ASTM D3803 Precision and Bias for New Versus Used Activated Carbon, Revisited

Peter Freeman,
Jacobi Carbons, Inc.,
432 McCormick Blvd.,
Columbus, OH 43213

ASTM D3803 Precision & Bias

- Current D3803,"Standard Test Method for Nuclear-Grade Carbon" precision follows E691, "Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method":
- Tests performed on presumably identical materials under presumably identical circumstances do not, in general, yield identical results.

ASTM D3803 Precision & Bias

- Many different factors (apart from random variations between supposedly identical specimens) may contribute to the variability in application of a test method,
- These include: the operator, equipment used, calibration of the equipment, and environment (temperature, humidity, air pollution, etc.).

ASTM D3803 Precision & Bias

- Precision, when evaluating test methods, is expressed in terms of two measurement concepts, repeatability and reproducibility.
- Under repeatability conditions the factors listed above are kept or remain reasonably constant and usually contribute only minimally to the variability.
- Under reproducibility conditions the factors are generally different (that is, they change from laboratory to laboratory) and usually contribute appreciably to the variability of test results.
- Thus, repeatability and reproducibility are two practical extremes of precision.

ASTM D3803 Precision & Bias

- Current values for D3803 precision following E691 are:
- Repeatability = 0.76 at 1 % Penetration

  (95 % Confidence Interval: 0.32 to 1.85 % Penetration)
- Repeatability = 1.77 at 10 % Penetration

  (95 % Confidence Interval: 8.30 to 11.84 % Penetration)

ASTM D3803 Precision & Bias

- Current values for D3803 precision following E691 are:
- Reproducibility = 0.77 at 1 % Penetration

  (95 % Confidence Interval: 0.31 to 1.85 % Penetration)
- Reproducibility = 1.77 at 10 % Penetration

  (95 % Confidence Interval: 8.30 to 11.84 % Penetration)

ASTM D3803 Precision & Bias

- Current D3803 precision following E691
- This data is shown in detail for the six participating laboratories in Appendix 5 of the standard
- It represents testing new and used carbon at 95% RH
  - New Carbon average result: 1.082% penetration
  - Used Carbon average results: 10.072% penetration

ASTM D3803 Precision & Bias

- Current D3803 bias statement:
- “Bias depends on exact conformance to the empirical conditions of the test.
- Interlaboratory comparisons have shown that results from laboratories which do not rigorously follow the specifications for test system design, operation, and calibration often exhibit a very significant bias.
- This bias cannot be corrected for because of the non-uniformity of the effects of variations of the specified parameters and procedures on different carbons.”

ASTM D3803 Precision & Bias

- This testing at 30 °C and 95% RH works well for new carbons tested to AG-1 (batch test)
- And for new and used carbons tested according to Reg. guide 1.52 for ESF systems and 1.140 for non- ESF systems
- But both 1.52 and 1.140 allow testing at 70% RH for systems with RH control

ASTM D3803 Precision & Bias

- In order to add this test to D3803 we need round robin data to develop a E691 precision statement
- But a minimum of six labs are needed!
- So decided to go data mining!

ASTM D3803 Precision & Bias

- Data were presented at the 19th DOE/NRC NACC
  - By Chris Scarpellino and Claude Sill of INEL sponsored by the NRC
- Although not the final data, 70% RH tests on used carbon were performed by the same labs that participated in the final round robin (except for one)

ASTM D3803 Precision & Bias

- The data for six labs was used, each performing three tests on the same sample:

Laboratory	Penetration ± STD. DEV, %	Final moisture Content, %	Test Bed Density, g/ml
1	24.5 ±1.0	26.5 ±0.4	0.573 ±0.011
3	19.0 ± 0.3	23.6 ±0.5	0.572 ±0.002
6	19.1 ±0.6	26.1 ±0.7	0.600 ±0.006
7	24.1 ±0.6	21.3 ±0.08	0.570 ±0.017
9	22.8 ±1.1	24.7 ±0.6	0.571 ±0.005
11	24.9 ±0.5	24.6 ±0.8	0.556 ±0.003

ASTM D3803 Precision & Bias

Results:

Average penetration: 22.4%

Repeatability at 95% confidence level: 2.7%

(19.7 -25.1%), S_r = 0.545 %

Reproducibility at 95% confidence level: 7.6%

(14.8-30.0%) , S_R = 2.73%

ASTM D3803 Precision & Bias

The question then is this acceptable precision for used carbon at the 22% penetration level?

The floor is open for discussion and questions.