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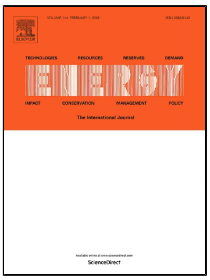

Mathematical model simulating the ignition of a droplet of coal water slurry containing petrochemicals

Dmitrii O. Glushkov, Geniy V. Kuznetsov, Pavel A. Strizhak, Semen V. Syrodoy

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Dmitrii O. Glushkov*, Geniy V. Kuznetsov, Pavel A. Strizhak, Semen V. Syrodoy
National Research Tomsk Polytechnic University
30, Lenin Avenue, Tomsk, 634050, Russia
Tel.: +7(3822) 701-777, ex. 1953

* Corresponding author.
E-mail addresses: dmitriyog@tpu.ru (Dmitrii O. Glushkov), kuznetsovgv@tpu.ru (Geniy V. Kuznetsov), pavelspa@tpu.ru (Pavel A. Strizhak), ssyrodoy@yandex.ru (Semen V. Syrodoy).

Abstract

Global problems of effective coal and oil processing waste recovery can be solved by making use of these wastes as the main fuel components for coal water slurries containing petrochemicals (CWSP). Until now, no predictive models have been developed that would simulate the sustainable ignition of CWSPs based on components with highly different properties, such as ash, moisture, and volatile content, heat of combustion, etc. This is exactly the type of model we are presenting in this paper. In order to gain a greater insight in the process under study, the experimental research has been conducted. We have created an experimental database with the main characteristics of CWSP ignition, namely the duration of stages, gas-phase and heterogeneous ignition delay times, maximum combustion temperatures, and minimum sufficient oxidizer temperatures. A mathematical model has been developed predicting the conditions and characteristics of CWSP droplet ignition. The signature feature of the model is that it accounts for all the main heat and mass transfer processes and chemical reactions in the *solid fuel – liquid fuel – water* system under study. This mathematical model can serve as the basis for estimating and comparing the ignition characteristics of different CWSPs.

Keywords: coal water slurry containing petrochemicals; coal and oil processing wastes; hot air; ignition; mathematical model.

Nomenclature and units

C	heat capacity, J/(kg·K)
c	concentration
D	diffusion coefficient, m^2/s
E	activation energy, J/(mole·K)
h_d	parameter of the smearing of the front, m
k	pre-exponential factor, 1/s
K_P	permeability of porous structure, m^2
l	effective pore size, m
m	porosity
p	pressure, Pa
Q	enthalpy of process, J/kg
R	radius, m
R_{out}	outer radius, m
R_t	perfect gas constant, J/(mole·K)
T	temperature, K