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LIST OF FIGURES

NOMENCLATURE

a, A	=	Constant
%ash	=	Weight percentage of ash in biomass
b	=	Radius of bonding neck
B, B0, B1, B2 B3, B4, B5	=	Constant
C	=	Constant
C_1, C_2, C_3, C_4	=	Constant
C_b	=	Bulk oxygen concentration
C_{new}	=	Constant
$C_{p,f}$	=	Fluid heat capacity
d_{ag}	=	Agglomerate diameter
d_b	=	Bubble diameter
d_p	=	Particle/Bed particle diameter
$d_{p,av}$	=	Average bed particle diameter
$d_{p,char}$	=	Char particle diameter
D	=	Particle separation distance
D_{AB}	=	Gas molecular diffusivity
D_b	=	Bed diameter
$D_{b,eq}$	=	Equivalent bed diameter
$D_{0,S}$	=	Pre-exponential factor for surface diffusion coefficient
E_S	=	Activation energy for surface diffusion
E_μ	=	Activation energy for viscosity
$E_{\mu,s}$	=	Activation energy for surface viscosity
f, f_1, f_2, f_3	=	Function
f_N	=	Existing ratio of alkali in bed material
F_{ad}	=	Adhesive force
$F_{ad,total}$	=	Total adhesive force
F_{br}	=	breaking-up force
$F_{LB,S}$	=	Static liquid bridge force
$F_{LB,V}$	=	Viscous force in liquid bridge
F_{seg}	=	Segregate force
F_{VW}	=	van der Waals force
g	=	Average gravity; 9.8 m/s^2
h	=	Heat transfer coefficient
H_b	=	Static bed height
H_{mf}	=	Bed height at minimum fluidization velocity
k	=	Boltzmann constant / constant
k(T)	=	Kinetic constant of devolatilization process
k_c	=	Combustion rate constant
k_f	=	Fluid conductivity
k_g	=	Gas conductivity
k_m	=	Mass transfer coefficient
K, K_2	=	Constant
m_{bed}	=	Bed inventory
m'_{fuel}	=	Fuel feed rate
m_p	=	Mass of a single particle/bed particle
M	=	Average convective sold mass flux
n	=	The number of particles/bed particles

p	=	Constant
P	=	Pressure in Pa
ΔP	=	Different pressure between in bridge and the surrounding Pressure
q	=	Heat of reaction at complete combustion ($C + O_2 \rightarrow CO_2$)
Q_{pp}	=	Polymer feed rate
r_p	=	Particle/Bed particle radius
r_a	=	Radius of curvature of asperities at a particle surface
$r_{LB,c}$	=	Liquid bridge meridional radius of curvature
$r_{LB,n}$	=	Liquid bridge neck radius
R	=	Gas constant
S	=	Adhesive stress / Bubble separation length
t	=	Time
t_{def}	=	Defluidization time
T	=	Operating temperature
T_{ag}	=	Agglomeration temperature
T_b	=	Bed (combustion) temperature
T_{char}	=	Char surface temperature
T_S	=	Sintering temperature
u_0	=	Absolute velocity of a solid/bed particle at initial conditions
u_b	=	Bubble velocity
u_p	=	Absolute velocity of a solid/bed particle
U	=	Superficial gas/air velocity
U_{BB}	=	Bed breaking fluidizing velocity
U_D	=	Defluidization velocity
U_f	=	Fluid velocity
U_{mf}	=	Minimum fluidization velocity under normal conditions
$U_{mf,S}$	=	Minimum fluidization velocity under sintering conditions
U_S	=	Limiting gas velocity
V	=	Particle-Particle relative velocity
W	=	Weight
W_{bed}	=	Weight of the bed particles in the bed
x_c	=	Critical sintering neck radius
X^2	=	Equivalent of neck contact area between particles
X_{ash}	=	Mass fraction of ash in the biomass
$X_{K\ in\ Ash}$	=	Mass fraction of potassium in the ash
$X_{K\text{-}Fuel}$	=	Mass fraction of potassium in the fuel
X_{melt}	=	Ash melt fraction based on the initial ash compositions

Greek letters

π	=	Pi constant
γ	=	Surface tension
φ	=	Three-phase contact angle
α	=	Half-filling bridge angle / ratio of volume of solids carried by bubble to bubble volume
μ_0	=	Pre-exponential factor for viscosity
μ_f	=	Fluid viscosity
μ_g	=	Gas/Air viscosity
μ_s	=	Surface viscosity
μ_{pp}	=	Polymer intrinsic viscosity

μ_l	=	Viscosity of molten material
ρ_{coat}	=	Density of coating material
ρ_f	=	Fluid density
ρ_g	=	Gas/Air density
ρ_p	=	Particle/Bed particle density
ρ_{pp}	=	Polymer particle density
ρ_s	=	Solid density
ε	=	Bed void fraction / Emissivity
ε_{mf}	=	Bed void fraction at minimum fluidization
ψ	=	Sintering force function / alkali feed rate
σ	=	Stefan-Boltzmann constant, 5.670×10^{-8} W/m^2 K^4
σ_S	=	Yield stress of neck
ϕ	=	Particle shape factor
η_0	=	Pre-exponential factor for surface viscosity
ζ	=	Specific surface free energy
δ	=	Lattice constant for a crystalline solid / Coating thickness
β	=	Magnitude of relative contribution in MLR analysis
υ_f	=	Fluid kinematic viscosity

Abbreviations

AI	=	Alkali Index
BAI	=	Bed Agglomeration Index
EARS	=	Early Agglomeration Recognition System
FBC	=	Fluidized Bed Combustion
FBG	=	Fluidized Bed Gasification
K/Bed	=	Potassium consumption to bed material weight ratio
M.P.	=	Melting temperature
RDF	=	Refuse Derived Fuel
$R_{b/a}$	=	Base to Acid ratio

Dimensionless group

Ar	=	Archimedes number; $\dfrac{\rho_f(\rho_s-\rho_f)d_p^3 g}{\mu_f^2}$
Co	=	Cohesive number; $\dfrac{6S}{(\rho_p-\rho_f)d_p g}$
Ga	=	Galileo number; $\dfrac{g d_p^3}{\upsilon_f^2}$
Nu	=	Nussult number; $\dfrac{h d_p}{k_f}$
Pr	=	Prandtl number; $\dfrac{c_{p,f}\mu_f}{k_f}$

Re_p = Reynolds number based on the particle; $\frac{\rho_f U_f d_p}{\mu_f}$

Sc = Schmidt number; $\frac{\mu_f}{\rho_f D_{AB}}$

Sh = Sherwood number; $\frac{k_m d_p}{D_{AB}}$

St = Stoke number; $\frac{2m_p u_0}{3\pi\mu_f r_p^2}$