The effects of scale-up on the hydrodynamics of circulating fluidized beds (CFB) are investigated using a single cold laboratory facility with the ability to recycle fluidization gas mixtures of adjustable density and viscosity. By matching five dimensionless parameters, experiments employing plastic, glass and steel powders achieve hydrodynamic similarity with high-temperature CFB risers of 0.32, 0.46 and 1m diameter. Comparisons of results obtained with the plastic and glass powders indicate that static pressure and its fluctuations scale with the riser and particle diameters, respectively. Experiments with the steel powder exhibit incipient choking behavior consistent with the greater analogous bed size that they simulate. The onset of choking with plastic and steel powders is well predicted by the correlation of Yang [*Powder Technology* **35**, 143 (1983)]. Experiments with coated glass beads indicate that the magnitude of the Coulomb friction coefficient affects CFB hydrodynamics in the limit where this coefficient is small.
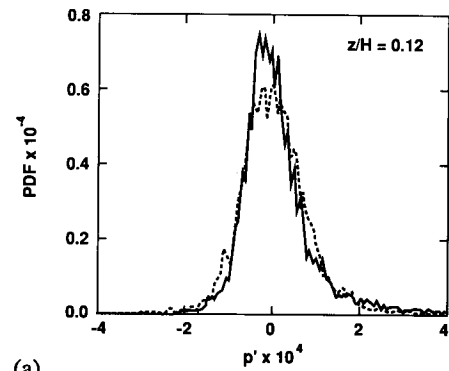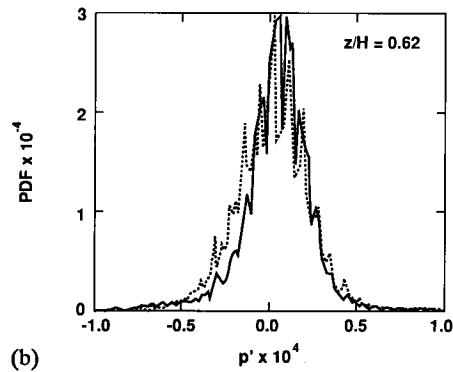
Figure excerpts
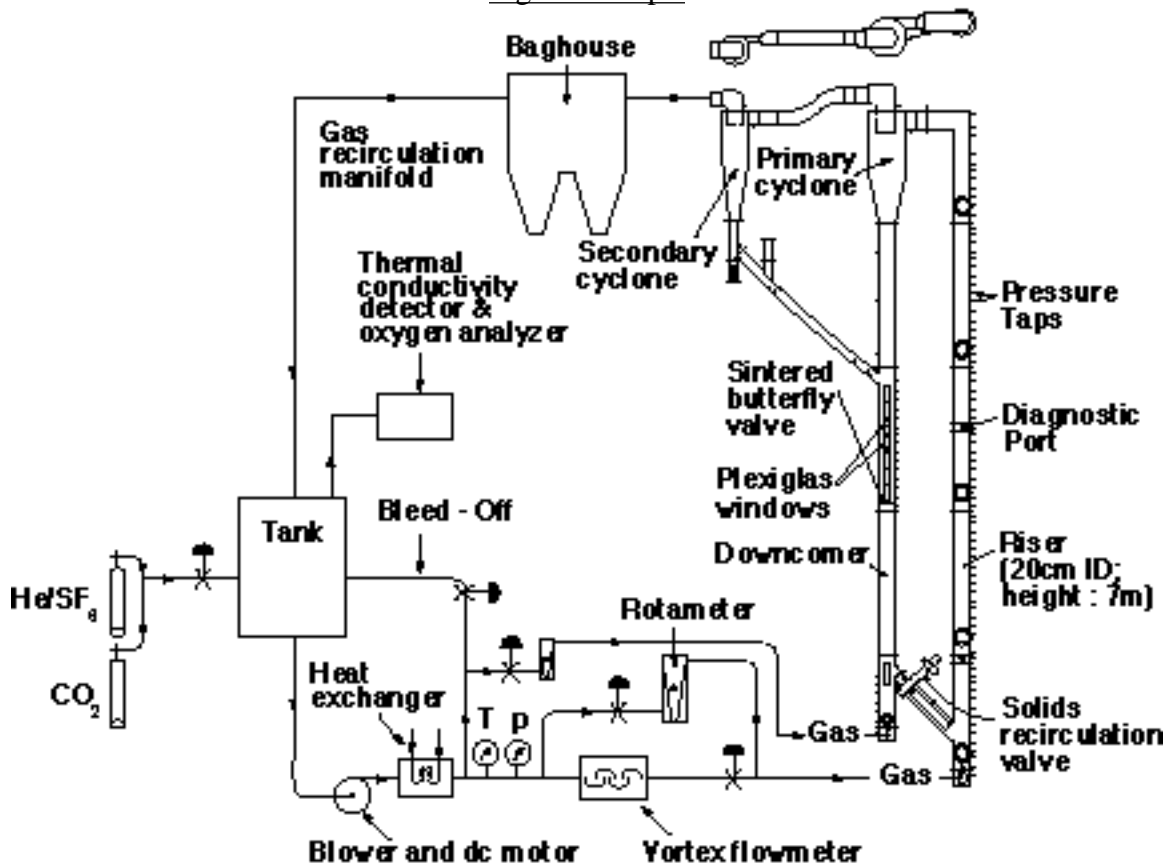
The circulating fluidized bed facility.
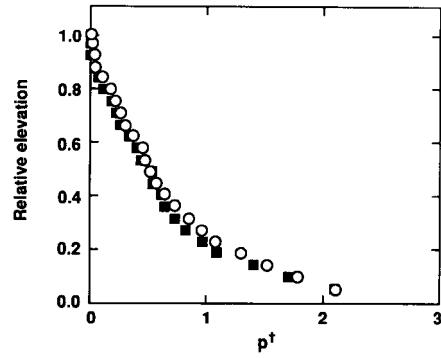
Dimensionless pressure $p^\dagger$ in the riser *vs.* relative elevation z/D for the conditions $Fr^* = 172$, $M = 33$. The open circles ($L^*=1240$) and solid squares ($L^*=1830$) represent the plastic and glass powders, respectively.
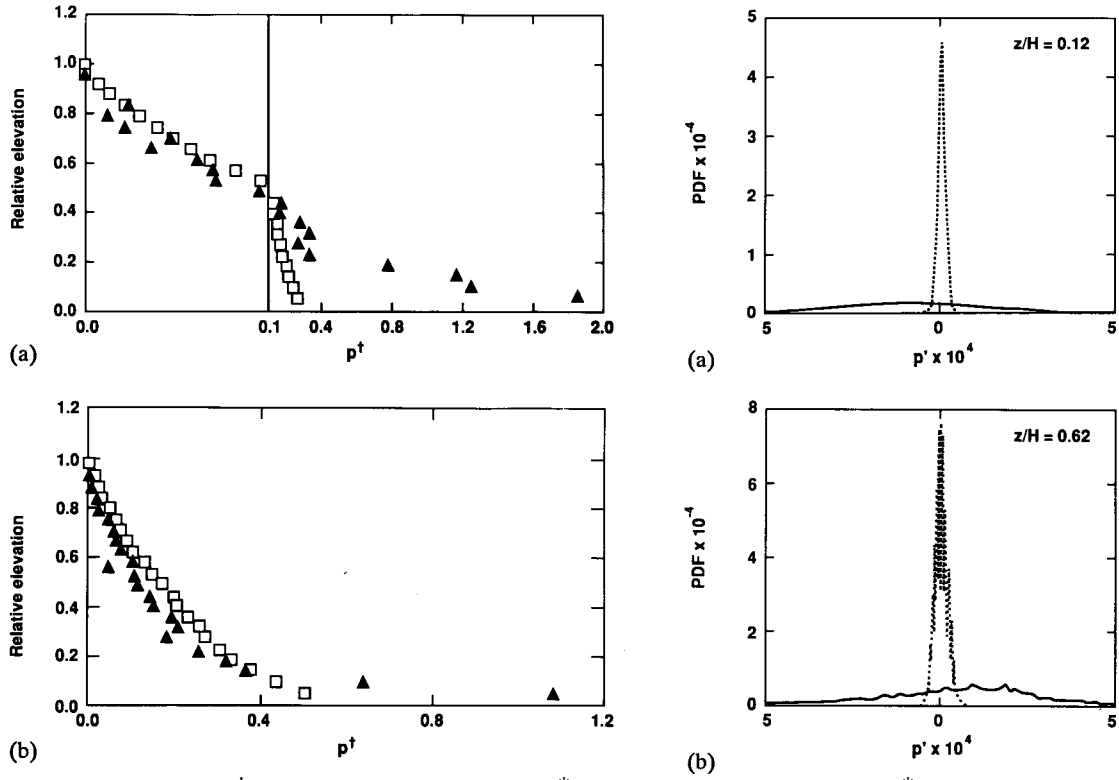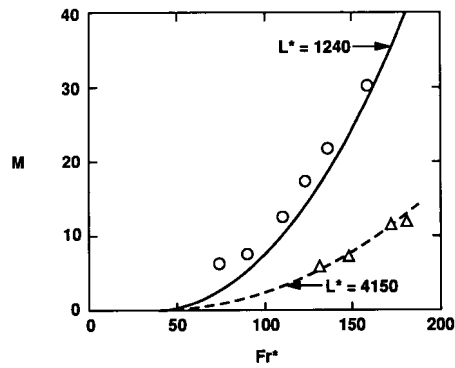

