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P.O. Box 245, H-1519 Budapest, Hungary
Phone: +36 1 464 8240
E-mail: ak@akademiai.hu
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Recovering of metals and metal oxides through thermal decomposition process of coal bottom ash: a comprehensive kinetic analysis

Bojan Janković¹, Marija Janković², Jelena Krneta Nikolić², Milica Rajačić², Ivana Vukanac², Nataša Sarap², Nebojša Manić^{3,*}

¹University of Belgrade, Department of Physical Chemistry, “Vinča” Institute of Nuclear Sciences – National Institute of the Republic of Serbia, Mike Petrovića Alasa 12-14, P.O. Box 522, 11001 Belgrade, Serbia

²University of Belgrade, Radiation and Environmental Protection Department, “Vinča” Institute of Nuclear Sciences – National Institute of the Republic of Serbia, Mike Petrovića Alasa 12-14, P.O. Box 522, 11001 Belgrade, Serbia

³University of Belgrade, Fuel and Combustion Laboratory, Faculty of Mechanical Engineering, Kraljice Marije 16, P.O. Box 35, 11120 Belgrade, Serbia

*E-mail: nmanic@mas.bg.ac.rs

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In this work, the thermal decomposition process of coal bottom ash (collected after lignite combustion in coal-fired power plant “Kostolac B” (TEKO-B), Serbia) was investigated, using simultaneous TG (thermogravimetry) – DTG (derivative thermogravimetry) techniques in an inert (Ar) atmosphere, at various heating rates (10.3, 20.9 and 32.1 K/min). In addition to thermal characterization of the sample, the chemical composition and naturally occurred radionuclides were also determined. Using the model-free (isoconversional) (by Friedman (FR), Kissinger-Akahira-Sunose (KAS), Ozawa-Flynn-Wall (OFW) and Vyazovkin (VY) methods) analysis, the complex kinetic nature of the process was successfully resolved. The conducted numerical optimization of the process (using non-linear least square optimization) had confirmed accuracy and reliability of estimated kinetic parameters. Model-based (model-fitting) kinetic analysis showed the existence of a complex reaction scheme, over two consecutive reactions steps and one single-stage reaction step, *via* mechanism order An , $F2$, Fn , $R3$, Cnm (through n -dimensional nucleation/growth, chemical reactions, and n -th order and m -power with autocatalysis mechanisms). Through physicochemical interpretation of mechanism scheme, an assessment of recovery of valuable metals and metal oxides was performed, by analysing the concentration of reaction species in a function of temperature of individual steps. Likewise, the influence of certain precursor involved in decomposition process as catalyst (in order to increase the yield of targeted product) was also inspected. Finally, the simulation of actual process using the results obtained from applied methods/models was performed, through application of modulated dynamic (MD) prediction.

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