

Economics, business, marketing, policy

04/00041 Clean fuels from coal: the path to 1972

Burton, H. *Preprints of Symposia – American Chemical Society, Division of Fuel Chemistry*, 2003, 48, (1), 141–143.

During its infancy, the United States utilized renewables as its source of energy. With time, coal became the dominant source of energy for home, industry and transportation and gradually replaced renewables during the 1800s. During this period the conversion of coal to gas was developed and grew in use until natural gas subsequently supplanted it. Scientific advances in the utilization of coals began with the establishment of the US Bureau of Mines and the German laboratory in Mulheim, among others, in the early 1900s. The period 1920–1940 was characterized as the flowering era of fuel science and technology. A brief perturbation was superimposed on the research activities for coal by the fear of an oil shortage during 1944–1953 but this emphasis declined with the exploitation of Mid-East oil. The oil crisis of 1972 set the stage for the activities for the period of the current symposium: 1972–2002.

04/00042 Distinctive features of coal reconversion in the European Union

Rabanal, N. G. *Applied Energy*, 2003, 74, (3–4), 281–287.

The phenomenon of industrial rationalization is part of the economic reality. The several rhythms of economic growth, besides the changes in the dynamic of the markets, the endowment of productive factors and the technological change, have made their study a complex task, in which there are elements to keep in mind and numerous points of view that could be adopted. Coal in Europe is in a particularly delicate situation. After more than three decades of restructuring and modernization, the coal industry is still not competitive, when compared with world market prices, and the social situation of coal workers and coal communities is hard. The importance of these processes and their effects on the economic and social development in areas or regions in which the coal industry affects their whole activity, in the author's opinion, justifies the interest in deepening the knowledge of the complex reality of coal rationalization. The objective of this report is to offer an overall impression of the coal sector in the European Union as well as the main instruments for economic and social regeneration in the coal regions.

04/00043 Hard coal for energetic purposes: price–quality relationships; international coal market observations and Polish practice

Lorenz, U. and Grudzinski, Z. *Applied Energy*, 2003, 74, (3–4), 271–279. Coal is the most abundant and commonly used energy carrier in the world. In coal-producing countries, coal is often the cheapest fuel for electricity and heat production. Prices of steam coals offered by exporters on international markets reflect current economic and market conditions and are also related to the prices of other fossil fuels like crude oil and natural gas. International coal-market observations and analyses lead to the conclusion that steam-coal prices depend only on heating value. In Polish practice, steam-coal prices are calculated using a price formula in which coal price is a function of three quality parameters: net calorific value, ash content and sulfur content, and a price of 'basic' or 'reference' coal (which means: coal of defined quality). This paper presents the results of international coal-market analyses of relationships between coal price and quality and describes the Polish coal-pricing system. A new solution, relevant to domestic coal mines and power plants, is presented to improve and simplify the conditions of bilateral settlements of coal deliveries.

04/00044 Present situation and prospects for lignite in the Polish power-generation industry

Kozowski, Z. *Applied Energy*, 2003, 74, (3–4), 323–329.

In Poland, lignite is mined in open pits and four deep mines, producing totally about 60–65 million tons a year. Extracted lignite constitutes a fuel for power plants with a total installed capacity of 8833 MW, which generate some 35% of electric energy nationally. This energy is cheaper compared with that from other sources. Poland, with its huge deposits of lignite, is placed in a privileged position, for apart from at present mined deposits, which constitute only about 15% of workable reserves, some abundant areas exist, where mining working can be started. At present, the mined deposits allow us to maintain a current yearly output for the forthcoming 15 years, whereas through the subsequent 30 years, it will decline. In order to maintain supplies of lignite, which is a significant fuel in Poland, it is necessary to fully utilize deposits in the existing areas, and develop new zones where lignite occurs.

04/00045 Progress of coal science in the 20th century

van Heck, K. H. *Preprints of Symposia – American Chemical Society, Division of Fuel Chemistry*, 2003, 48, (1), 144–146.

The lecture deals with the development and advances of coal science in the last century under the driving forces of politics, economics, and technology and interaction with the progress achieved by other scientific and engineering disciplines. The growth and status of knowledge is demonstrated choosing examples under the guideline 'Structure and Basic Reactions'.

