Electricity from coal waste

It's better to burn waste from coal washeries than dump it, and better to turn the heat produced into electricity than send it up the chimney. That's the message coming from the operation of a pilot waste-burner at the Glenlee coal washery near Camden, N.S.W.

Scientists from the CSIRO Division of Fossil Fuels have been operating the fluidized-bed combustor since 1977 in collaboration with the Joint Coal Board and the colliery owners, Clutha Development Pty Ltd (see *Ecos* 26). They have proved to their satisfaction that many sorts of coal waste — coarse or fine, wet or dry, high or low ash — can be consumed without difficulty at the unit's unusually low operating temperature of 850°C.

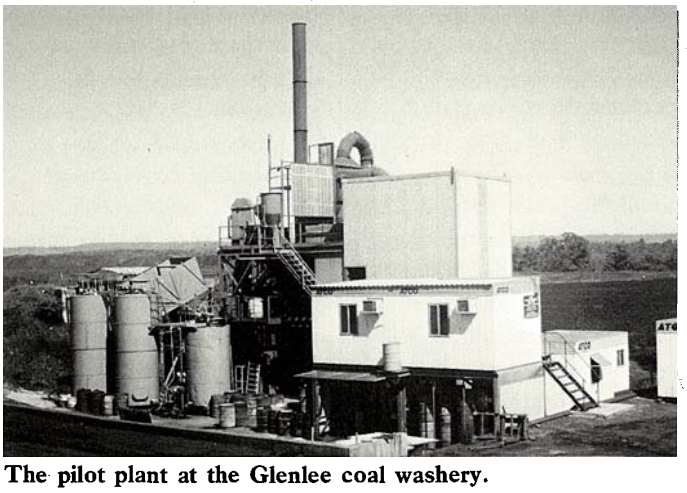
Dr Robert LaNauze and Dr Greg Duffy, of the Division, now want to prove that a fluidized-bed furnace is good for more than incinerating troublesome waste. If the heat at present being released to the air could be harnessed by a boiler, electricity could be generated from the steam. They envisage that the power generated would be used by the coal washery and the excess fed to the State electricity grid.

With the aid of a grant of $712 000 from the National Energy Research Development and Demonstration Council, a boiler is now

The cost of tailings disposal

treatment	moisture content after treatment (% by weight)	cost of treatment including disposal ($ per dry tonne)
tailings ponds		
without thickeners	95–97	1–3
with thickeners	60–80	3–6
deep cone thickeners	35–50	8–11
vacuum and mechanical filter presses	25–45	10–16
solid bowl centrifuges	40–55	6–9
fluidized-bed combustion		
incineration alone	0	7–8
with power generation		
1·5 c per kWh	0	3
2·0 c per kWh	0	0

The cost of disposing of coal-washery tailings by fluidized-bed combustion compares well with that of alternatives.



The pilot plant at the Glenlee coal washery.

being installed at the plant to put their idea to the test. The 3-MW boiler will only raise steam, but its performance will show how much electricity could be produced. The grant also provides for additional research on the combustion characteristics of different coal-waste types, including those known to be especially difficult to burn.

The commercial feasibility of fluidized-bed combustion for coal-waste disposal has been confirmed in an independent assessment of its technical and economic aspects by Merz & McLellan & Partners, a firm of consulting engineers. The consultants found that a full-scale fluidized-bed combustor would provide an economically sound and environmentally attractive means of disposing of coal-waste tailings. And if heat recovery and electricity generation were implemented, the operation should run at a profit.

In either case, the promise of a cleaner environment offers an added incentive.

All the coal exported from Australia (42% of that mined) is washed, separating out low-grade, high-ash material. Coarse rejects are generally placed in embankments at the washery site, and a tailings stream — a slurry of fine coal and dirt — is confined in settling ponds.

These methods of disposal can create environmental problems, and furthermore they consign around 16% of the energy in the mined coal to waste. The total energy content of the 20 million tonnes of Australian coal waste produced last year has been estimated to be 247 million GJ — equivalent to that of all the brown coal (or half the black) consumed in Australian power stations in the year.

Washery wastes are completely unsuitable for burning in conventional boilers; but the key advantage of fluidized-bed combustors is that they can burn comparatively low-energy materials. And, as well as allowing energy to be recovered, combustion of these wastes reduces them to an inert form more suitable for disposal.

The Glenlee pilot plant operates on both coarse rejects (crushed to less than 10 mm) and tailings (thickened to 30–40% solids), fired either separately or together. Tailings present the most difficult disposal problem, so

the plant is mainly used to burn this high-moisture-content waste.

Merz & McLellan & Partners looked at the economic and technical feasibility of a plant burning 25 tonnes (dry weight) of tailings per hour — about the capacity needed to serve a washery treating 3·5 million tonnes of raw coal a year. They assumed that tailings had been thickened to 35% solids; this is standard practice in many washeries, in order to cut down on water consumption.

The study examined two systems. In the first, which did not include electricity generation, the optimum design was found to be one that burns one-third of the tailings and uses the heat from this to dry the rest. The ash and dried tailings can then be dumped with the unburnt coarse refuse.

This scheme needs the smallest, cheapest plant. And the consultants estimate a treatment cost of $7.70 per tonne of dry tailings. Although more expensive than disposal in a tailings pond, this system compares well with any other alternative when dumping costs are included (see the table).

The second system involves combustion of all the tailings and a fraction of the coarse material and uses a waste-heat boiler (taking heat from the flue) to generate power.

The envisaged plant, rated at 165 MW (thermal), would require considerably more capital investment ($17 million), but this cost would be balanced by the income from the sale of electricity. Gross electricity output would be 22 MW, of which, after meeting colliery requirements, 15 MW would be available for sale.

At a selling price of 2 cents per kilowatt-hour (roughly the cost of supply from the grid), the system would break even, with income matching treatment costs. At a price of only 1·5 c per kWh, disposal would cost $3 per tonne — less than some of the disposal methods common today.

If all the wastes from the washery were burnt, then a much larger plant would be required. The study did not examine this option in detail. However, some preliminary figures can be presented.

The coarse rejects would supply 62% of the total heat, raising the plant rating to 385 MW. Still capturing waste heat indirectly, as before, 70 MW of electricity could be generated, an efficiency of only 18%. However, improved energy recovery could be achieved if heat exchangers were placed in the bed, rather than in the flue. If this were done, only about 6% of the energy in the raw coal would be lost at the washery instead of approximately 16% as at present.

Any markets that could be developed for the light-coloured fine aggregate (a possible construction material) left after combustion would further enhance the viability of the process.

Reducing the environmental impact of coal-washing practice in Australia. G.J. Duffy, R.D. LaNauze, and J.W. Kable. *Minerals and the Environment*, 1981, 3, 103–10.

Burning waste as it floats on air. *Ecos* No. 26, 1980, 10–12.