Coal rejects – a wasted resource?

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ABSTRACT

The paper outlines potential uses for coal washery rejects. It considers in detail the use of fluidized-bed combustion as a means of lessening rejects disposal problems, as a method of recovering energy for drying, steam raising and electricity production and as a source of ash as a substitute for natural aggregate. Considerable technical information is now available on the use of fluidized beds for these purposes and the paper concludes that it is appropriate to consider a more detailed, site-specific, evaluation.

INTRODUCTION

During 1980/81 Australian coal mines produced 106 million tonnes of black coal. Over 80 million tonnes of this coal were treated in coal preparation plants (washeries) to give a higher grade product for domestic and export markets. Most of the washed coal is used in metallurgical coke manufacture, although in recent years a growing export market for steaming coal has emerged.

In the washing process a low-ash fraction is separated from the run-of-mine coal by various gravity techniques. Generally no further processing of the remaining high-ash fraction is attempted and this is dumped near the washery site. In 1980/81, 20.5 million tonnes of such waste were produced. Continued growth of coal production and consequently waste production are projected. Disposal of such large quantities of waste in an environmentally acceptable manner poses a major problem for the Australian coal industry.

Over the last ten years the CSIRO Division of Fossil Fuels has been investigating the fluidized-bed combustion (FBC) process as a means for recovering energy from coal wastes and providing an inert product suitable for safe disposal (Szpindler et al., 1974). Since 1977, the Division, in conjunction with the Joint Coal Board, has been operating a 4.5 MW (thermal) pilot plant at the Glenlee coal preparation plant at Clutha Development Ltd., near Camden, New South Wales (Duffy et al., 1980; La Nauze et al., 1980). The project has given emphasis to the treatment of the finer, high moisture content fraction of the wastes (referred to as tailings throughout this report) since it presents the main disposal problem to washeries. Based on results from the pilot plant a conceptual design study for a full-scale FBC facility was commissioned (Merz and McLellan and Partners, 1981). It showed that the process offers a technically feasible and economically competitive alternative to existing methods for treating coal washery tailings.

This paper describes the nature of coal washery rejects and the environmental controls imposed on their disposal. Current practices for disposal and the limited number of alternative uses made of the reject material are briefly outlined. In response to the question posed by the paper title, the remainder of the paper sets out to show that fluidized-bed combustion enables one to consider coal wastes as a resource capable of exploitation.

PRODUCTION AND NATURE OF COAL WASHERY WASTES

Production of coal wastes has risen from 1.9 million tonnes in 1959/60 to 20.5 million tonnes in 1980/81. This represents an increase from 14% to 25% of coal washed, reflecting less selective mining due to increasing mechanization within the coal industry over the last 20 years. There are currently about 54 coal washeries in operation throughout New South Wales and Queensland. In New South Wales many washeries are located close to the major population centres of Sydney, Wollongong and Newcastle. Such locations and the stricter requirements imposed by regulatory bodies have required coal companies to improve their methods for disposal of washery wastes.

The wastes from coal preparation plants are in two forms: (i) coarse rejects, lumps of carbonaceous shale up to 200 mm in size, and (ii) tailings, a suspension of fine (=0.5 mm) clay, coal and other mineral matter in water at a solids concentration of 3 to 60%. On the basis of a survey of ACIRL (Pollard et al., 1980), Stockton (1980) estimated that tailings made up 24% of wastes produced in Australia on a dry basis. This represents a 6% increase from earlier surveys by Szpindler and Waters (1974, 1975), though some of the difference may be attributed to the different methods and assumptions used in the calculations.

It is the tailings with their high moisture content, fine solids and clays which pose the major disposal problem. While on a dry basis they represented over 2.8 million tonnes in 1978/79 (Stockton, 1980), at their average solids concentration of 18.8% they amounted to 25.5 million tonnes, or 62% of total waste production.

Coal washery wastes show wide variations in composition, but in general the coarse rejects are higher in ash content and lower in heating value than the tailings on a dry basis. Coal wastes represent a considerable energy resource (Table 1). The Joint Coal Board (1980) estimated that New South Wales wastes alone contained 1.3 x 10¹⁷ J at an average specific energy of 14.7 MJ/kg (dry basis). Stockton (1980) estimated a value of 2.5 x 10¹⁷ J for all Australian wastes, with 36% of this energy in the tailings.
ENVIRONMENTAL CONTROLS FOR THE DISPOSAL OF COAL WASHERY WASTES

The general guidelines published by the SPCC (1979) are summarized below.

