Questions about NUPEC Benchmark

Markus Glück, 20 June 2005-06-11

I like to ask some questions about the **measuring data** at the following example cases:

Void_Fraction_Test / Steady_State / 0011-55

- **Question 1:**

  What about the *negative* void fractions (chordal average, cross-sectional average) in the measuring data? Are these measuring errors and to be count as zero?
  A: Yes it is. It shall be treated as zero.

- **Question 2:**

  Is there any sketch where the lateral directions (x and y) are to be seen?
  A: See figure, x direction is west to east and y direction north to south.

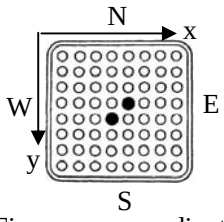


Figure x-y coordinates

- **Question 3:**

  In which direction (x or y) lie the alleys which are used for the chordal averaging? Or are all geometries and the related radial power profiles symmetric in such kind that the above mentioned direction is not relevant?

  A: The chordal averaging (X-ray beam) direction is from west to east (x direction). The order of data is from north to south (y direction) that means ROD1 to ROD9 correspond y=1 to 9 each in the steady-state void fraction data.

- **Question 4:**

  Why do the "CT Sub-channel Averaged void Fractions" of symmetrical channels differ so much?
  E.g.: In the current case '0011-55' the radial power distribution is uniform. Regarding the symmetrical geometry of the bundle, in my opinion the void fractions in sub-channels (x = 1, y = 1) and (x = 9, y = 9) should be equal. But in the given table they have the values:
  (x = 1, y = 1): **39.3** %
  (x = 9, y = 9): **32.2** %
  This is much more than the given measuring accuracy of 3 %, which is given in table 2.4.2.
  There are a lot of examples of that kind. Was there really a uniform radial power distribution used.

  A: Although some manufacturing error may exist, for the benchmark analysis using a radial power distribution defined in the specification is suggested. As for the above discussion on the symmetry, the void fraction at the moment at the fixed location fluctuates due to a nature of the bubbly or slug two phase flow. It's not a homogeneous flow, but gas phase at the moment and liquid phase at the moment. Because the measurement was conducted by the X-ray CT scanner in time domain within a rotational scanning time of 15 s, some disparity of the void distribution from the symmetry could occur.

Void_Fraction_Test / Transient / 4102-001~009

- **Question 1:**

  In the data file's table header for the densitometers there is written "*Chordal* Averaged void Fraction". Is it not the "*Cross-sectional* averaged void fraction" each?

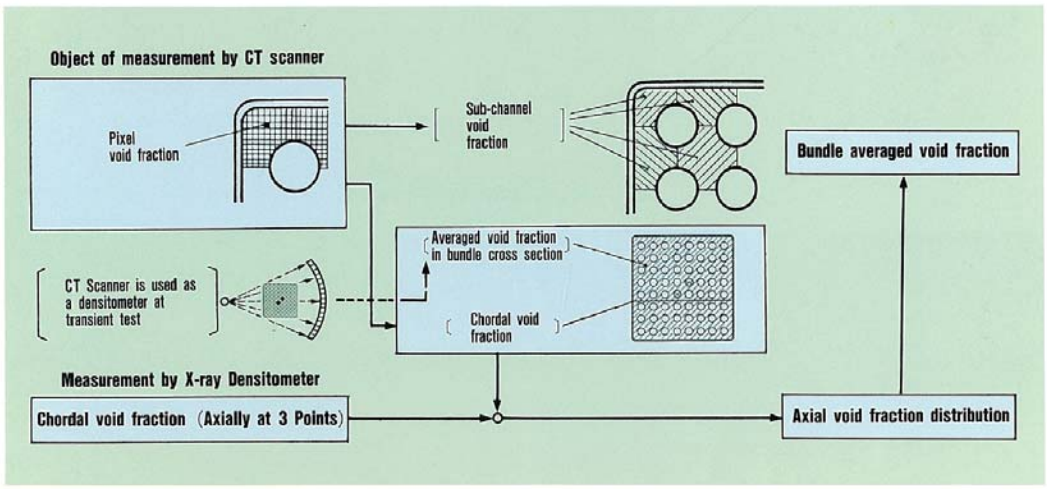
  A: Void fraction measurement system is shown in below. Void measurement with a fixed X-ray beam was referred as "*Chordal*". In the transient the X-ray CT scanner is not rotated but fixed. CT Chordal Averaged void fraction is redacted from data measured with the fan-shaped X-ray beam of 34 degree radiation angle at the fixed position. The X-ray densitometer was fixed at the y position in the transient and was moved in y direction (y=1 to 9) with test by test. Therefore the same transient case was repeated for nine times. Each data is called as "*Chordal* Averaged void Fraction" (same as in steady-state data). In the transient data file's, CT Chordal Averaged void fraction is the value averaged over nine times measurement of it and DEN Chordal averaged void fraction is the value averaged over measurement at the position y=1 to 9.

- **Question 2:**

  Why is at the beginning of the transient (steady state) the averaged void fraction at the higher elevation (CT) lower than at the lower elevation (DEN #1)?

  A: It could occur. According to the steady-state void distribution data measured with the X-ray CT scanner, it is a center-peaked between rods. As for CT Chordal averaged void fraction, the fan-shaped X-ray beam covered over the cross section. On the other hand, in DEN Chordal averaged void fraction, the X-ray beam was through at the center of between rods.

Void fraction measurement system



Specifications of X-ray CT Scanner

· Method of scanning	: 360 degree rotation with pluse X-ray
· Type of X-ray beam	: Fan-shaped X-ray beam of 34 degree radiation angle
· Voltage of X-ray tube	: Max. 120 kV
· Current	: Max. 400 mA
· Scanning time	: 15 sec
· Scanning region	: ϕ300mm
· Sampling time	: 12 sec for 360 degree rotation Max. 60 sec (Variable) as stationary densitometer
· Number of pluse	: 800/sec
· Dimensions of reconstruction element	: Appox. 0.3mm×0.3mm

Specifications of X-ray Densitometer

· Method of measurement	: Continuous X-ray at fixed position
· Type of X-ray beam	: Pencil type beam
· Voltage of X-ray tube	: Max. 160 kV
· Current	: Appox. 19 mA at 160 kV
· Sampling time	: Max. 60 sec (Variable)
· Synchroniza-tion	: 3 X-ray densitometers synchronize with X-ray CT scanner for data gathering

Answered by

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