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# Experimental and numerical study of coal swirl fluidized bed drying on $10^0$ angle of guide vane

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## Abstract

Currently, low-rank coal is widely used as fuel in power plants. The swirl flow method is quite effective used to increase heating value through the drying process. This research studies the characteristics of low-rank coal drying using a swirl fluidized method with $10^0$ angle of blade inclination experimentally and numerically. Coal with a moisture content of 25.17 % and a size of 6 mm was dried by dry air with a temperature of 55 °C, the relative humidity of 10.5 % and flow rate of 0.06 kg/sec. Moisture content is measured by the ASTM D3 Numerical simulations performed in 3 dimensional, transient and multicomponent. The results of the ex t show that drying was effective in the first 5 minutes, which reduced moisture ratio to 0.26 while the sim results reduced moisture ratio to 0.28. Numerical simulations show the pathline, velocity vectors, temperature, and humidity contours. Particle trajectory as simulation results agrees to the experiment.



# Abbreviations

*MR:*

Moisture ratio

*Mi:*

Moisture content at initial time

*Me:*

Moisture content at equilibrium

*M:*

Moisture content at time, t

$m_{vap}$ :

Mass of moisture evaporated, kg

$h_{fg}$ :

Enthalpy evaporation, J/kg

$m_{air}$ :

Mass of moisture evaporated, kg

$\Delta h_{air}$ :

Increasing of air dryer enthalpy, J/kg

$m_p$ :

Particle mass, kg

$C_p$ :

Heat specific of coal particle, J/kgK

$T_p$ :

Particle temperatur, K

$h$:

Coefficient of convection, $W/m^2K$

$A_p$ :

Surface area of particle, $m^2$

$T_\infty$ :

Infinity temperature, K

$d_{mp}$ :

Reducing of particle mass, kg

$N_i$ :

Molar flux of vapor ($kmol/m^2$-s)

$k_c$ :

Mass transfer coefficient (m/s)

$C_{i,s}$ :

Vapor concentration at the droplet surface ($kmol/m^3$)

$C_{i,\infty}$ :

Vapor concentration at the droplet surface ($kmol/m^3$)

$F_D$ :

Drag force, $kgm/s^2$

u□ :

Velocity vector of air dryer, m/s

u□ $_p$ :

Velocity vector of particle, m/s

$\rho_p$ :

Density of particle, $kg/m^3$

$\rho$:

Density of air dryer, $kg/m^3$

$Re$:

Reynolds number

$d_p$ :

Particle diameter, m

$C_D$ :

Drag coefficient

$\mu$:

Dynamic viscosity, kg/m.s

$a_1, a_2, a_3$ :

Are constants that apply over several ranges of Re given by Morsi and Alexander

$P_{sat}$ :

Saturation pressure, Pa

$R$:

Universal gas constant, 8134 J/mol K

$\varepsilon_D$ :

Drying efficiency

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- References

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