Q & A

Some modelers had questions regarding the Challenge problems. In the interest of clarity, the questions and their answers are posted below, so that every modeler can benefit from these clarifications.

<u>CFB-related Questions:</u>

Q1. What is the meaning of the unit "SCMs" in the Test Cond. sheet?
A1. "SCMs" stand for "Standard cubic meter per second".

Q2. How do you get "Riser Superficial Gas Velocity at the Bottom" from the "Volumetric Gas Flow at the Riser Bottom"?
A2. The superficial gas velocity at the bottom of the riser is corrected for T and P, and this information is described in the comment field for the table column. This is given only as a useful reference point. The reported superficial velocity is that velocity at the bottom of the riser at the actual pressures and temperatures at that location. The outlet pressure of the riser was at the ambient outside conditions. Thus, it is necessary to correct the superficial velocity reported at the riser bottom to compensate for the differences from the standard conditions.

Q3. In the "Axial Profile", the unit of pressure gradient is "kg/m3" at different heights, while the locations are the same as the locations of pressure taps, so how to get the differential pressure?
A3. Each location was identified at the top of the interval being measured. If the high pressure was measured at 2.5 m and the low pressure at 2.8 m, then the location of the interval would be defined as 2.8 m and the interval would be 0.3 m.

Q4. How much solids are input in the CFB (or the solids inventories) of different cases?
A4. Information on total solids inventory in the system for different operation conditions is now available on the website. It should be noted that total solids inventory was not a controlled parameter, because the measurements were made over the period of several months and the primary process parameter was the solids circulation rate as measured by the spiral. We have estimated what the total inventory for each test run using the SP height, the Lvalve inventory, and the riser dP (assuming minimal contributions in the cyclone, crossover, free-fall region of the SP, and stress at the riser wall) and provided the variability we had. The variance in these tracked inventories was relatively small and is also provided.

Q5. How many holes are in the L-Valve Sparger?
A5. The L-valve sparger is a continuous porous tube such that the gas flow is uniformly distributed across the length of the L-valve along its bottom. We have laid porous tubes across the bottom of the L-valve. The tubes exhibit sufficient pressure drop at these flow rates to insure uniform flow. There are countless number of holes, each being tiny.

Q6. What is the detailed configuration and flow of the standpipe aearation? (include the location, diameters of the holes, and velocities at these inlets)?
A6. We controlled the mass circulation rate via feedback from the spiral to alter the mass flow controllers in the Standpipe and not the aeration rates; however, we did track the flows. The aeration rates are distributed along the length of the standpipe. A list of the mass flow controllers used, their locations, outlet pipe size, and the variability in the flows have been uploaded to the website. The velocities can be determined from the flows and areas at standard or calculated process conditions. We also estimate the air flow being carried along with the solids into the riser from a model of the standpipe. In the original statement of the flows, this flow was added into the aeration flow being carried along with the solids into the riser.

Q7. Are both gas tracer injection ports flowing at the same time?
A7. In practice the answer is No, the concentrations were measured at different times so that the effects of one CO2 injection did not influence the downstream measurements.

Q8. What are the restitution coefficients for the Group A and Group B materials?

A8. We do not measure coefficient of restitution for these materials. It is hoped that any critical model parameters could be estimated by comparing the minimal fluidization test data as provided for each bed material.

Q9. Can I get the native CAD file, hopefully in Inventor format?
A9. CAD format files are on the website. There are no further CAD drawings available at this time.

Q10. What is V-500? Is it a feed hopper?
A10. V-500 is indeed the feed hopper. V-500 stands for Vessel 500 in P&ID nomenclature.

BFB-related Questions:

Q1. Case 1 and Case 2 are defined as having a pipe manifold; however, the results spread sheets indicate that Case 1 and Case 2 have ring spargers. Please clarify.
A1. Both Case 1 and Case 2 used a PIPE MANIFOLD. I'll correct this in the spreadsheet. The figure for the pipe manifold is Fig. 4 (referred to as Fig. PSRI-4 in the spreadsheet tables to avoid confusion with NETL figures).

Q2. What is the diameter of the bubble probe?
A2. The bubble probe diameter is 1 in (25.4 mm). Note that the 1 inch steel tube carries two 5/16 inch (8 mm) parallel steel tubes (one vertically above the other), whose centers are 0.5 in (12.7 mm) apart - there are spacers at both ends. These two smaller tubes are the ones that have the optical fibers. We refer to each tube as a concentration probe. To be more specific, the two protrude 0.5 in (12.7 mm) from the flat end of the 1 inch tube.