04/00046 Progress toward the coal-finery

Schobert, H. H. *Preprints of Symposia – American Chemical Society, Division of Fuel Chemistry*, 2003, 48, (1), 153–154.

In a review the progress in the conversion of coal into synthetic liquids, phenols, coke and other compounds for chemical feedstocks is presented.

04/00047 The market for low-sulphur coals under the restrictive environmental standards in Poland

Kudeko, M. *Applied Energy*, 2003, 74, (3–4), 261–269.

This paper describes the low-sulfur coals market in Poland. It is a crucial issue question because these types of coals will be particularly in demand after the year 2005, when the Polish environmental standards will be more restrictive. This is applicable especially to the energy sector, which is the main consumer of coal in Poland. The purpose of this work is the evaluation of abilities to balance the quantity and quality of low-sulfur coal supplies to the basic consumers, which are domestic heat-and-power plants and others. The article focuses on three key issues. The first one includes an analysis of the supply side of the coal market in Poland. The second concern is an overview of present and future emissions-standards for the energy sector. The third problem applies to the demand side of the coal market and describes the consequences of putting into operation related emissions standards. The analysis ends with conclusions and recommendations for applying an appropriate strategy to meet the new environmental regulations. Conditions under which the burning of low-sulfur coals can be sufficient to meet emissions standards are also described.

Derived solid fuels

04/00048 Application of image analysis in the determining of coke pore structure parameters

Ren, S.-B. *et al. Anhui Gongye Daxue Xuebao, Ziran Kexueban*, 2003, 20, (1), 66–68. (In Chinese)

With Optimas 6.5 (the image analysing and processing software), many images of seven factories' coke were segmented and counted and the best threshold value was gotten. Segmented and identified the image of coke pore structure with the value, it was achieved to detect the parameters of coke pore structure with the method of image analysis. Comparing with the trade methods, this method has the advantages with more precise more representative, etc.

04/00049 Charcoal briquette rod

Shimizu, H. *Jpn. Kokai Tokkyo Koho JP 2003 105,363 (Cl. C10L5/44)*, 9 Apr 2003, Appl. 2001/338,673. (In Japanese)

The invention relates to a charcoal briquette rods, suited for use as a fuel for picnic or camping, comprising a low grade coal powder consolidated with a saw dust and sugar, wherein the ends of the rod are capped for integrity.

04/00050 Coal fuel briquets and their manufacture

Shimazaki, K. *et al. Jpn. Kokai Tokkyo Koho JP 2003 64,377 (Cl. C10B53/08)*, 5 Mar 2003, Appl. 2001/261,612. 6. (In Japanese)

The fuel briquettes are manufactured by mixing coal powder (grain size ≤ 5 mm at ≥ 50 weight%; moisture ≥ 15 weight%) with starch binder 1–10 weight%, extruding to form pellets, coating with 0.1–5 weight% of heavy oils on pellet surface, and extruding in a double-roll molding machine. The method increases the heating value of coal fuel briquettes and reduces operation cost.

04/00051 Coking properties of perhydrous low-rank vitrains. Influence of pyrolysis conditions

Laggoun-Défarge, F. *et al. Journal of Analytical and Applied Pyrolysis*, 2003, 67, (2), 263–276.

Compositional transformations occurring during natural coalification generally lead to increased coking potential of coals characterized in the resulting cokes by large sizes of molecular orientation domains (MOD) determined through transmission electron microscopy with 002 dark field mode. In this study, two sets of perhydrous low-rank vitrains (WJV and UCV) have been pyrolysed using an open-system with two heating rates in an attempt to increase their coking potential. Results show that, despite the high potentialities of such vitrains for producing hydrocarbons, i.e. a suspensive medium efficient for their coke-faction,

