Answer to rod displacement issues in BFBT Benchmark

Effects of rod displacements on subchannel void distributions have been discussed by Matthieu MARTIN (CEA Saclay) [(1)] at the 5th BFBT workshop. Some questions were raised. In order to respond the questions, a confirmation process has been initiated with a responsible person for the NUPEC BFBT experiments. Since the detailed test report has been disposed of, the answer is based on the memory of the responsible person.

Question 1 (Q1)

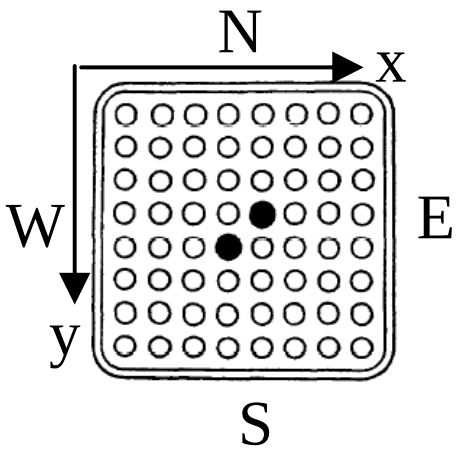
When converting the fine-scale void map to the sub-channel void map, the x-y axis must be permuted to ensure consistency between rod displacements and void map distortions?

Answer 1 (A1)

It is not permuted. The x-y axis is consistent with that of the CT data.

The coordinates of the void fraction measurement are defined by Figure 2.4.2 in the BFBT Benchmark Specifications (Volume I). The x-y axis is defined by Cartesian coordinates with the origin in the Upper-Left corner.

Figure 2.4.2 Void Fraction Measurement Directions



The x-y axis of the void data is consistent with the definition as follows.

CT void fraction data:

y/x	1	2	3
1	888.0	888.0	888.0
2	888.0	888.0	888.0
3	888.0	888.0	888.0

Sub-channel averaged void-fraction data;

y/x	1	2	3	4	5	6	7	8	9
1	7.3	16.9	18.2	14.3	14.5	14.9	19.3	16.6	9.5
2	16.8	31.1	33.0	26.3	25.8	29.5	32.7	29.2	19.6
3	21.0	36.1	43.0	38.9	35.5	39.0	38.8	36.7	20.3

Figure 1 is the constructed picture from CT data for 0011-56 in the test report submitted from NUPEC to METI. Water rods are on the line of NE-SW.

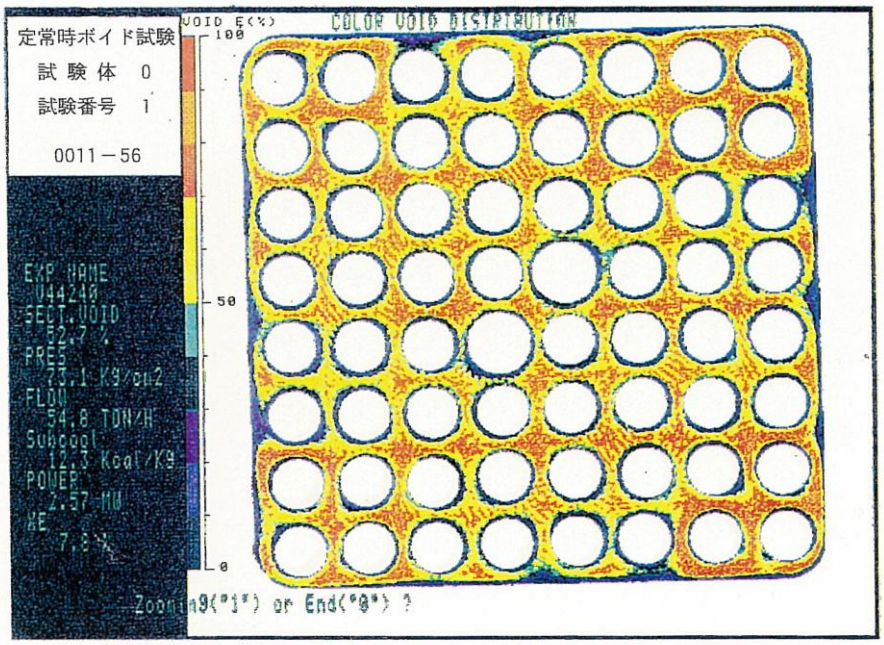


Figure 1. Constructed picture from CT data for 0011-56

On the other hand, water rods are on the line of NW-SE in the constructed picture for 0011-56 in Ref. (1) where the origin of the coordinates is in the Lower-Left corner.

