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EPRI EA-5176
Volume 1
Project 2485-8
Interim Report
August 1987

0911684
(9)

Inorganic and Organic Constituents in Fossil Fuel Combustion Residues

Volume 1: A Critical Review

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RECEIVED
MAR 23 2006

14467

REPORT SUMMARY

SUBJECTS Solid-waste studies / Solid by-product disposal/reuse / Water quality/aquatic resources / Hazardous/toxic substances

TOPICS Solid wastes, Coal ash, Oil ash, Scrubber sludge, Leachates

AUDIENCE Environmental and R&D scientists and engineers

Inorganic and Organic Constituents in Fossil Fuel Combustion Residues

Volumes 1 and 2

Accurate prediction of groundwater contamination from solid-waste disposal sites requires leaching rates for fossil fuel combustion waste chemicals. In a wide-ranging literature review, this study obtained data on 28 inorganic constituents and identified the need for new data to improve leachate composition prediction models.

BACKGROUND Fossil fuel wastes contain many chemicals, some of which may leach in waste disposal environments and migrate to groundwater. To help utilities accurately predict the leaching of wastes under actual disposal conditions, EPRI is developing comprehensive data on the processes controlling the extent and rates of fossil fuel waste leaching and incorporating them in new models to predict leachate composition.

OBJECTIVES

- To summarize the available data on concentrations and leachability of elements found in fossil fuel combustion wastes.
- To critique the data available for predicting the leachability of inorganic constituents and various organic solutes in fossil fuel wastes.

APPROACH Researchers conducted an extensive literature review of fossil fuel combustion waste chemistry; classified the references by chemical constituent, waste type, and technical content; and critiqued the existing data. Summarized information for inorganic and organic constituents includes (1) concentration in various waste types, (2) morphological association and physical distribution, (3) hypothesized and observed solid phases harboring the inorganic constituents, (4) state-of-the-science understanding of fundamental leaching reactions, and (5) applicability of existing thermochemical and geochemical data to quantify leaching of utility waste constituents. The analytic approach was based on thermochemical principles and knowledge of chemical reactions for site- and waste-specific conditions.

RESULTS This report compiles current knowledge on fossil fuel combustion waste characteristics and their leaching behaviors. Volume 1 contains a critical review, and volume 2 is an annotated bibliography. Utilities can use this

information for interim predictions. General and specific conclusions include the following:

- Combustion processes generally increase the concentrations of volatile elements (for example, boron, fluorine, and selenium) in coal fly ash and flue gas desulfurization sludge.
- Oil ash is enriched in antimony, copper, lead, molybdenum, nickel, selenium, vanadium, and zinc.
- Coal fly and bottom ashes have similar contents of nonvolatile inorganic elements (for example, aluminum, calcium, iron, and silicon).
- Water extracts from wastes have variable compositions that depend on pH, dissolution reactions, and solid-phase chemistry and morphology of the waste particles.
- Precipitation/dissolution reactions control the concentrations of several elements (for example, aluminum, barium, calcium, iron, silicon, and sulfur) in coal fly ash leachates.
- Few data are available on organic constituents in wastes and leachates.

EPRI PERSPECTIVE

This critical review underscores the importance of fundamental studies to determine the causes and rates of waste constituent leaching and to identify solid phases involved in leaching control. Thus, researchers continuing this project are characterizing selected waste samples covering a large composition range and using them in laboratory and field experiments. EPRI reports EA-4215, EA-4740, and EA-4747 contain results to date on leaching characteristics of utility solid wastes. Reports EA-4417 and EA-4544 present fundamental and geochemical data for interpreting the leaching-attenuation chemistry. And EA-3417 describes geohydrochemical models that can use these results for predicting subsurface chemical migration.

PROJECT

RP2485-8
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