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In the hot bed of controversy

Britain has a Cinderella technology that even makes its own cinders. It makes them by burning coal and practically anything else efficiently and cleanly. It is, however, a Cinderella technology because, although much of the most important work on it has been done in Britain, successive British Governments have kept it starving in a garret while lavishing resources on its nuclear step-sisters.

The basic idea of fluidised-bed combustion is simple and elegant. You take a boxful of sand or other inert material. You blow air up through the layer of sand from below. The rising air lifts the sand particles, until the sand churns and bubbles like a boiling fluid: a "fluidised bed." You then heat the churning particles up to incandescence, by playing a flame over the bed or burning gas in the fluidising air. When the bed is incandescent it looks like boiling lava. Any fuel - indeed anything even slightly combustible - that you drop into the incandescent bed will at once be ignited and burn. The heat released by the burning fuel will then keep the bed hot, and the start-up heating can cease.

When this fluidised-bed combustor is operating, burning fuel constitutes no more than perhaps 1 per cent of the total mass of the bed. The rest is hot sand and ash. The heat stored in the bed material keeps the temperature stable, and the turbulence keeps the temperature uniform throughout. Cheap low-grade fuels, including some which would not support combustion in a conventional firebox, or would quench the fire - high-ash coal, soaking wet, or raw urban refuse, or sewage sludge which is half water - can all be burnt in a fluidised-bed combustor. Indeed they can be burnt interchangeably, without shutting down, or mixed.

The heat from the burning fuel is carried away by the hot combustion gases above the bed; some heat may also be transferred to water pipes immersed in the bed. This heat transfer takes place not only by convection and radiation but by direct conduction, as the glowing bed particles bounce off the pipes and the transfer is so efficient that a fluidised-bed combustor can be significantly smaller than a conventional unit with the same output; it may thus cost less. More importantly, a fluidised-bed combustor can be fitted into a space comparable to that of an oil-fired or gas-fired unit of the same output.

The high rate of heat transfer also means that a fluidised-bed combustor can operate at a lower temperature than a conventional unit. This reduces materials problems, not least because the operating temperature is below that at which coal ash melts, so that the ash remains soft and less abrasive. The low temperature also minimises the formation of nitrogen oxides.

FBC offers a simple and highly effective way to control the emission of noxious sulphur oxides from high-sulphur coal. An appropriate amount of crushed limestone or dolomite is fed into the bed with the fuel. The sulphur in the fuel reacts not only with oxygen but also with the calciurn in the stone, to form solid calcium sulphate. The calcium sulphate remains in the bed until it spills out through the ash overflow. By this means it is possible to trap more than 90 per cent of the sulphur in coal, reducing dramatically the pollution emitted from coal-burning, without the capital cost or sludge disposal problem associated with flue gas scrubbing.

If FBC has all these advantages, why has it not long since set the world alight? FBC attracted sporadic attention from the mid-1940s onwards ; but it was effectively re-invented at the end of the 1950s, by a British engineer, Douglas Elliott, at the Marchwood Laboratories of the Central

Electricity Generating Board. However, the CEGB was, at the time, losing interest in coal, as cheap petroleum poured into the country and Government planners plumped for nuclear power.

The National Coal Board Coal Research Establishment at Stoke Orchard was also investigating the potential of fluidised-bed combustion, as was the British Coal Utilisation Research Association (BCURA) at its Leatherhead laboratory. However, official statements, especially the 1967 White Paper on Fuel Policy, left no doubt that official planners saw little long-term future for British coal. But a small and dogged band of believers including Elliott, his colleague Raymond Hoy at the Leatherhead lab, and Leslie Grainger, NCB Member for Science, kept the fluidised-bed faith, even when North Sea gas was joined by North Sea oil.

In 1968 Hoy and Elliott conceived the notion of placing the entire fluidised-bed combustor inside a pressure shell. A pressurised fluidised-bed combustor would be even more compact than one operating at atmospheric pressure; furthermore, it might be possible to feed the hot high-pressure combustion gases directly into a gas turbine, thus achieving a coal-fired gas turbine. Hoy and Elliott even managed to scrape together enough money to build a small prototype PFBC unit at Leatherhead, an 8-megawatt unit commissioned in 1969 which was for a decade the largest PFBC unit in the world.

In 1971 the NCB asked the Government for investment funds to build a prototype PFBC power station. The sum requested was only about £20 million, but it was refused. BCURA was disbanded. But Hoy and his team kept the Leatherhead laboratory open by getting a handful of research contracts from the US, where interest in FBC had begun to burgeon. Although working on advanced uses of coal, they found that they could not always afford even to heat the laboratory.

Then came October 1973. Almost overnight coal once again became black diamonds. Coal engineers, from being technological pariahs, could once again come in out of the cold. In 1974 the NCB and British Petroleum set up Combustion Systems Ltd, to market their FBC expertise. CSL then persuaded Babcock and Wilcox to convert a boiler at their Renfrew plant to FBC. The Renfrew boiler became a test bed for future development, while still supplying steam to the plant.

To counter the challenge from OPEC, the OECD countries set up the International Energy Agency. Most of its efforts were directed to gathering and disseminating information: but British representatives won agreement from the US and West Germany to co-sponsor a full-scale research project, an 80-megawatt PFBC test unit at Grimethorpe; in fact a successor to the proposal turned down in 1971 by the British Government. The research programme on the unit is due to begin in June 1981. The cost of the project has been split three ways between the partners. The one-third share of the Grimethorpe unit is the only significant support ever provided by the Britisli Government for FBC; and even that is provided not directly but through the IEA.

The NCB has long given up hope of seeing FBC used for coal-fired power stations in Britain. Instead they are now focusing on industrial applications, with a series of demonstration units designed, built and paid for by NCB but operated by various industries, who pay the running costs. NCB-inspired FBC units are in service at a tomato nursery, a luggage factory, a cement plant and a north London estate; several grass driers and incinerators are also in operation.

The NCB's glossy illustrated *Fluidised Combustion of Coal* (1980) is an impressive testimonial to the progress being made.

In 1976 Energy Equipment Co. sold an FBC boiler of their own design to Cadbury-Schweppes, on a straightforward commercial basis, the first such sale anywhere. Thompson Cochran, Europe's largest manufacturers of shell boilers, now have an FBC design on the market. Stone-Platt Fluidfire, a company co-founded by Douglas Elliott in 1972, has several FBC units of a distinctive Elliott design. Fluidfire has also taken over the Johnson Boiler Co. in the United States, and Johnson have subsequently won several FBC contracts internationally. Babcock & Wilcox too have found an upsurge of interest internationally.

In Britain, however, FBC continues to struggle. One of the NCB's most promising FBC demonstration units was installed at the River Don works of British Steel; but this plant may now itself be earmarked for shutdown. Industries which might otherwise seize the opportunity to switch from oil and gas to coal-fired FBC cannot find the capital to re-invest. Britain's FBC pioneers may have to resign themselves to seeking their markets overseas, against ever-fiercer competition from foreign FBC manufacturers.

A Fairy Godmother has been glimpsed in Whitehall. The Department of Energy announced that it is to contribute 25 per cent of the £710,000 cost of Britain's first industrial combined heat and power system including fluidised bed combustion. The unit is to be built at Stevensons (Dyers) of Ambergate, Derbyshire.