each of the pyrolysis methods does not lead to solid residues chemically equivalent to natural coking coals, since the cokes from these residues are always made of smaller MOD than those obtained for coking coals. For comparison, a similar characterization, carried out on a conventional vitrain (Fouthiaux) pyrolysed in a confined-system that prevents the release of hydrocarbons, leads also to non-coking coals. The formation of such MOD is likely due to the peculiar chemical composition of the precursors and/or the pyrolysis conditions. FTIR data show that perhydrous vitrains are characterized by a low degree of condensation of aromatic units with a very small concentration of aromatic rings of large size. Thermal treatment originates depolymerization reactions in the vitrinite network with the formation of low molecular weight products that are not efficient to form large anisotropic domains. The oxygen, present in relatively high amount in some vitrains (UCV and Fouthiaux) might also act as a cross-linking agent preventing the formation of large MOD. Furthermore, while open-medium pyrolysis leads to an important effluent release, as shown by the rapid decrease of H/C ratio, hydrocarbon effluents are conversely retained within the coal matrix in the case of confined-medium pyrolysis. However, the latter pyrolysis induces secondary cracking reactions leading to the formation of lighter products. Therefore, the enhancement of coking properties has not been totally reached by the experiments insofar as they did not lead to oxygen-poor artificially matured coals, similar to natural coking coals.

04/00052 Curing temperature effect on mechanical strength of smokeless fuel briquettes prepared with molasses

Blesa, M. J. *et al. Fuel*, 2003, 82, (8), 943–947.

Environmental acceptable smokeless fuel briquettes have been prepared with a low-rank coal and olive stone as biomass. The binder chosen for this study was molasses which acts with different roles, as chemical and matrix type. The effect of the curing temperature on these briquettes has been studied by Fourier transform infrared spectroscopy, temperature programmed decomposition (TPD) followed on-line by mass spectrometry and optical microscopy. TPD experiments help to predict the final properties of the briquettes more clearly than infrared spectroscopy. The aliphatic structures and methoxy groups as well as the hydrogen bonds decrease during the curing. On the other hand, the carboxylic groups tend to be formed due to the oxidation produced by the effect of curing temperature. In addition, the briquettes cured at 200°C, 2 h showed the highest mechanical strength. These curing conditions also produce waterproof briquettes due to the presence of carboxylic groups which contribute to the stabilization of the briquettes because of the formation of hydrogen bonds.

04/00053 Economic industrial fuel briquets

Zhou, J. and Zhou, Q. Faming Zhuanli Shenqing Gongkai Shuoming-shu CN 1,358,829 (Cl. C10L5/04). (In Chinese)

Fuel briquettes are composed of coal powder 84–92% and ordinary silicate cement 8–16%. The fuel briquettes are manufactured by extruding the coal powder-silicate cement mixture with predicted amount of water to form pellets, drying and then calcining.

04/00054 Effect of steam injection on pore structure and distribution in coke samples produced by delayed coking

Karacan, C. O. and Badger, M. *Fuel*, 2003, 82, (8), 909–917.

Porous structure of the petroleum coke produced in delayed coking technique is investigated by high-resolution X-ray computed tomography imaging. Cokes analysed for these studies were produced from decant oil with and without steam injection. Images taken at different regions along the length of the coke columns have been used to characterize and quantify porosity and pore size (>20 µm)/shape distribution within the coke samples. Fractal analysis was performed to investigate the pore complexity distribution within the coke and to compare the two coke samples produced by different methods. High-resolution X-ray computed tomography was utilized also to scan a 1.1 cm section in the middle of the steam treated coke in volume mode to scan 80 images in one scan. Multi-planar reconstruction and 3D rendering of the pores were used to understand how the flow channels are developed and the degree of connectivity. Results showed that each coke sample shows a wide range of pore sizes and shapes that vary along the length of the coke samples. This variation in the coke that is not subjected to steam is more pronounced. Quantification of macropore size distribution shows that, in each coke sample the middle sections are the most similar regions in terms of pore size distribution and porosity. In general, steam injected coke has larger pores. Box counting fractal analysis in the cokes shows that pore distribution has fractal scaling at the locations scanned and helps in the interpretation of the pores at different locations in terms of their complexity in the distribution and shapes.

04/00055 Large char particle high-pressure oxidation rates and mechanisms

Mathias, J. A. *et al. Energy & Fuels*, 2003, 17, (3), 587–601.

