Ex/BESUS/ ME-804/10/ 06

B.E. (ME) Part-IV 8th Semester Examination, 2006

Circulating Fluidized Bed Technology

(Elective-II) (ME-804/10)

Time : 3 hours | **Full Marks : 100**

Use separate answerscript for each half.

*The questions **are of** equal value.*

FIRST HALF

(Answer either Q.No.l or Q.No.2 and also answer Q.No.3 and 4.)

1. a) Define fast fluidized bed in the context of its use in a CFB boiler.

   b) Describe, with a neat sketch, the up and down movement of solid agglomerates in a very dilute dispersion of solids in a fast fluidized bed.

   c) Show schematically the transition from pneumatic transport to fast fluidization.

   d) Show a schematic repres<mtationjrf^^^ a vertical column. What are choking and captive state?

2. a) Show, with a diagram, that the fast fluidization is bounded by two velocities which depend on the circulation rate.

   b) What is transport velocity? Consider the time of emptying a column and show the transport velocity with the help of a diagram.

   c) Show with a neat diagram the transition from one regime to another depending on operating and design parameters.

3. Find the minimum velocity for fast fluidization for 300 |im sand particles at 27°C and 825°C for the following conditions. The desired solid circulation rate in the fast regime is 30 kg/m^2s. The cross-section of the bed is 0.203 m x 0.203 m. The density of the particles is 2500 kg/m^3.

	Set I	Set II
Temperature	825°C	27°C
Gas density	0.316 kg/m^3	1.16 kg/m^3
Gas viscosity	4.49 x 10^{-5} $N\text{-}s/m^2$	1.84 x 10^{-5} $N\text{-}s/m^2$

4. Estimate the bed inventory in a CFB furnace operating at 825°C and the bed voidage at 4 m above a fast bed that is 20 m tall. Also find the voidage at the wall at this height using the empirical equation :

$e(r) = e_{av}[^{3}\text{-}^{62TM6\prime47 + 0}\text{-}^{191}]$, l>r/R>0.75 Given that

P_p = 2500 kg/m^3, U = 8 m/s , d_p = 300 urn.

The secondary air is injected at the level of 3 m. The bed cross-section is 2.5 m x 10m below and 5 m x 10m above this level.

Assume e_a = 0.85 = asymptotic voidage , a = decay constant = **1**.0 m~ .

SECOND HALF

(Answer Q.No.5 and 6 and any ONE from Q.No. 7 and 8.)

5. Find the convective heat flux on a plane wall of a CFB furnace operating at 6 m/s and 860°C with 200 um sand. The wall temperature is 360°C. Use the cluster renewal model. Given :

k_g	74xlO~^{6}kW/m.K	Pb= 18 kg/m^3		e_s =	0.88
k_p	1.81 xlO~^{3}kW/m.K	P_p - 2500 kg/m^3		e_g =	0.112
$\bar{k}_{gf}$	= 64xlO~^{6}kW/m.K	P_g = 0.321 kg/m^3		e_n =	0.86
=	= 1.24kJ/kg.K	A = 4 m x 2 **m**		**P**	= 0.62
C_p	= 0.85 kJ/kg.K	T_b = 860°C			= 0.9946
u_g	= 48xlO~~^{6}N.s/m^2	T_s = 360°C		P_r =	0.731
$\bar{u}_t$	: 1.648 m/s			L =	10m

6. Refer to the question No.5 and using the same data, calculate the radiative heat flux and overall heat flux on the wall.

7. a) Explain with a diagram the sequence of events during combustion of a coal particle.

   b) Show diagramatically the sequence of volatile release during different stages of devolatilization.

8. a) Discuss the communication phenomenon during coal combustion.

   b) Give a global view of the combustion process in the different zones of a CFB boiler furnace.