The developers of a coal waste disposal site are required to demonstrate that existing and future land uses will not be adversely affected and to show that adverse impacts on the natural environment can be avoided. The wastes should be contained in structures designed to have long-term stability and low visual prominence. Revegetation is required to produce a minimum standard of end-use a safe, stable, non-polluting site compatible with the surrounding environment.

Potential air pollutants from the wastes are dust, smoke and noxious gases. Dust control requires that working areas where dust can be generated are kept to a minimum. The use of windbreaks and water-spray systems may be required under the regulations to control dust. Proper compaction of emplacement structures is required to minimize the risk of accidental or spontaneous combustion and the subsequent evolution of smoke and noxious gases.

The guidelines state that preferred practice is to design controls to avoid discharge of potential water pollutants from the disposal of coal wastes which include acid leachates, saline waters, toxic elements and suspended solids. Embankments should be designed to ensure that there are no unacceptable discharges from tailings dams to waterways or seepage to underlying aquifers. Any discharge from the site would be required to comply with the standard set down.

Noise nuisance may arise from fixed and mobile equipment, especially trucks and earth-moving equipment. Acceptable noise levels are related to the general background noise levels in the area. Acoustic barriers may be required and operating hours (including truck movements) may be restricted.

CURRENT METHODS FOR TREATING COAL WASHERY WASTES

The Australian Coal Industry Research Laboratories Ltd (Stockton, 1981) reviewed methods of waste disposal in 53 Australian washeries. The study showed that all coarse refuse, amounting to 15.4 million tonnes in 1978/79, is disposed of in surface emplacements. Some is used to form the walls of ponds or dams into which tailings are pumped. Where open-cut mining is carried out, the coarse refuse is often used to re-contour abandoned sites and in this case performs an important role in the final rehabilitation of the site.

Tailings, equivalent to about 4.8 million tonnes per annum on a dry basis, are discharged by most plants for dewatering in ponds, dams, opencuts or abandoned underground workings. Tailings dams were by far the most important means of disposal accounting for 58.3% of tailings. Discharge to open cuts (18.8%) and ponds (9.4%) resulted in the three surface disposal methods accounting for 86.5% of total tailings with only 13.5% pumped to abandoned underground workings (Stockton, 1981).

In ponds and dams the solids are allowed to settle while the water filters through the porous walls to be collected and recycled where possible to the washery. Ponds may be defined as relatively small enclosures having capacities sufficient for up to one year’s operation. In some cases the settled solids are recovered for disposal elsewhere along with the coarse refuse and the pond reused. Dams are large enclosures which allow for settling over a relatively long period, and usually provide a permanent placement for the tailings.

Open-cut disposal involves pumping tailings to ponds or dams formed largely by excavations to remove the coal. On reaching the end of their useful life, ponds and dams are usually covered with a layer of coarse refuse.

With underground disposal, tailings are pumped via borehole or pipeline to abandoned mine workings. Since no land area is required to implement this method it offers an aesthetically acceptable alternative to tailings ponds. However there is the possibility of the water in the tailings reducing safety in working areas of the mine or causing leaching of pollutants into natural water courses.

Some form of tailings dewatering is normally practised within most plants (Stockton, 1980). A combination of classifying cyclones and slurry screens is a common method used to partially dewater tailings while some 30 plants use thickeners as the final treatment. The average solids content of tailings leaving washeries is, however, only 18.8%.

In recent years there has been a trend towards eliminating the use of tailings ponds and dams. This requires further treatment of the tailings with some form of mechanical dewatering device to give a product which can be blended with coarse refuse prior to combined disposal in emplacements. The ACIRL survey (Stockton, 1981) reported that mechanical dewatering was being carried out in 4 of the 53 plants surveyed. In these plants solid bowl centrifuges were being used after conventional thickeners to reduce moisture contents to 35 to 50%. The cake produced has at best a semi-solid consistency and may have to be spread out to dry in thin layers before it can be incorporated with coarse refuse.

Other mechanical dewatering devices being used overseas include vacuum filters, pressure filters and band press filters. There are at present few commercial installations of these devices in Australia, although

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Table 1 Comparison of energy content of coal washeries wastes and energy fuels supplied to Australian power stations (Duffy & Kable, 1984).

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