CLASSIFICATION OF COAL

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Summary

Coals are complex heterogeneous solids that vary widely in their properties and in their suitability for possible applications. The full characterization of a coal is time consuming and expensive. Hence, over the years, a great deal of effort has been spent in the development of systems of coal classification. The background and historical development of coal classification are described in this section. The properties of coal (chemical, physical, mechanical, and petrographic) are used as classification parameters. Some of the properties of coal that are used in its evaluation for end use processes appear in a number of classification systems. There are two kinds of classification system: “commercial/technical” and “scientific,” which serve different purposes. Over the years, many classification systems have been proposed for coal. The majority of these include both scientific and commercial features. Some of the classification systems currently in use in the main coal-producing countries, such as the US, China, Australia, Russia, Germany, France, and Poland, are also discussed here. The international classification (for both hard and soft coal—i.e. anthracite, bituminous coal, sub-bituminous coal, and lignite or brown coal) and the new international codification of medium and high rank coals are also covered.

1. Introduction

Coals occur worldwide and vary significantly in their physical and chemical characteristics for a variety of reasons, both with respect to the organic coal substance and to associated mineral matter that is always present to a varying extent. Coals are an important source of energy, as well as being essential for the production of metallurgical

cokes and are also widely used as feedstocks for other industrial process such as the production of gaseous fuels and synthesis gas. However, coals are complex, heterogeneous solids that vary widely in their properties and hence in their suitability for particular applications. Irrespective of the way coal is looked upon, there has always been a need to classify it, particularly by coal geologists, technologists, and scientists. Such a need becomes evident when one realizes that the principle of systematization has always been applied to coals for the purpose of establishing their classification. The purpose of any classification is to group together things that are similar and to distinguish between those that are not. The nature of a classification system will depend upon the particular application for which the system is to be employed. Classifications for coal may be subdivided into those that are scientific/genetic and those that are technical or commercial, for immediate practical or applied use.

As far as caustobioliths (fossil sedimentary organic matter, including coal) are concerned, the first attempt at systematization was that of A. Libavius in 1599, followed by J. Stockar, whose work was published in 1763 by E. Bertrand. In the latter case, classification was already based on scientific criteria. In the nineteenth century, when the industrial revolution spread from England to the continent, and the steam boiler, the coke oven, and the blast furnace began to make their appearance, an increasing need was felt for a more detailed definition of fuels, which, up until 1800, had merely been classed as bright coal, black coal, and brown coal. In about 1820, the terms “lean coal,” “fat coal,” “hard and soft coal” and “bituminous coal” were adopted. In 1826, Karsten introduced a classification of coal on the basis of the composition of the residue left when coal is heated; he made a distinction between “Sand Kohle” (Sand coal), “Sinterkohle” and “Backende Kohle” (Caking coal). Methods of systematization solely for coal have been attempted since V. Regnault (1837), a work to which L. Gruner applied scientific criteria in 1874, and which was later published by Gruner and Bousquet in 1911. In Germany, it was especially Schondorff (1875) and Muck (1881) who worked on the classification of coal. In the USA, Fraser (1877), following the work of Rogers (1858), devised a system based on the so-called fuel ratio—the ratio between carbon residue and the volatile matter content. The terminology in this system is still being used in America. In 1928, Parr elaborated a suggestion by Campbell (1906) that not only the content of volatile matter, or the fixed carbon content, but also the calorific value should be used as a classification parameter. This suggestion has resulted in the US standardized coal classification system. In Great Britain, Seyler published a system in 1899 which, after being extended and refined in 1931, and again in 1938, may still be regarded a masterpiece of scientific coal classification. Seyler’s system is entirely based on the elementary composition of coal, which may be the reason why it has never met with ready acceptance in commercial and technical circles. The National Coal Board of Great Britain has introduced an entirely different system, which is based on the content of volatile matter and the caking power. In China, Wenhao Weng and Kaiying Jin (1926) devised a system based on the ratio between carbon residue and both the volatile matter and added moisture content in coal.

With the renewal of the international coal trade after the Second World War, it became apparent that every country used its own classification system. A need was thus felt to replace these with a real international classification system for coals. The first attempt to formally systematize coal classification internationally was devised and published in

1956 by the Economic Commission for Europe of the United Nations (Geneva)—UN-ECE, with regard to hard coals. In 1957, this was extended to brown coals. Both these international systems were elaborated with ultimately practical intentions in mind. Both were commercial and technological, and both were based exclusively on chemical parameters and/or physical-chemical tests. Furthermore, both systems are expressed by numerical codes and thus can also be considered as codifications. Both systems are also, at present, totally out of date and inapplicable due to developments in coal technology and in world commerce in solid fuels. Furthermore, both systems cited are based on Northern Hemisphere coals, and therefore do not correspond to all coals presently known and utilized worldwide, particularly regarding hard coals.

In recent decades, Van Krevelen, B.Alpern, Mc Cartney, Teichmuller, R.J. Marshall, Erimin, C.A. Uribe, and P. Chen have published many articles studying classification methods for coals. Around 1980, B. Alpern developed an international petrographic classification for coals. Alpern took the light reflectance of the main petrology of coal viz. vitrinite, as the rank parameter for all coals; this being more suitable than the volatile matter. The first to adopt this petrographic rank parameter for general coal classification was the Standards Association of Australia (1987). In 1988, the ECE coal committee also adopted this rank parameter for a new classification system for higher rank coals. Since this system is no longer hierarchical (with no principal or class parameter), it is better termed a codification system. Combined with the ISO codification of brown coals and lignites (1974), it provides the complete codification for coals in international trade. In 1992, ISO/TC27/WG18 was set up to establish an ISO classification of coals for all ranks, which provides a simple system for the international comparison of coal in terms of some key characteristics, and categorizes coals descriptively in terms of estimates of world and regional coal resources. A committee draft of "Classification of Coals" has been drafted for discussion (see first Document ISO/TC27/WG18-N18, NP11760, 30 June 1999). In 1998, an integrated coal classification system at once technical (Classification systems for Chinese coal, GB 5751-86), commercial (Codification systems for Chinese coals, GB/T16772-1997), and genetic (Classification of in seam coals, GB/T 17607-1998) was approved as the National Standard of People's Republic of China.

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Biographical Sketch

Prof. Chen graduated from the Department of Chemical Engineering, Zhejiang University, in 1956. As a visiting scholar, Chen studied coal structure at Ohio University in 1981 and the University of Utah in 1982 for two years. Currently, Chen is the Deputy Head of Academic Committee of BRICC, CCRI, a tutor of Ph.D. degrees, the committee member of ISO/TC27/WG18: Classification of Coal, the editor in the Far East of "*Fuel Processing Technology*," and a member of the editorial board of the "*Journal of Coal Science and Engineering*." He is also the director of the China Composite Material Society and a member of the Committee of Chemistry Science, the National Natural Science Foundation of China, and a member of Technical Committee of Coal Standardization in China.

His research interests through the years include: coal carbonization , coal hydrogenation and liquefaction, activated carbon fiber from pitch, mesophase of coal pitch, physico-mechanicals properties of coal, coal classification, organic sulfur in coal and its determination, rational utilization of steam coal in China, evaluation method of coking coal for coke making and determination method of Caking Index, application of coal petrography for coal blending and predication of the quality of coke, etc.

Prof. Chen is engaged mainly in clean coal technology, particularly researching efficient, rational, clean, and comprehensive coal utilization technology. He has been awarded the first (or second) prize for Scientific and Technical Advance by National Award or Ministry Award seven times. He has published more than 170 articles and 4 books in Chinese, English, and Japanese.