energies

Editorial

Special Issue [Energies] "Clean Utilization and Conversion Technology of Coal"

Marek Sciazko * and Aleksander Sobolewski

Institute for Chemical Processing of Coal, ul. Zamkowa 1, 41-803 Zabrze, Poland; asob@ichpw.pl
* Correspondence: msc@ichpw.pl or msc@agh.edu.pl

check for updates

Citation: Sciazko, M.; Sobolewski, A. Special Issue [Energies] "Clean Utilization and Conversion Technology of Coal". *Energies* **2021**, *14*, 4502. https://doi.org/10.3390/en14154502

Received: 21 July 2021
Accepted: 22 July 2021
Published: 26 July 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Clean Utilization and Conversion Technology of Coal has at least 40 years of history, beginning with the USA-born Clean Coal Technology program and at the same time the European Thermie research and development program was started. Coal reserves are still abundant in some regions of the world, and they provide resources for secure energy supply. Clean coal technologies should ensure effective production of electricity, heat and cold, or gaseous and liquid fuels or chemical products, while meeting contemporary environmental protection requirements and at acceptable costs. More and more often, the final assessment of the effectiveness of these technologies is carried out in the form of a product lifecycle analysis, covering all production phases, from the extraction and enrichment of coal to the management of post-production waste such as carbon dioxide, ash, wastewater, etc. The importance of coal is well supported by its use. It contributes to 25% of the world demand for primary energy and 35% for electricity generation. It is also widely used for other sectors, including metallurgy, chemical industry, and cement manufacturing. Accounting for the current position of coal use, it is reasonable to deliver the latest developments in the field, launching a Special Issue dedicated to coal properties and processing. In this volume, one can find several articles which cover various aspects of coal. We encourage the readers to pick the most interesting articles according to the represented profession, what may be helpful for further studying this subject.

In this Special Issue the following articles can be found:

von Bohnstein et al. [1] investigated the effect of sulfur species, which are significant in high temperature corrosion of pulverized coal fired furnaces. They developed the prediction of sulfur species concentrations by using a 3D-Computational Fluid Dynamics simulation model, which allows the identification of furnace wall regions that are exposed to corrosive gases, so that countermeasures against corrosion can be applied. In the work, a model for the release of sulfur and chlorine species during coal combustion was presented. The model is based on the mineral matter transformation of sulfur and chlorine-bearing minerals under coal combustion conditions. The detailed reaction mechanism for gaseous sulfur and chlorine species and hydrocarbon related reactions, as well as a global three-step mechanism for coal devolatilization, char combustion, and char gasification was accounted for. Experiments in an entrained flow were carried out to validate the developed model.

Guangyu Li et al. [2] focused on coal gasification characteristics collected in a full-scale two-stage pressurized entrained-flow gasifier. The study aimed at elucidating the effects of gasifying agent concentration, coal input rate, and operation period under full reactor load on the performance of a utility two-stage pressurized entrained-flow gasifier. The authors ran a number of tests, changing steam input in the combustor and measuring resulted gas composition. The coal conversion rate was monitored. The work can offer a further understanding of the gasification performance of the full-scale two-stage pressurized entrained-flow gasifier and motivates the potential for the cleaner utilization of coal resources.

Sciazko et al. [3] delivered a comprehensive paper on coal coking. A series of experimental coal pyrolysis studies were conducted to define the parameters of a kinetic model to enable complete mass and energy balances by identifying basic process products. The developed model determines chemical enthalpy of pyrolytic reactions, making it possible to determine the share of exothermic conversions in the coking process. To validate the model, a series of experimental pyrolysis tests of coking coals used in the coke plant and their blends were conducted, including TGA, retort, and industrial coke oven scale. Despite significant differences in the chemical composition of various coal types, element balancing allowed detection of the difference in product composition and the heat effects of the chemical conversion of such a complex substance as coal. Analysis of the heat effects of pyrolytic coal decomposition indicates substantial variability. In the first coking period, there are endothermic reactions; in the second, exothermic reactions occur. The developed model can be used to analyze other pyrolytic processes because it also takes into account the heating rate.

