An Investigation of the Combustion of Pulverized Coal–Air Mixture in Different Combustor Geometries

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A two-dimensional theoretical study of the flow and combustion of pulverized coal by diffusion flames is presented. The model predicts gas flows, species concentrations, and temperatures in combustors having specific geometries. The conservation equations are solved utilizing the $\kappa-\epsilon$ turbulence model. Coal devolatilization is modeled by the two-competing-reactions scheme, which generates two sets of volatiles and char, each by a specific rate constant, described in Arrhenius form. Char combustion from devolatilization occurs by reaction with oxygen, carbon dioxide, water, particle dispersion, and radiative heat transfer between furnace wall and particles. The model is used to investigate the interaction between flow and combustion in flames produced by arranging the locations of the primary inlet and the secondary air inlets in a furnace. The predictions, which could be valuable for designing furnaces, indicate that a centered primary inlet and a minimum recirculation are some of the criteria that could favorable for combustion.

NOMENCLATURE

A	area
B	preexponential factor
C	coefficient, empirical constant
C_p	specific heat capacity
D	drag force
$\mathbf{D}$	diffusion coefficient
E	activation energy
$\hat{F}$	view factor
G	generation of turbulent kinetic energy
$\hat{h}$	heat transfer coefficient for a particle of size d_p
H	enthalpy
J	mechanical equivalent of heat (1 Cal = 4.186 Js)
K	thermal conductivity, specific reaction rate constant
Le	Lewis number $(= K/C_p D_\rho)$
M	mass
$\bar{n}$	number density (number of particles per unit spatial volume)
Nu	Nusselt number
P	pressure
q	heat transfer rate
r	radius
R_u	universal gas constant
Re_{d_p}	Reynolds number based on particle diameter
S	burning surface, source or sink
t	time
T	temperature
U	velocity in the x direction
V	velocity in the y direction
$\vec{V}$	velocity vector
W	source or sink term
x	coordinate
y	coordinate
Y	mass fraction of species

Greek Symbols

ρ	density
ϕ	porosity (void volume/total volume)

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Published by Elsevier Science Publishing Co., Inc.

0010-2180/92/$5.00