Q3. Are the wall pressure measurements made with the two bubble probes inserted into the flow field? I assume that you have two symmetrically positioned bubble probes. The problem statement indicates that the pressure measurements are all made simultaneously, but it is unclear where the probes are located. Are the pressure results the same regardless of the probe positions? If so, could you let everyone know?
A3. There are two symmetrically positioned bubble probes referred to as Probe 1 and Probe 2 or also as PSRI1 and PSRI2 in the spreadsheet. Measurements are started with the two probes positioned at the outermost radii. They are then moved inwards. Measurements at the r = 0 are done with one probe at a time - ideally they should read the same. The pressure fluctuations measurements are obtained by purged tube probes (0.25 in OD) that are positioned, at all times, 1 in (25.4 mm) from the column inner wall. Pressure probes are not traversed - the bubble probe signal at location r is simultaneously sampled with pressure signals at 4 circumferential locations around the column, 1 inch from the wall.
IN ADDITION: There is another set of pressure sensors that measure average static pressure drops across sections along the height of the column. These measurements give an indication of the average suspension density in the column as a function of height. Plastic tubings were used to connect 0.25 inch snubbers (threaded connectors with a sintered metal disc) to pressure transducers.

Q4. Does the pressure probe measure the total normal stress at the wall? The documents imply that the pressure probes only record the hydrostatic pressure. Is this an assumption or a matter of experimental design?
A4. We were only concerned with hydrostatic pressure.

Q5. Is the flow statistically stationary, statistically periodic, or statistically unsteady? Are the influent and effluent boundary conditions unsteady?
A5. Statistically stationary. A batch of material was loaded into the column to the required static bed height. Air was introduced slowly until the required fluidizing velocity was reached and then maintained constant. The given superficial gas velocity is based on the conditions at the bottom of the bed. The outflowing air exited via cyclones, where entrained solids (assume 100% collection efficiency) were separated out and sent back into the column via the cyclone diplegs. The air then entered a baghouse and was vented out into the atmosphere.

Q6. How long does the experiment run before the wall pressure measurements and the bubble samples are

extracted? Are the components of the velocity measured?
A6. Data was sampled when the unit attained steady state. Generally, it took between 30 minutes and an hour. I'm not sure what velocity components you are referring to. If it is the bubble velocity, then the interest was the vertical component. The bubble probe gives out two data sets (in volts), one from the bottom sensor and the other from the top sensor (referred to as PSRI1BOT and PSRI1TOP for bubble probe 1 and PSRI2BOT and PSRI2TOP for bubble probe 2). The data gives indication of the solids concentration at the given location. The passage of a bubble (void) at the measurement location can be identified from the bubble probe signal.

Q7. The drawing provided in the PSRI spreadsheet (see Test Unit:PSRI Fluid Bed tab) implies that an "air distributor" is located about 208 cm from an end plate that covers the bottom of the column (see Notes 3 and 4) . The ring sparger and the pipe distributor are below this level. Could you clarify the reference points for the dimensions referred to in Notes 3 and 4? Is there a "support screen" that retains all of the solids? If so, where is it located?
A7. The two air distributors (pipe manifold and ring sparger) were used one at a time. Tests at a gas vel of 1 ft/s used the pipe manifold and tests at 2 ft/s used the ring sparger. There is no "support screen", the column has a conical bottom. The horizontal centerline of the ring sparger is 38 cm above of the pipe manifold's centerline (Figure 2). The centerline of the pipe manifold is 89 cm above the end cover (i.e the flange covering the 30 cm dia. bottom section). The reference point of the static bed heights is 110 cm above the end cover. This is the same as 9 inches (22.9 cm) above the pipe manifold's centerline (or 6 inches (15.2 cm) below the ring sparger's center line.

Q8. The Case 1 experiment has a static bed of 10 ft. If a support screen is located at 208 cm above the bottom of the column, does a static loading of 10 ft cover the solids return line from the baghouse? The Case 2 experiment specifies a static loading of 4 ft, which seems to suggest that a support screen is located at 208 cm from the bottom cover plate (see equipment schematic just above the notes). Was the return line from the cyclone and/or the baghouse operating during the experiments? Where does the return line from the baghouse enter the BFB? There is a gap in the specifications.
A8. The centerline of the cyclone solids return line is 315 cm above the reference point in Answer A7. The return line was operating during the experiments.