(a)

(b)

PDF of dimensionless pressure fluctuations p' for the conditions $Fr^* = 131$, $M = 21$ at a relative elevation z/H=0.12. The solid and dashed lines represent the plastic and glass powders, respectively.
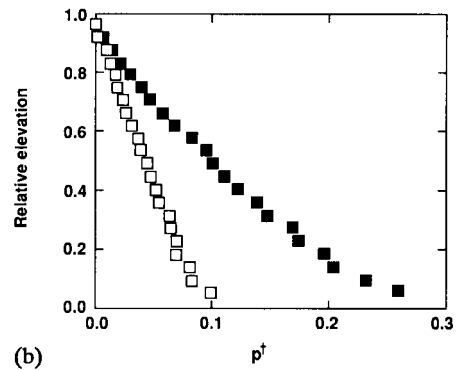
Vertical profiles of $p^\dagger$ for the conditions (a) $Fr^* = 102$, $M = 5$; and (b) $Fr^* = 131$, $M = 10$. The squares ($L^*=1830$) and triangles ($L^*=4150$) represent the glass and steel powders, respectively.

Dimensionless choking lines. The circles and triangles represent conditions at incipient choking for the plastic and steel powders, respectively. The solid and dashed lines are the corresponding predictions of Yang's correlation [34] for $L^* = 1240$ and $L^* = 4150$. The grey region encircles conditions of our previous, unchoked, scale-up tests.
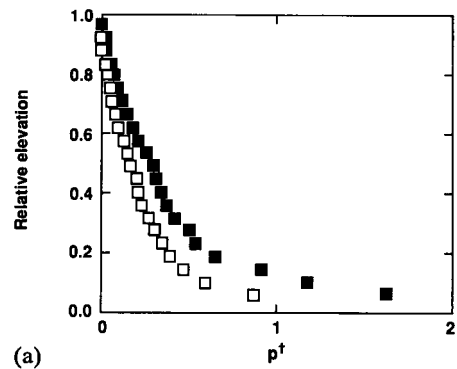
Vertical profiles of $p^{\dagger}$ for the conditions (a) $Fr^* = 102$, $M = 5$; and (b) $Fr^* = 131$, $M = 16$. The open and solid squares represent the coated and uncoated glass powders, respectively.

Fluidization gases				Solid powders				Analogous
He	CO_2		$\mu \times 10^5$	type	s	$\bar{d}_s$	$\bar{d}_s$	Diameter D_0
%	%	kg/m^3	kg/m.sec		g/cm^3	μm	μm	m
92	8	0.30	2.0	plastic grit	1.44	234	161	0.32
79	21	0.51	1.9	glass spheres	2.53	109	109	0.46
19	81	1.49	1.6	steel grit	7.40	67	49	1.00