

In the present study, the new measurement system using a pin gage is introduced to measure the cell size of an irradiated spacer grid and the dimensional measurement of a spacer grid was conducted to investigate the cell size of an irradiated spacer grid in a hot cell at IMEF (Irradiated Materials Examination Facility) of KAERI.

2. Methods and Results

The dimensional change of the spacer grid cell should be measured to investigate the irradiation effect on the deformation behavior of the cell spring and dimple. The cell size can be measured as the distance between a tangent of the cell spring and the dimple horizontally and vertically, as shown in Fig. 1.

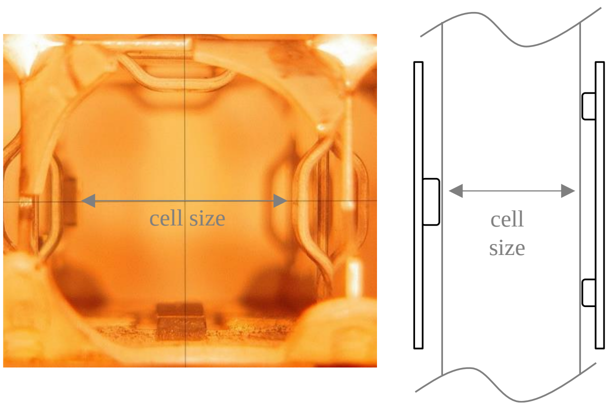

Fig. 1. Image and schematic illustration of a cell size of a spacer grid.

As shown in Fig. 2, the existing three dimensional measurement apparatus consists of a measurement part in a hot cell and a controller part in an operating area. The x-y table can be moved so that the camera can take the images of the parts (such as spring and dimple) of the grid at two different positions. The displacement of the x-y table is measured using the linear scale, and its coordinate values are then converted into the distance between two points using a dimensional measurement program.

The grid cell size measurement system using pin gage is newly proposed as shown in Fig. 3. The features of the standing fixture include the x-y table, the z axis, the grid holding fixture and pin gages. The motor driven x-y table has a function for horizontally positioning the grid and is equipped with the grid clamp for holding the grid so the pin gage can be dropped into the grid cell being tested.

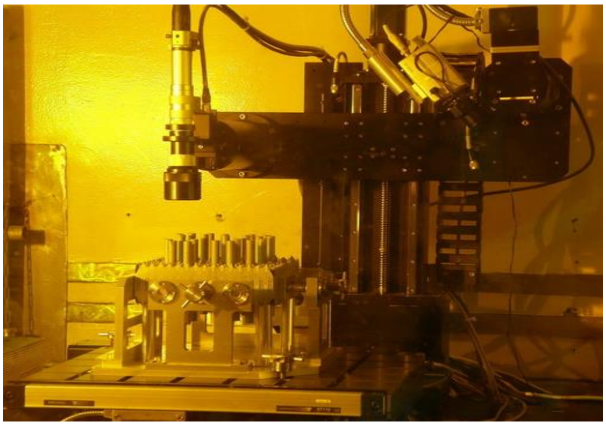

Fig. 2. Experimental set-up for the three dimensional measurement of an irradiated grid in a hot cell.

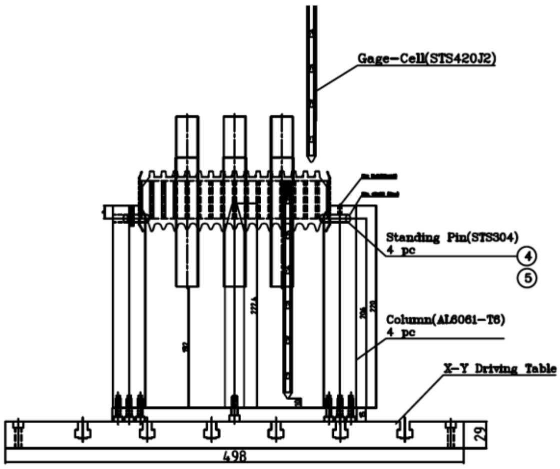

Fig. 3. Schematic diagram of the grid cell size test set-up.

