ANNEXURE - III

COMPUTATIONAL FLUID DYNAMICS ANALYSIS FOR FLUID FLOW IN RECLAMATION UNIT

Introduction

It is important to know the velocity, pressure and temperature in detail involving fluids viz. liquids, air and gases. Computational Fluid Dynamics (CFD) is the tool to resolve the complexity of nature of fluid flow. For the scrubber and fluidized bed, to visualize the internal flow of air, two dimensional unsteady flows in complex geometries are obtained. This was made possible by making use of fluent package.

Velocity Magnitude in Fluidized Bed

Contour of air velocity magnitude in Fig. F1 for 30s shows a red portion of high velocity (7.57 m/s) at the top. This indicates that at 30s, the velocity uniformity in the fluidizer is to be attained.

In Fig. F2 for 60s of time, air velocity at the bottom of the bed slowly increases and gradually builds up for a 40% of the distance and then fades. This shows that the momentum is being gained.

For 150s, the maximum velocity magnitude contour moving to the middle of the bed is shown in Fig. F4 and Fig. F5. Fig. F4 is represented by vectors.

At 150s, 210s, 240s, 270s, and 300s, the velocity magnitude is observed to be increasing gradually from the bottom to the top of the bed as shown in Fig. from F7 to
Fig. F11. Attaining uniform velocity is clearly observed consecutively from Fig. F27 to Fig. F32, the duration being 600s, 630s and 900s.

Before reaching this uniform velocity flow in fluidizer, it has already crossed several non-uniform flow stages in the system with respect to velocity as shown in figures from Fig. F6 to Fig. F26. Frequently in between the velocity is represented by vectors and grid e.g. Figs. F6, F12, F13, F20, F21 and F26.

We could infer from the velocity contour of 900s, Fig. F32, the air velocity magnitude is uniform over every cross section of the fluidized bed. This confirms that 900s is the optimal value for the fluidization. Fig. F31 and Fig. F32 are for the velocity magnitude of 90s and 900s respectively. The difference at initial and final status is made clear in these photographs. In Figs. F27, F28, F29 and F30 we observe blue dense areas scattered in the middle and at the top. This is due to the effect of fluctuation in air supply.

**Temperature Distribution in Fluidized Bed**

From contours observed at 900s in Fig. F35, the temperature (675°C) is uniform throughout the fluidized bed whereas in Fig. F33 at initial stage at 180s, the temperature is only 100°C.

The value of temperature of 675°C obtained from CFD analysis matches with the optimal temperature value of experimental work.

**Velocity Magnitude in Scrubber**

In Fig. S1, the air velocity in the regenerating tube of the scrubber is almost zero at 4s. At 8s in Fig. S3 the velocity is more at the entry of regenerating tube and it
gradually is increasing and spreading so as to attain uniform velocity all over in the scrubbing cell as shown in Fig. S8. The path lines traced by different size grains are shown in Fig. S5. It is clear from the path that the 60 micron grains are taken up to the top of the cell so as to part from larger grains and enter the dust collectors or cyclone separator. On the other hand the particle of size 255 micron moves through the regenerator tube. After having attrition with the conical target the particle returns to the "well".

The Fig. S5 demonstrates the velocity of the sand particles by vectors. At center the velocity is high due to venturi effect, as it is crossing the centre pipe namely regenerating tube. Near the walls the velocity direction is downward. The last Fig. S8 shows the velocity magnitude of air at 300s. The velocity here is uniform and equal to 1.19 m/s in almost all cross sections of the scrubber. This proves that 300s is the optimal retention value in the scrubbing cell which tallies with optimal value of experimental trials.

**Pressure Distribution in Scrubber**

In the Fig. S4, it is shown that the pressure distribution in the scrubber is uniform without any variation.

Since, the hot sand at 675°C is transferred from the fluidizer to the scrubber, the temperature distribution is analyzed only in the fluidized bed. Moreover in the scrubber when the hot grains are transferred from fluidized bed hot waste air from the scrubber is also simultaneously let into the scrubber.
Reclamation of CO2/Sodium Silicate Sand in Foundry

### Annexure - III

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Velocity Magnitude (m/s)</th>
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</tr>
</tbody>
</table>

Contours of Velocity Magnitude (air) (m/s) (Time=3.0000e+02) Jun 15, 2005

**Photo - F9**

**Photo - F10**

**Photo - F11**

**Photo - F12**

**Photo - F7**

**Photo - F8**

**FLUENT 6.1 (2d, segregated, eulerian, lam, unsteady)**
Reclamation of CO₂/Sodium Silicate Sand in Foundry

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Contours of Velocity Magnitude (m/s) (Time=4.5000e+02) Jun 15, 2005
FLUENT 6.1 (2d, segregated, eulerian, lam, unsteady)

Contours of Velocity Magnitude (m/s) (Time=5.1000e+02) Jun 14, 2005
FLUENT 6.1 (2d, segregated, eulerian, lam, unsteady)
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Contours of Velocity Magnitude (m/s) (Time=9.0000e+02) Jun 07, 2005
FLUENT 6.1 (2d, segregated, eulerian, lam, unsteady)

Contours of Static Temperature (K) (Time=9.0000e+02) Jun 15, 2005
FLUENT 6.1 (2d, segregated, lam, unsteady)

Contours of Static Temperature (W) (Time=9.0000e+02) Jun 15, 2005
FLUENT 6.1 (2d, segregated, lam, unsteady)

Contours of State Temperature (W (Time=9.0000e+02) Jun 15, 20051 ' ' FLUENT6.1 (2d, segregated, tern, unsteady)

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