The main objective of this study was to investigate the high-pressure oxidation rates of large (6–9 mm diameter) char particles for a wide range of five experimental conditions, with particular focus on the role of the ratio of the carbon-oxide combustion products at the reaction surface and on its analytical consequences on the Stefan flow (BLD) behaviour. The char particles were obtained by pyrolytic heating of a Pittsburgh HV bituminous coal in nitrogen. The experimental conditions and ranges were gas temperature (825–1200 K), gas (oxidizer) velocity (0.08–1.28 m/s), particle mass (0.056–0.16 g), oxygen mole fraction (0.04–0.21), and total pressure (1–5 atm). This allowed for a suite of 13 different permutations of operating conditions, with each repeated five times for a total of 65 experiments, generating ≈1000 experimental data points. The experiments were conducted in a high-pressure, controlled-profile (HPCP) laboratory reactor with a cantilever balance attachment in a wire basket for continuous weighing to obtain the oxidation rates. The reaction was mostly governed (controlled or dominated) by boundary layer diffusion (BLD), as broadly expected and predicted for particles of this size from the Stefan flow BLD analysis, but results also showed numerical variabilities in the carbon oxides ratio (CO/CO₂) that are believed to be original in this work. In sum, reaction rate increased with increasing temperature oxygen concentration and ambient velocity, in agreement with past work. Burn-out time was independent of total pressure, in agreement with prediction where the reaction rate is controlled or dominated by boundary layer oxidizer diffusion. The particles burned in two stages: stage I extended through 85% to 90% of the char mass loss at which point there was a temperature drop or (nominal) 'extinction' accompanied by slower reaction in the subsequent stage II. The primary focus in this study was on the stage I where comparison with rigorous theory established that the reaction was diffusion-controlled for nine of the 23 sets of experimental conditions. In the remaining four sets (high velocity, low pressure, and low oxygen concentration), there was a measurable chemical reaction resistance; however, diffusion, though not controlling, was still dominant. For eight of the 13 sets of test conditions, analysis indicated full conversion of CO to CO₂ at the particle surface. For the other five sets of test conditions (low oxygen, low temperature, and flow velocity), however, CO accounted for 14% to 79% of the product gas leaving the surface, with the balance being CO₂. The effects of the test variables were quantity accounted for by incorporating Stefan flow behaviour in a rigorous theory of particle burning.

04/00056 Method and apparatus for manufacture of composite solid fuel from coal powder and plant biomass

Miyamori, M. *et al. Jpn. Kokai Tokkyo Koho JP 2003 129,074* (Cl. C10L5/14), 8 May 2003, Appl. 2001/331,802. (In Japanese)

The solid fuel is manufactured by the following steps: (1) cleaning of coal powder with water content 2–15 weight% by dielectrical separation for removal of S, (2) addition of desulfurization agent powder at 1–2 weight equivalent to combustible S content in the cleaned coal powder, (3) mixing the resulting mixture with 5–45 weight% plant-derived organic polymer powder with calorific value ≥3000 kcal/kg and water content 2–20 weight%, and (4) press-molding the resulting mixture. The plant-derived organic polymer powder may be agricultural or industrial wastes, such as waste wood, sawdust, pulp, rice husk, paperboards, and so on. Since almost all of the desulfurization agent powder is deposited on the coal powder, addition amount of the agent can be decreased, and generation of SO₂ by combustion of the solid fuel is effectively suppressed. The apparatus having means for conducting the manufacturing processes mentioned above and the resulting solid fuel are also claimed.

04/00057 Method for production of blast furnace coke good quality by using low-rank coals

Konda, T. and Nomura, M. *Jpn. Kokai Tokkyo Koho JP 2003 55,668* (Cl. C10B57/04), 26 Feb 2003, Appl. 2001/248,315. (In Japanese)

The method is carried out by heat treatment of the low-rank coal (e.g. brown coal) in a liquid medium (e.g. water, Me naphthalene oil) having ≥1 MPa vapour pressure at ≤400°, at ≤400° and 1–20 MPa, then separating the heat-treated coal and the liquid medium, followed by charging the heat-treated coal as portion of coal blend into coke for carbonization, with optional adding caking-enhancement filler, like petroleum pitch, to the heat-treated coal.

04/00058 Method for production of coke with different quality

Konda, T. and Uebo, K. *Jpn. Kokai Tokkyo Koho JP 2003 64,371* (Cl. C10B47/10), 5 Mar 2003, Appl. 2001/256,669.

The method is carried out by dividing the carbonization chamber of the horizontal-chamber coke oven at length direction by rigid container, to have two sections, and charging different-kind raw coal into the section, respectively, for carbonization to produce coke with different shape (e.g. powdered, block) and/or strength.