APPENDIX - I

Figure 5.3.2 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 0^\circ$ and using 5.5 mm HDPE as bed material.

Figure 5.3.3 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 0^\circ$ and using 7.4 mm HDPE as bed material.
Figure 5.3.4 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 0^\circ$ and using 3.2 mm nylon as bed material.

Figure 5.3.5 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 0^\circ$ and using 5.5 mm nylon as bed material.
Figure 5.3.6 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 0^\circ$ and using 7.4 mm nylon as bed material.

Figure 5.3.7 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 0^\circ$ and using 3.2 mm acetal as bed material.
Figure 5.3.8 Minimum fluidizing velocity with distributor having angle of
air injection $\phi = 0^\circ$ and using 5.5 mm acetal as bed material.

Figure 5.3.9 Minimum fluidizing velocity with distributor having angle of
air injection $\phi = 0^\circ$ and using 7.4 mm acetal as bed material.
Figure 5.3.10 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 5^\circ$ and using 3.2 mm acetal as bed material.

Figure 5.3.11 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 5^\circ$ and using 5.5 mm acetal as bed material.
Figure 5.3.12 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 5^0$ and using 7.4 mm acetal as bed material.

Figure 5.3.13 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 10^0$ and using 3.2 mm acetal as bed material.
Figure 5.3.14 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 10^\circ$ and using 5.5 mm acetal as bed material.

Figure 5.3.15 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 10^\circ$ and using 7.4 mm acetal as bed material.
Figure 5.3.16 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 3.2 mm HDPE as bed material.

Figure 5.3.17 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 5.5 mm HDPE as bed material.
Figure 5.3.18 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 7.4 mm HDPE as bed material.

Figure 5.3.19 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 3.2 mm nylon as bed material.
Figure 5.3.20 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 5.5 mm nylon as bed material.

Figure 5.3.21 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 7.4 mm nylon as bed material.
Figure 5.3.22 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 3.2 mm acetal as bed material.

Figure 5.3.23 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 5.5 mm acetal as bed material.
Figure 5.3.24 Minimum fluidizing velocity with distributor having angle of air injection $\phi = 15^\circ$ and using 7.4 mm acetal as bed material.
APPENDIX - II

Figure 5.4.2 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = $0^\circ$, using 3.2 mm acetal

Figure 5.4.3 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = $0^\circ$, using 7.4 mm acetal
Figure 5.4.5 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 5°, using 3.2 mm acetal

Figure 5.4.6 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 5°, using 7.4 mm acetal
Figure 5.4.8 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = $10^\circ$, using 3.2 mm acetal

Figure 5.4.9 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = $10^\circ$, using 7.4 mm acetal
Figure 5.4.11 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 15°, using 3.2 mm acetal

Figure 5.4.12 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 15°, using 7.4 mm acetal
Figure 5.4.13 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 15°, using 3.2 mm HDPE

Figure 5.4.14 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 15°, using 5.5 mm HDPE
Figure 5.4.15 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 15°, using 7.4 mm HDPE

Figure 5.4.16 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection ($\Phi$) = 15°, using 3.2 mm nylon
Figure 5.4.17 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection (Φ) = 15°, using 5.5 mm nylon

Figure 5.4.18 Variation of bed pressure drop with superficial velocity for distributor having angle of air injection (Φ) = 15°, using 7.4 mm nylon
Figure 5.5.6 Variation of bed pressure drop with superficial velocity for different particle size at 90 mm from the centre of the distributor ($\Phi= 15^\circ$), using acetal.

Figure 5.5.7 Variation of bed pressure drop with superficial velocity for different particle size at 120 mm from the centre of the distributor ($\Phi= 15^\circ$), using acetal.
Figure 5.5.8 Variation of bed pressure drop with superficial velocity for different particle size at 150 mm from the centre of the distributor ($\Phi=15^\circ$), using acetal

Figure 5.5.10 Variation of bed pressure drop with superficial velocity for different particle size at 90 mm from the centre of the distributor ($\Phi=15^\circ$), using nylon
Figure 5.5.11 Variation of bed pressure drop with superficial velocity for different particle size at 120 mm from the centre of the distributor ($\Phi = 15^\circ$), using nylon

Figure 5.5.12 Variation of bed pressure drop with superficial velocity for different particle size at 150 mm from centre of the distributor ($\Phi = 15^\circ$), using nylon
Figure 5.6.1 Variation of bed pressure drop with superficial velocity for different density materials of 3.2 mm diameter, at 60 mm from the centre of the distributor (Φ = 15°)

