CHAPTER 6

THE REDISTRIBUTION OF TRACE ELEMENTS DURING THE BENEFICIATION OF COAL

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6.1 INTRODUCTION

Concern over potential environmental and health effects of trace elements has grown in recent years. In the United States, the Clean Air Act Amendments of 1990 identify 189 hazardous air pollutants (HAPs), of which 12 are elements and their compounds found in coal, usually in trace amounts. These elements are Sb, As, Be, Cd, Cl, Cr, Co, Pb, Mn, Hg, Ni and Se. In addition to these specific elements, radionuclides are also listed as HAPs; these too are known to occur naturally in coal. Finally, F, in the form of hydrofluoric acid, is listed.

The 1990 Clean Air Act Amendments mandates the US Environmental Protection Agency (EPA) to prepare a report for Congress on hazardous air pollution produced by electric utilities, scheduled for completion in November 1995, as well as a report on utility emissions of Hg, scheduled for completion in November 1994. After EPA completes these reports, the agency will determine if regulation of utility HAPs is warranted. If regulations are created, it is reasonable to assume that they will include limits on the release of HAPs during coal combustion.

Fortunately, the majority of these elements are associated, at least in part, with the mineral constituents of coal rather than organically bound (R.B. Finkelman, Chapter 3). Physical coal cleaning techniques are effective in removing mineral matter from coal and can, therefore, remove at least some of the trace elements associated with specific minerals if two conditions are met:

- The target mineral is liberated. Physical coal cleaning is a sorting process that separates one particle from another based on physical characteristics such as size and density. The cleaning process does not change the characteristics of the individual particles, but rather sorts them into clean coal or refuse. Fine-sized minerals embedded in particles that are predominantly in coal cannot be removed by physical processes unless the coal particle is ground fine enough to release (liberate) the mineral particle.
• The cleaning process is able to sort based on some physical characteristic of the target mineral. All liberated minerals cannot be removed by all physical processes. A classic example is the sulfur-bearing mineral pyrite. Pyrite is often liberated in fine-sized coal. The most commonly used method of cleaning fine-sized coal is froth flotation, a process that sorts by differences in surface properties. Unfortunately, the surface properties of coal and pyrite are so similar that froth flotation sometimes concentrates pyrite in the clean coal rather than sorting it to refuse.

Within these limitations, physical coal cleaning can be very effective in removing trace elements. Coal cleaning is likely, therefore, to play an important role in the control of HAPs. At the same time, coal cleaning offers numerous benefits. It reduces the ash-forming mineral content of coal and increases the heating value, reducing transportation costs and increasing boiler efficiency. Coal cleaning also provides environmental benefits by reducing the sulfur dioxide emissions potential of the coal and the amount of ash for collection and disposal.

6.2 TRACE-ELEMENT REDUCTION BY CONVENTIONAL CLEANING

In the US, work by CQ Inc., Southern Company Services, Inc., Consolidation Coal Company (CONSOL), and Bituminous Coal Research Inc. has demonstrated that conventional methods of coal cleaning can produce large reductions in the concentration of many trace elements. CQ Inc., under funding by the Electric Power Research Institute (EPRI), monitored trace element reduction in 10 coal cleaning tests performed at commercial scale at CQ Inc.’s Coal Quality Development Center (CQDC) located in Homer City, Pennsylvania (Akers and Dospoy, 1994). These tests were performed at the CQDC primarily to measure ash and sulfur reduction. As no attempt was made to enhance removal of any trace element, these results are representative of trace-element reductions that occur as a by-product of cleaning for ash and sulfur reduction.

Under funding by EPRI and the US Department of Energy, Southern Company Services, Inc. measured the trace-element reductions that occurred during one commercial-scale cleaning test at CQ Inc.’s CQDC and at one commercial cleaning plant (CQ Inc. and Southern Company Services, Inc., 1993). CONSOL has published information on trace-element reductions in 8 commercial cleaning plants (DeVito et al., 1994) and Bituminous Coal Research (under funding by the Department of Energy) has published trace-element reduction data for 6 commercial plants (Ford and Price, 1982). Combined, these sources provide trace-element reduction data for 16 commercial and 10 commercial-scale cleaning tests, as presented in Table 6.1. As with the CQ Inc. data, the trace-element reductions measured are by-products of cleaning for ash and sulfur reduction.