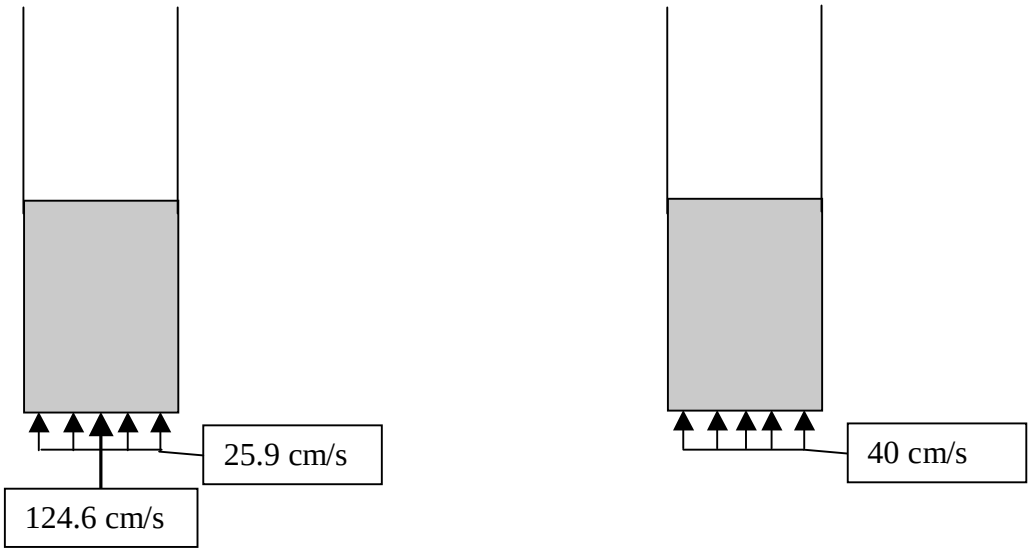
Bubbling Fluidized Bed Simulation

This tutorial demonstrates the modeling of bubbling fluidized beds. The fluidized bed is a cylindrical vessel 14 cm in diameter and 100 cm tall. Initially the bed is under minimum fluidization conditions with a bed height of 50 cm. The bed consists of 400 μm sand particles of density 2 g/cm^3. The void fraction at minimum fluidization is 0.42, and the minimum fluidization velocity is 25.9 cm/s. The fluidizing gas is air at a constant density (0.0012 g/cm^3) and viscosity (0.00018 g/[cm.s]). The fluidbed1 models a fluidized bed with a central jet as shown in the diagram on the left, and fluidbed2 models a uniformly fluidized bed as shown in the diagram on the right.



The data files are set up for a 2-second transient simulation (TSTOP = 2) in axisymmetric cylindrical coordinates with 100 cells in the axial direction and 7 cells in the radial direction. Constant mass inflow conditions are specified at the bottom boundary (distributor), and a constant pressure outflow condition is specified at the top boundary. The default boundary conditions of symmetry along the centerline and no-slip condition at the wall are used.

Conduct the two simulations in two different run directories (say, fluidbed1 and fluidbed2). After the runs are completed you will see that there are several files with the name BUB01.* in fluidbed1 directory and BUB02.* in the fluidbed2 directory. For animating the simulation results, change directory to one of those directories and type ani_mfix.exe from a DOS window. The first time ani_mfix is invoked, it will ask you for the restart file name. Enter the names as BUB01.RES or BUB02.RES (all caps). This will bring up an Animation Window and a Control Window.

By default the void fraction field (EP_g) is shown in the Animation Window. Void fraction is displayed with the color scale 0.4 (red) to 1.0 (blue). Because we are using axisymmteric cylindrical coordinates only the right half of the bed will be shown in the Animation Window. To show the whole cross section of the bed by reflecting the right

half, click on the 'sym_x' button in the Control Window. Bubbles can be seen as blue regions moving up in the Animation Window. To freeze the animation, type 'f' while the mouse-pointer is in the Animation Window. To step through the animation type 's'. These and other commands may be found by clicking the left mouse-button on the 'Help' menu-item in the Control Window.

By clicking the right mouse-button in the Animation Window and selecting another variable the displayed variable may be changed. Also by clicking the right mouse-button in the Animation Window and selecting 'Toggle Gas Vectors' you may superimpose gas velocity vectors on the variable being displayed.

Use post_mfix for extracting data from the output files. To plot the void fraction just above the jet entrance, for example, extract the data as follows. Change directory to the fluidbed1 directory and type post_mfix. Enter BUB01 as the run name. Then select 1 (Examine/print data) for retrieving data. Now conduct an interactive session as follows (answers are shown in bold):

Time: (0.00, 0.00) > **0. 2.**
Time average ? (N) > **N**
Variable: (EP_g) > **EP_g**
I range: (1, 1) > **2 2**
J range: (1, 1) > **2 2**
K range: (1, 1)> <hit return>
File: (*)> <hit return>

Then the time and the void fraction at the location (2, 2) will be printed out a table in the DOS window. To write the data into a file, give a name rather than the asterisk (*) when prompted for a file name.