# THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY, PATIALA
## Department of Chemical Engineering

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***End-Semester Examination --- Fluidization Engineering (CH-030)***

Semester – I, 2006-07 | December 05, 2006
Max. Marks: 50 | Tuesday
***Answer all parts of the question at same place*** | 14.00 – 17.00 Hrs
***Assume suitable data, if required*** | *Faculty: Dr. D. Gangacharyulu*

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|---|---|---|
| 1. | a). Briefly write about the types of packings used in the packed beds and fluidization beds? | 5 |
| | b). Calculate the minimum velocity at which spherical particles, having specific gravity of 1.6, of diameter 1.5 mm will be fluidized by water in a tube of 10 mm. The viscosity and density of water may be taken as 1.0 mN.s/m$^2$ and 1000 kg/m$^3$. The Kozeny's constant is 5.0. The voidage may be taken as 0.48. If wall effect is considered, then what will be the minimum fluidization velocity? The wall effect is calculated as, $f_w = (1.0 + S_c / S)^2$, Where, $S_c$ is the ratio of surface area of the container and volume of the bed, where as $S$ is the ratio of surface area of the particle and its volume. Take the unit height of the column for calculations. | 5 |
| 2. | a). Briefly write about the types of distributors used in the packed beds and fluidization beds? | 5 |
| | b). Cold particles of glass beads are fluidized with heated air in a bed in which a constant flow of particles is maintained. The gas flow rate is 0.2 kg/(m$^2$-s), the specific heat of the air is 0.88 kJ/(kg-K), the viscosity of air is 0.015 mN.s/m$^2$, the particle diameter is 0.25 mm and the thermal conductivity of the air is 0.03 W/(m-K). When steady state has been established, the temperatures recorded by a bare thermocouples immersed in the bed are as follows: | 5 |

| Distance above bed support (mm) | 0 | 0.64 | 1.27 | 1.91 | 2.54 | 3.81 |
|---|---|---|---|---|---|---|
| Temperature (K) | 339.5 | 337.7 | 335.0 | 333.6 | 333.3 | 333.2 |

Take, $\varepsilon = 0.57$

It may be expected that the area under the curve for above data as 8.82 mm K. Calculate the coefficient for heat transfer between the gas and particles, and the corresponding values of the particle Reynolds and Nusselt numbers.

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| 3. | a). Describe the applications of the fluidized bed technique with the help of neat sketch for:<br>• Process of ***Fluidized Bed Catalytic Cracking*** (FCC), and<br>• Process of ***Fluidized Bed Combustion*** (FBC) | 5 |
| | b). Calculate the rate of entrainment from a vessel fluidizing fine particles at high pressure. At the gas velocity used all the bed particles are entrainable, and the fluidized bed has a very high freeboard. The data of the problem is as follow: Average $d_p$ = 130 μm, $\rho_s$ = 1200 kg/m$^3$, $\rho_g$ = 5.51 kg/m$^3$, and $u_o$ = 0.61 m/s. You may use the corresponding figure provided in Fig. 1. | 5 |

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| 4. | Explain, with the help of neat sketch, the ***3-phase model*** developed for the freeboard entrainment bubbling fluidized bed. | 10 |
| 5. | a). Explain, with the help of neat sketches, the behaviour of lean up-flow and horizontal flowing gas solid-mixtures in pneumatic transport lines? | 5 |
| | b). Find the resulting pressure drop when solid particles are transported pneumatically by a gas through a vertical pipe of 0.2 m diameter and 20 m long. At the bottom end of the pipe the solids are accelerated. The data of the problem is as follow:<br><br>Solids: average $d_p$ = 200 μm, $\rho_s$ = 2000 kg/m$^3$, $u_t$ = 1.3 m/s<br>Gas: $\rho_g$ = 1.0 kg/m$^3$, $\mu$ = 2×10$^{-5}$ kg/(m.s), $u_0$ = 20 m/s.<br><br>Take, $G_s/G_g$ = 10, $f'_s$ = 0.0033. | 5 |

**--: END :--**

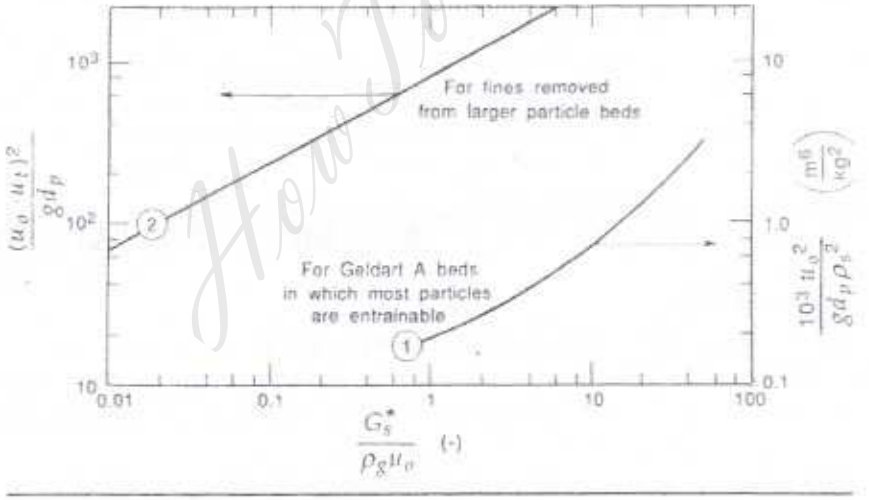


FIGURE 1
Dimensionless plot for estimating the saturation carrying capacity $G_s^*$ of a gas: curve ① from Zenz and Weil [21]; curve ② adapted from Gugnoni and Zenz [8]