In order to avoid such confusion for the coordinates, it is suggested that the participants use the Cartesian coordinates with the origin in the Upper-Left corner for the constructed picture, consistently with the measured void data.

Q2

What is the definition and position of the “sub-channel filter”?

A2

The following process was performed to produce the “subchannel filter”.

A similar process has been already done by the ANL team [2] in this benchmark.

1) Central Subchannel

- Identify the structure (channel box, rods) based on the CT data
- Identify the center of each rod
- A subchannel is defined by the square made by the centers of 4 neighboring rods
- In case there is a large water rod in the center, nine subchannels are defined by the grid made by the centers of surrounding 4 by 4 rods

2) Side and Corner Subchannel

- Extend the line connecting the centers of the rods to the channel box
- A sub-channel is defined as the area made by the extended line and the channel box

Q3

How to propagate the geometrical uncertainties through the code?

A3

As for the geometrical uncertainties we may follow Volume II of the BFBT Benchmark Specifications - page 14 (as follows). Effects of rod displacements on subchannel void distributions would be studied in Exercise I-4.

As it can be seen in Figure 3.1.1 the assembly walls are not quite horizontal or vertical. The deviation for the horizontal (W-E) or the vertical (N-S) is 4 pixels in each edge.

The average deviation of rod centers from the designed (in pixels) is shown to be about 1.5 pixels for both the *x* and *y* errors.

Based on the observation of the X-ray CT scan data (see Figure 3.1.1), one can make assumptions about the distortion for the heater pin and the channel box, which can quantify the accuracy of the rod diameter due to manufacturing (1.5 pixels), the accuracy of the rod pitch (1.5 pixels), and the accuracy of the bundle inner width (4 pixels).

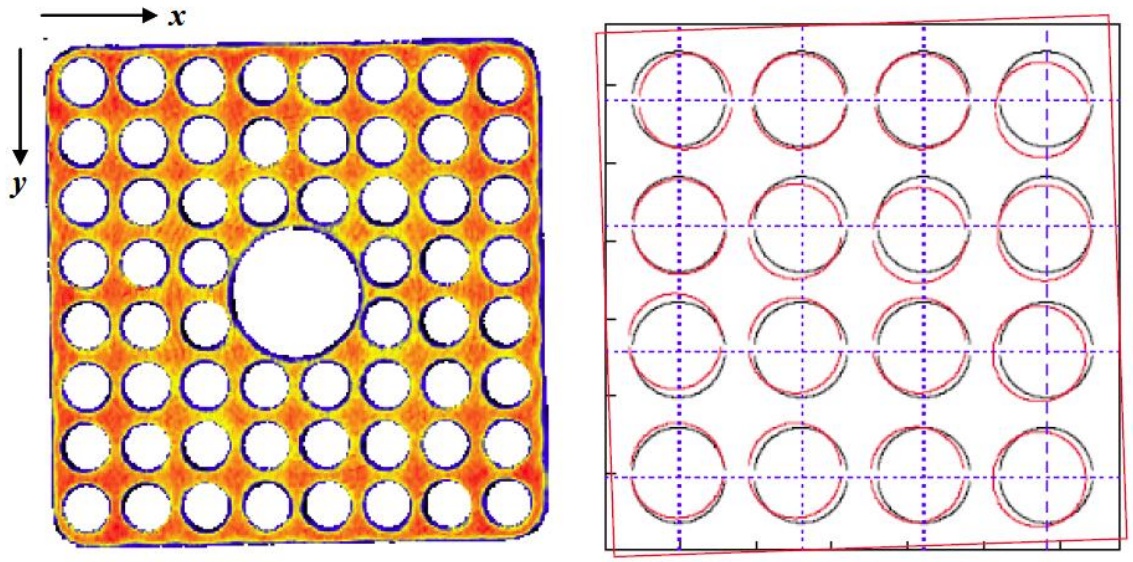


Figure 3.1.1: Distortions of test assembly observed with fine-mesh void measurement

References

(1) Analysis of experimental data for duplicated tests: Effects of rod displacements on subchannel void distributions, Matthieu MARTIN, CEA, BFBT-5 Garching, April 1, 2008.

(2) E-mail communication between A. Tentner and H. Utsuno, June 2007.

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