Valentina Zubkova et al. [4] investigated the thermal behavior of a raw bituminous high-volatile coal during carbonization, and compared it to thawed bituminous high-volatile coal, after storage in low temperature. The research was carried out using the following techniques: X-raying, thermogravimetry/Fourier transform-infrared spectroscopy (TG/FT-IR), extraction, Diffuse Reflectance Infrared Fourier Transform Spectroscopes (DRIFT), Attenuated Total Reflectance (ATR), and SEM. The increase in range of the viscous-liquid state and a decrease in temperature of its appearance were stated, along with the formation of a more compact residue, at the re-solidification stage. During the pyrolysis of thawed coal, the yield in volatile products of pyrolysis increases, and the composition of these products changes. The contribution ratio of saturated and unsaturated hydrocarbons, CO_2, alcohols, and phenols decreases in the composition of volatile products of thawed coal. It is suggested that the use of freezing during the storage of a freshly mined coal that has a poorer caking ability can improve its plasticization during carbonization.

Gazda-Grzywacz et al. [5] aimed at the mercury emission abatement while burning coal. Power production from coal combustion is one of two major anthropogenic sources of mercury emission to the atmosphere. Two sorbents, i.e., powdered activated carbon and the coke dust, were analyzed. The assessment included both direct and indirect emissions related to various energy and material needs lifecycle, including coal mining and transport, sorbents production, transport of sorbents to the power plants, and injection into flue gases. The results show that the average mercury concentration in processed flue gasses accounts to 28.0 g Hg/m^3, the removal of 1 kg of mercury from flue gases required 14.925 Mg of powdered activated carbon, and 33.594 Mg of coke dust, respectively. However, the whole lifecycle carbon footprint for powdered activated carbon amounted was three times greater. It was stated that considering the relatively low price of coke dust and its lower impact on GHG emissions, it can be found as a promising alternative to commercial powdered activated carbon.

Mianowski et al. [6] considered an effective methodology for the evaluation of polydisperse coal grain self-compacting. Two isomorphic sets of grains, small and large, were analysed—without specifying their dimensions—under the acronym CMC (Curve of Maximum Compression) and taking into account the effects of segregation. The proposal is particularly valuable for optimal blend preparation in the gravity system in coke making. The main advantage of this work is the proposal of using the grains triangle, which limits the values calculated by the relations: bulk density-share of coarse/fine grains, for different levels of moisture content. The grains triangle practically covers the vast majority of laboratory and industrial test results, and geometrically or computationally indicates the ability of a given particle size distribution to reach maximum bulk density. This paper presents an analysis of the results of tests on crushing, coal briquettes, and grinding coal blend in selected mechanical systems. Results of tests on coke quality (CRI, CSR) in connection with the grain size triangle are discussed.

The presented above contributions from the recent research works included in this Special Issue offer new data, information, and findings to continue the R & D effort in this field. Coal technology needs much more work to be done in the future, particularly improving its cleaner and more efficient use.

Together with co-guest Editor Dr. Aleksander Sobolewski, we wish to thank the authors who contributed with their works to this Special Issue.

Funding: This research received no external funding.

Acknowledgments: Each paper was reviewed by at least three reviewers; therefore the Guest Editors would like to thank them for their work, which helped the authors to improve their manuscripts. In addition, the Guest Editors would like to thank Sherwin Chen Managing Editor for his help and support in the Editorial process.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Von Bohnstein, M.; Yildiz, C.; Frigge, L.; Ströhle, J.; Epple, B. Simulation Study of the Formation of Corrosive Gases in Coal Combustion in an Entrained Flow Reactor. *Energies* **2020**, *13*, 4523. [CrossRef]
2. Li, G.; Wang, L.; Wang, C.; Wang, C.; Wu, P.; Che, D. Experimental Study on Coal Gasification in a Full-Scale Two-Stage Entrained-Flow Gasifier. *Energies* **2020**, *13*, 4937. [CrossRef]
3. Sciazko, M.; Mertas, B.; Kosyrczyk, L.; Sobolewski, A. A Predictive Model for Coal Coking Based on Product Yield and Energy Balance. *Energies* **2020**, *13*, 4953. [CrossRef]
4. Zubkova, V.; Strojwas, A. The Influence of Freezing on the Course of Carbonization and Pyrolysis of a Bituminous High-Volatile Coal. *Energies* **2020**, *13*, 6476. [CrossRef]
5. Gazda-Grzywacz, M.; Winconek, Ł.; Burmistrz, P. Carbon Footprint for Mercury Capture from Coal-Fired Boiler Flue Gas. *Energies* **2021**, *14*, 3844. [CrossRef]
6. Mianowski, A.; Mertas, B.; Sciazko, M. The Concept of Optimal Compaction of the Charge in the Gravitation System Using the Grains Triangle for Cokemaking Process. *Energies* **2021**, *14*, 3911. [CrossRef]