

NOMENCLATURE

Dimensional quantities

a	thermal diffusivity of gas, m^2/s
C_p	heat capacity of gas, $\text{J}/\text{kg}\cdot\text{K}$
C_{p_p}	heat capacity of the particle material, $\text{J}/\text{kg}\cdot\text{K}$
D	pipe diameter; diameter of the sphere (cylinder) of collisions, m
d_p	particle diameter, m
f_c	frequency of interparticle collisions, Hz
f_{cw}	frequency of collisions of particles with the pipe (channel) walls, Hz
g	free fall acceleration, m/s^2
k	turbulent energy of gas, m^2/s^2
k_0	turbulent energy of gas in the absence of particles, m^2/s^2
k_p	energy of particle velocity fluctuations, m^2/s^2
L	characteristic length, m
l	Prandtl–Nikuradze mixing length, m
l_c	mean free path of particles between successive collisions, m
l_{cw}	mean free path of particles between successive collisions with the pipe (channel) walls, m
m_p	particle mass, kg
N	number density of particles, m^{-3}
p	instantaneous pressure, Pa
P	averaged pressure, Pa
p'	fluctuation pressure, Pa
R	pipe radius; radius of the sphere (cylinder) of collisions, m
r	distance from the pipe axis, m
r_p	particle radius, m
t	instantaneous temperature of gas, K
T	averaged temperature of gas, K
t'	fluctuation temperature of gas, K
T_f	characteristic time of gas in averaged motion, s

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T_L	characteristic time of gas in large-scale fluctuation motion, s
t_p	instantaneous temperature of particle, K
T_p	averaged temperature of particle, K
t'_p	fluctuation temperature of particle, K
u_*	dynamic velocity, m/s
u_i	projections of instantaneous velocity of gas, m/s
U_i	projections of averaged velocity of gas, m/s
u'_i	projections of fluctuating velocity of gas, m/s
v_i	projections of instantaneous velocity of particle, m/s
V_i	projections of averaged velocity of particle, m/s
v'_i	projections of fluctuation velocity of particle, m/s
w_i	projections of instantaneous velocity of particles relative to gas and of colliding particles relative one another, m/s
W_i	projections of averaged velocity of particles relative to gas and of colliding particles relative one another, m/s
w'_i	projections of fluctuation velocity of particles relative to gas and of colliding particles relative to one another, m/s
x, r, φ	axial, radial, and azimuthal cylindrical coordinates, m, deg
x, y, z	axial, radial, and azimuthal Cartesian coordinates, m

Greek symbols

β	core of collisions, m ³ /s
ε	rate of dissipation of turbulent energy, m ² /s ³
η	Kolmogorov scale, m
λ	thermal conductivity of gas, W/m·K
λ_p	thermal conductivity of the particle material, W/m·K
μ	coefficient of dynamic viscosity, N·s/m ²
ν	coefficient of kinematic viscosity, m ² /s
ρ	density of gas, kg/m ³
ρ_p	density of the particle material, kg/m ³
τ	time, s
τ_c	time between consecutive collisions of particles, s
τ_{cw}	time between collisions of particles with the pipe (channel) walls, s
τ_K	characteristic time of gas in small-scale fluctuation motion (Kolmogorov time scale of turbulence), s
τ_p	time of dynamic relaxation of particle, s
τ_{p0}	time of dynamic relaxation of Stokesian particle, s

COLLISIONS IN PARTICLE-LADEN GAS FLOWS

τ_t	time of thermal relaxation of particle, s
τ_{t0}	time of thermal relaxation of Stokesian particle, s
τ_w	shear stress on the wall, Pa

Dimensionless quantities

C_D	coefficient of aerodynamic resistance of particle
C_{x0}	body resistance coefficient
C_{xp}	coefficient of body resistance due to the effect of particles
c_f	coefficient of friction
m	instantaneous mass concentration of particles
M	averaged mass concentration of particles
m'	fluctuation mass concentration of particles
Re_D	Reynolds number
Re_p	averaged value of the Reynolds number of particle
\tilde{Re}_p	instantaneous value of the Reynolds number of particle
Re'_p	fluctuation value of the Reynolds number of particle
Re_x	local value of the Reynolds number based on longitudinal coordinate
Stk_c	Stokes number for the process of interparticle collisions
Stk_{cw}	Stokes number for the process of collisions of particles with the pipe (channel) wall
Stk_f	Stokes number in averaged motion
Stk_K	Stokes number in small-scale fluctuation motion
Stk_L	Stokes number in large-scale fluctuation motion
γ	Kármán constant
η	coefficient of particle deposition
φ	instantaneous volume concentration of particles
Φ	averaged volume concentration of particles
φ'	fluctuation volume concentration of particles

Indices

$\langle \dots \rangle$	averaging over the cross-sectional area of the pipe (channel)
$\overline{(\dots)}$	time averaging, relative value
$(\dots)'$	fluctuation value

Subscripts

0	value in external flow, value in the absence of particles
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c	value on the pipe (channel) axis
i, j	characteristic of the species of particle
m	modified value
w	value on the pipe (channel) wall