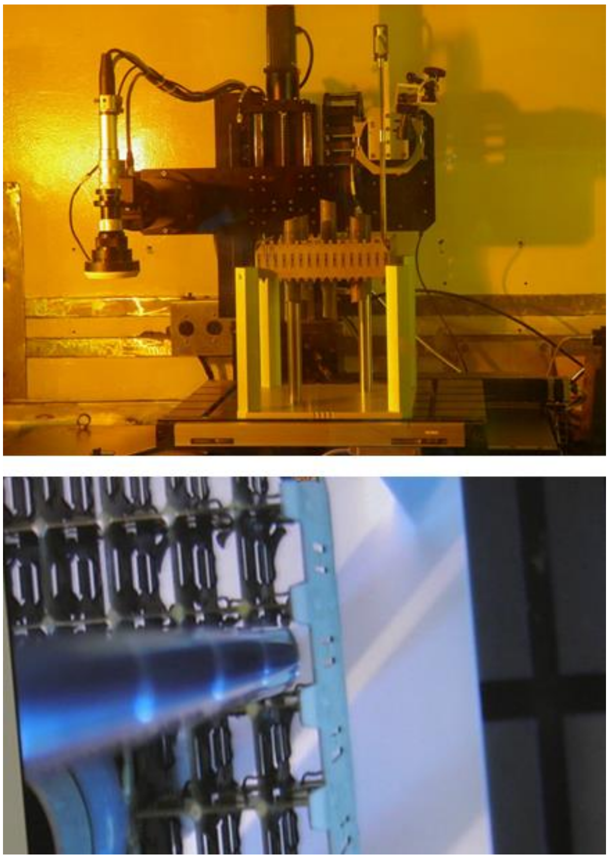

Fig. 4. The position of the test set-up in a hot cell (upper) and the pin location through the camera (lower) at the beginning of the grid cell size measurement.

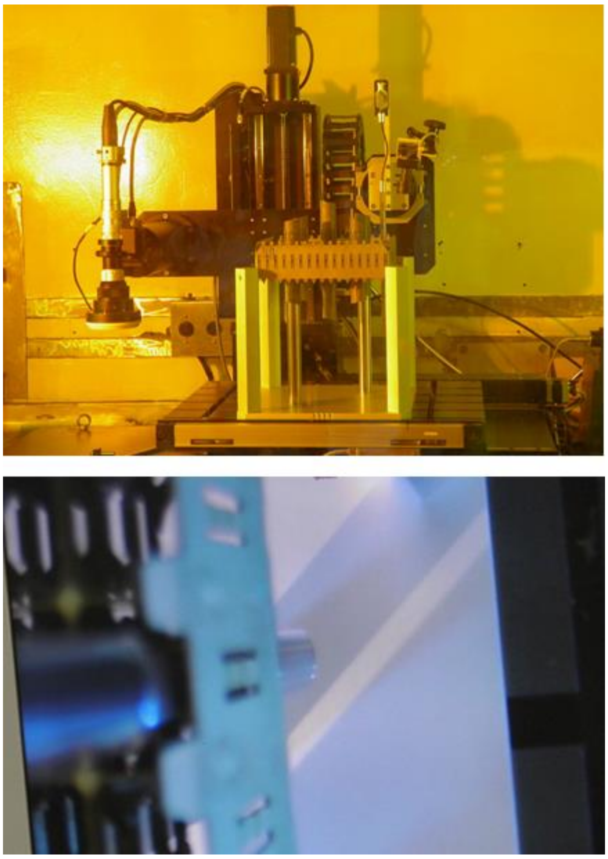

Fig. 5. The position of the test set-up in a hot cell (upper) and the pin location through the camera (lower) when the string goes slack.

The holding fixture should be designed to be enough distance to allow the pin to be fully inserted. The motor driven z axis can move vertically with digital display of vertical position and transport the pin gage to the grid cell being tested. The stepped pin gage has six sections that can cover the certain range of diameters and five pin gages were prepared to cover the whole cell size of the irradiated spacer grid. Each rod pin gage has visual marking on the flat surface of two sides of the pin for the diameter identification during the measurement. The flat sides have a function to prevent any interference from the grid cell geometry. Each pin consists of three parts; the holding plate, which is used to be hung up the z axis, the braided string and the stepped pin. The pin gage fabricated need to be calibrated before the installation and measurement in a hot cell.

The procedures to be used to determine the size of specific cells in a spacer grid in a hot cell can be described as follows. A spacer gird is placed into the grid holding fixture to secure the grid in a fixed position during the test. The x-y table is moved to the location of a grid cell being tested. The z-axis moves the pin into the grid cell being tested from the top of the grid as shown in Fig. 4. The pin is continuously lowered into each grids cell until the string goes slack as shown in Fig. 5.

The gage diameter marked on the pin is recorded and the gage pin can be removed by moving the z axis slowly up. If the smallest dimeter of the pin doesn't go into the grid cell, select a pin with an appropriate diameter and change the pin using the manipulator. The procedures can be repeated for all designated grid cells to be measured.

3. Conclusions

The new measurement system using a pin gage is introduced to measure the cell size of an irradiated spacer grid in a hot cell. The examination apparatus was designed to be controlled remotely for the highly radioactive substance in a hot cell. This cell size test set-up can be used to evaluate the fretting wear performance of an irradiated spacer grid for future hot cell examinations.

REFERENCES

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[2] M. H. Attia, On the Fretting Waer Mechanism of Zr-alloys, Tribology, Vol.39, p.1320, 2006.