COAL QUALITY AND COAL UTILIZATION IN THE TWENTY-FIRST CENTURY

R.B. Finkelman and H. Gluskoter
U.S. Geological Survey, MS 956, National Center, Reston, VA 20192

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Abstract

Worldwide coal utilization in the 21st Century will be influenced by concerns about the effects of coal combustion on the local, regional, and global environment and on human health. Reliable coal quality data can help decision makers to better assess the risks and limit the possible environmental degradation and impact on health. Although millions of coal analyses have been performed worldwide, existing national coal quality databases are generally of limited use because much of the data are not readily accessible; geographic coverages are not comprehensive; analytical data may not be accurate; and samples may not be representative, or current. The U.S. Geological Survey is collaborating with agencies from other coal producing countries to create an integrated, electronic, worldwide coal quality database. The database, on coals currently being burned, includes results of proximate and ultimate analyses; sulfur form data; concentrations of major, minor, and trace elements; semi-quantitative analyses of minerals; and modes of occurrence of environmentally important elements.

Introduction

When the U.S. Congress passed the 1990 Clean Air Act amendments (1) worldwide attention was focused on the potential environmental and human health problems that could be caused by the emissions of hazardous air pollutants from coal-burning power plants. Among the potential pollutants were about a dozen trace elements including the elements, or compounds of, antimony, arsenic, beryllium, cadmium, chlorine, chromium, cobalt, fluorine, manganese, mercury, nickel, lead, selenium, and radionuclides (e.g. uranium and thorium) as well as scores of organic compounds. The U.S. Environmental Protection Agency, therefore, sought reliable, comprehensive coal quality information to help assess the potential environmental and human heath impacts of these substances that might arise from coal use. These concerns may be with us well into the 21st Century as we learn more about the effects of long-term, low-level exposure to toxins.

Concerns about the environmental and health impacts of coal use are not constrained to the United States. Environmental and human health problems attributed to coal use have been documented from Czechoslovakia (2), China (3, 4), India (5), Ukraine (6), Russia, and elsewhere. The social cost of these problems is enormous and will continue to grow, especially in developing countries that tend to use poor quality coal in boilers with little or no pollution control systems or use coal for domestic cooking and heating.

The World Resources Institute (7) estimates that as many as 3.5 billion people rely on traditional fuels for cooking and heating. The World Bank (8) estimates that between 400 million and 700 million woman and children are exposed to severe air pollution, generally from cooking fires, a substantial proportion of these people rely on coal. The particulates, metals, gases (such as SO_x), and organic compounds (such as polycyclic aromatic compounds: PAC) can cause serious respiratory problems and toxic reactions.

While many of the environmental and health problems caused by coal use are local, some of the volatile pollutants (CO_2, SO_x, NO_x, Hg, Se, Cl, F) may have regional and even global environmental and human health impacts. Clearly these environmental and health problems create complex economic and social ills that will require carefully considered, multidisciplinary, 21st Century solutions. Reliable, comprehensive and readily available coal quality data can help decision makers to better assess the risks and limit the possible environmental degradation and impact on health.

Domestic Databases

Domestic databases of quality of coals in the United States, while incomplete, are available. The U.S.Geological Survey (USGS) maintains the largest publicly available coal quality database. The database contains information on almost 14,000 coal samples from every major coal basin in the U.S. Approximately 136 parameters are recorded for each sample. These parameters include geographical, geologic, and stratigraphic information, quantitative information on about 60 elements,

proximate and ultimate data, sulfur-form information, ash fusion temperatures, etc. Recently, much of this information has been made available on CD-ROM (9) and on the World Wide Web at URL http://energy.er.usgs.gov/products/databases/coalqual/intro.htm.

The Illinois State Geological Survey, the New Mexico Bureau of Mines and Minerals Resources, the University of North Dakota's Energy and Environmental Research Center (EERC), and the Pennsylvania State University also maintain high-quality, publicly available coal quality databases containing several hundred to more than 1,000 analyses.

A weakness of all the publicly available coal quality databases is that the samples represent coal that has been mined. For example, approximately 75 percent of the information contained in the USGS database was obtained prior to 1985. Twenty-first Century decisions will require information that reflects the characteristics of the coal that is currently being mined and burned and of the coal that will be mined in the near future. Moreover, current environmental concerns require new types of information to be included in these databases. For example, semi-quantitative analyses of minerals and modes of occurrence of environmentally important elements are necessary for the development of computer models to predict the behavior of these elements during coal cleaning and combustion. Petrographic characterization of coal may provide useful insights into the types and amounts of PAC's generated during domestic coal combustion (10).