Figure 5.6.2 Variation of bed pressure drop with superficial velocity for different density materials of 3.2 mm diameter, at 90 mm from the centre of the distributor (Φ = 15°)
Figure 5.6.4 Variation of bed pressure drop with superficial velocity for different density materials of 3.2 mm diameter, at 150 mm from the centre of the distributor (Φ = 15°)
APPENDIX – V

Figure 5.7.2 Variation of bed pressure drop with superficial velocity for different angles of air injection using 3.2 mm diameter acetal, at 90 mm from the distributor centre

Figure 5.7.3 Variation of bed pressure drop with superficial velocity for different angles of air injection using 3.2 mm diameter acetal, at 120 mm from the distributor centre
Figure 5.7.4 Variation of bed pressure drop with superficial velocity for different angles of air injection using 3.2 mm diameter acetal, at 150 mm from the distributor centre.

Figure 5.7.6 Variation of bed pressure drop with superficial velocity for different angles of air injection using 5.5 mm diameter acetal, at 90 mm from the distributor centre.
Figure 5.7.7 Variation of bed pressure drop with superficial velocity for different angles of air injection using 5.5 mm diameter acetal, at 120 mm from the distributor centre

Figure 5.7.8 Variation of bed pressure drop with superficial velocity for different angles of air injection using 5.5 mm diameter acetal, at 150 mm from the distributor centre
Figure 5.7.10 Variation of bed pressure drop with superficial velocity for different angles of air injection using 7.4 mm diameter acetal, at 90 mm from the distributor centre.

Figure 5.7.11 Variation of bed pressure drop with superficial velocity for different angles of air injection using 7.4 mm diameter acetal, at 120 mm from the distributor centre.
Figure 5.7.12 Variation of bed pressure drop with superficial velocity for different angles of air injection using 7.4 mm diameter acetal at 150 mm from the distributor centre
APPENDIX – VI

CALIBRATION CERTIFICATE OF MICRO-MANOMETER

The calculation details of digital micro-manometer are presented below.

Furness Controls Limited
CERTIFICATE OF CALIBRATION

This is to certify that the following instrument has been tested in accordance with the standards laid down and adhered to by Furness Controls Ltd., Bexhill, England. It was calibrated using standards whose calibration is traceable to European standards. Ambient temperature was 20 ± 2°C. Dry air was used for pressure calibration. This certificate is issued by Furness Controls Limited which holds ISO 9002 certification for the administration of its quality management system. The instrument is /is not/ within the manufacturer’s specification. (*delete as appropriate*).

Sales Order No : 36018
Customer : SARTECH INTERNATIONAL
Instrument : AIRPRO
Instrument type: FC0520
Supply voltage : Battery
Serial No : 0402176

Pressure range : -600 to 600 Pa

<table>
<thead>
<tr>
<th>Reference Pressure (Pa)</th>
<th>Instrument Display (Pa)</th>
<th>Deviation (Pa)</th>
<th>% of R</th>
</tr>
</thead>
<tbody>
<tr>
<td>600.130</td>
<td>-599.7</td>
<td>-0.4</td>
<td>-0.07</td>
</tr>
<tr>
<td>480.197</td>
<td>-480.0</td>
<td>-0.2</td>
<td>-0.04</td>
</tr>
<tr>
<td>359.757</td>
<td>-360.2</td>
<td>0.4</td>
<td>0.11</td>
</tr>
<tr>
<td>239.623</td>
<td>-240.0</td>
<td>0.4</td>
<td>0.17</td>
</tr>
<tr>
<td>120.239</td>
<td>-120.4</td>
<td>0.2</td>
<td>0.17</td>
</tr>
<tr>
<td>0.000</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>120.202</td>
<td>120.2</td>
<td>-0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>240.049</td>
<td>240.3</td>
<td>0.3</td>
<td>0.12</td>
</tr>
<tr>
<td>360.113</td>
<td>360.1</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>480.758</td>
<td>480.6</td>
<td>-0.2</td>
<td>-0.04</td>
</tr>
<tr>
<td>601.539</td>
<td>600.5</td>
<td>-1.0</td>
<td>-0.17</td>
</tr>
</tbody>
</table>

Reference instruments used to carry out calibration of the above unit.

Pressure standard: FRS4HR serial number (FCPS017), RS36, Calibration uncertainty better than 0.01% of reading + 0.002 Pa
Electrical multimeter: Thurlby 1905a - FCL ref. number WS96 Calibration accuracy 0.01% + 1 digit.

Approved sign. : G Thorogood

History of traceability to National Standards and a list of approved signatories are available from Furness Controls Ltd.

The uncertainties are for a confidence level of not less than 95%.