Coal, cleaner than clean

Washing coal with water separates out the shaley low-grade material, and this is the job of the many coal washery plants scattered around the country. Upgraded in this way, more than 60 million tonnes of coking coal are exported each year.

But even such prime clean coal carries a burden of incombustible mineral matter. When the coal is burnt it leaves 5–10% ash. This residue renders our most abundant fossil fuel unsuitable for a number of applications, and petroleum products and natural gas are used instead.

In particular, coal cannot be used in internal combustion engines, nor as feedstock for low-ash industrial carbons.

Recent research has sought a way around this obstacle, usually by turning coal into a gas or a liquid, thereby leaving the inorganic material behind. But what about plucking the mineral matter out and leaving the coal behind?

Mr Bruce Waugh of the CSIRO Division of Energy Chemistry and Dr Keith Bowling of the Division of Fossil Fuels are working on a chemical process that does just that, yielding 'superclean' coal. They find that by stewing coal with caustic soda, under pressure, they can convert more than 90% of the mineral matter and, with an acid wash, dissolve it out. Only 0·3 to 0·8% of mineral matter remains in the treated coal.

Possible uses for the pulverized product could include using it to fire boilers or gas turbines, or (in the form of a slurry in water or oil) as a fuel for slow-speed marine diesels and eventually for diesel cars and trucks. Heat treatment (pyrolysis) of the coal could be an attractive way of producing liquid and gaseous alternatives to various petroleum fractions, because the accompanying by-product carbon would be low in ash.

Solid industrial carbons could be produced this way. In particular, the consumable carbon electrodes for electrolytic refining of aluminium and in electric steel furnaces need a dense pure carbon, and petroleum coke presently supplies this requirement. 'Superclean' coal would be ideal for the purpose.

Calculations by Dr Bowling, who began his experiments after working on a different process for removing the mineral matter from brown coal, show significant economic advantages for the new process.

For example, petroleum coke presently costs from $160 to $200 per tonne and heavy fuel oil more than $200 per tonne. A provisional estimate by Dr Bowling suggests that a plant capable of producing 0·5 megatonnes of demineralized coal a year could take coal with 6·5% ash, costing $50 per tonne, and produce a high-purity product for about $110 per tonne. If a plant four times bigger were built, the cost would fall to near $100 per tonne.

Other chemical cleaning processes have been proposed, but none has the low cost or high yield of the present one.

Mr Waugh has done most of the investigations into the chemistry of the process. He finds a good recipe for chemically cleaning coal to be pressure-cooking it with 10% caustic soda for 3–6 minutes at 170–250°C and 1–3 MPa. The caustic soda dissolves silica from the coal and converts aluminium and silicon, present as clay or shale, into a compound that dissolves in acid during the subsequent washing stage.

Fine grinding of the coal is not necessary: the process can remove more than half the mineral matter from lumps of coal as big as 1 cu. cm.

The other factor that

Treating black coal to remove its mineral matter.

contributes to the low cost of the process is the ease with which the working solutions can be regenerated. Dissolved minerals build up in the solutions, but simply adding lime precipitates the minerals as insoluble calcium salts, and prepares the caustic soda for re-use.

The calcium-rich sediment can be safely disposed of, or it could be useful in the making of Portland cement.

Footnote: Scientists from the CSIRO Division of Energy Technology have recently tested a coal–oil mixture in a medium-speed diesel engine using demineralized brown coal. The test results show that stretching out oil this way still has some way to go before it becomes economical .

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The preparation of clean coal. A.B. Waugh and K. McG. Bowling. *Proceedings, Australian Coal Science Conference, Churchill, Vic., December 1984.*

Preparation and performance of brown coal/oil mixtures as a fuel for diesel engines. P.C. Bandopadhayay, R.J. Downie, W.R. Read, and J.J. Kowalczewski. *CSIRO Division of Energy Technology, Technical Report* No. 5, 1985.