To address these concerns, the USGS is teaming with other organizations to create a new coal quality database. This new database, known as the National Coal Quality Inventory (NaCQI) is supported by a partnership forged among federal and state governmental agencies, the utility and mining industries, and universities (11).

The project participants will collect suites of samples (core/channel, run-of-mine, raw/clean, power plant feed, etc.) from the major coal producing regions in the U.S. that will provide coal in the 21st Century. The samples will be characterized by traditional methods (12) for proximate and ultimate analysis, sulfur form data, major, minor and trace elements. The scope of this database will be broadened to include modes of occurrence information and semi-quantitative mineralogy on selected samples.

International Coal Quality Databases

Most of the growth in energy consumption in the 21st Century will be seen in developing countries such as China, India, and Indonesia, all of which have large indigenous coal resources (13). Increasing populations and rapid industrialization is placing enormous pressures on these countries to produce energy through increased coal use. With this rapid expansion of coal use comes the potential for serious environmental and human health problems. Unfortunately, many of these countries lack the reliable, comprehensive, electronic coal quality database needed to help minimize these problems.

Although millions of coal analyses have been performed worldwide, most existing national coal quality databases are generally of limited use because:

- Much of the data are in obscure publications, are in the native languages, or the data reside in paper files that are not readily accessible;
- Geographic coverages are not comprehensive;
- Analytical data may not be accurate or may be incompatible with analytical schemes used in other countries;
- The analyzed coal samples may not be representative of the full deposit, or the samples may have been collected and analyzed many years, often several decades, ago.
- Information is lacking on trace element concentrations, mineralogy, and modes of occurrence of the elements of environmental concern.

To help develop an integrated, electronic worldwide coal quality database, the USGS has initiated a unique compilation of coal quality information from all the coal-producing countries in the world. The database (World Coal Quality Inventory: WoCQI), will focus on information from coals currently being burned and will include results of proximate and ultimate analyses, sulfur form data, concentrations of major, minor, and trace elements, semi-quantitative analyses of minerals, and modes of occurrence of environmentally important elements on selected samples. The information in the database will be made available on the World Wide Web (WWW) and through a searchable CD-ROM.

The sources of coal quality information that will be incorporated into the database include capturing existing computerized databases and salvaging information from publications and hardcopy files. However, the highest priority will be given to developing cooperative agreements with representatives of coal-producing countries. In most agreements the host country will be responsible for the collection of the sample using appropriate sample collection protocols and the USGS would be responsible for sample characterization, database development, and information dissemination.

The information in the WoCQI database could be used to evaluate:

- National and regional energy resources
- Export/import potential
- Potential environmental and health impacts
- Technological behavior
- Technology transfer potential
- International Policy decisions
- Byproduct potential

WoCQI currently contains approximately 2,000 analyses from about 20 countries (exclusive of the U.S.). We intend to expand the scope of coal quality characteristics to include information on mineralogy, petrography, washability, modes of occurrence, etc.

We should strive to develop coal quality databases that anticipate the potential future uses of the coal quality data. This would require that 21st Century coal quality databases contain a broader range of coal quality parameters including quantitative information on modes of occurrence of the elements, semi-quantitative mineral composition, and information on the behavior of the elements during coal cleaning, leaching, and combustion.

In addition to addressing environmental and health problems, coal quality data can also be used to better anticipate technological problems such as boiler fouling, slagging, corrosion, erosion, and agglomeration. This, in turn, could lead to coal-blending or additives that would minimize these costly problems. Information on the textural relations (mineral-mineral and mineral-maceral intergrowths) should be useful in anticipating the removability of trace elements during physical, chemical, and biological coal cleaning. Anticipating the removability of certain elements from coal might create opportunities for economic byproduct recovery.

Coal quality data could play an important international role by providing useful information on potential foreign investment prospects. This information may also help to identify markets for coal industry goods and services.

Quantitative coal quality data, comprehensive databases containing a broader array of quantitative coal quality parameters, and multi-disciplinary, multi-organizational, and multi-national cooperation should help to ensure the efficient and environmentally compatible use of our global coal resources in the 21st Century.

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