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## **Coming on at the gasworks end**

*Walt Patterson on the new, clean power technology based on a Victorian value*

In 1887 living near the gasworks was a synonym for squalor. In 1987 the cleanest coal-fired power station in the world is built around a gasworks. The key to this startling paradox is a technology called 'integrated gasification combined cycles' – IGCC. In a few short years IGCC has emerged from the theoreticians' notebooks into full scale industrial operation, to become perhaps the most promising of all the advanced coal-use technologies.

Commercial coal gasification has been around for nearly two centuries. In Britain it was still a major industry as recently as two decades ago, until overtaken by the advent of natural gas from the North Sea. The principle of gasification is simple. When you burn coal, the carbon it contains combines with oxygen to form carbon dioxide and release heat. If instead you limit the amount of oxygen, only part of the coal burns. The heat it releases vaporises light molecules from the coal – 'volatiles' that are still combustible. The rest reacts to form carbon monoxide - a combustible fuel gas. If you also add water or steam, the hot carbon strips the oxygen from water molecules to leave hydrogen, another fuel gas. By adjusting the temperatures and pressure and the proportions of coal, oxygen and water you can adjust the composition of the fuel gases produced.

Traditional gasification processes could only gasify coal at a limited rate. In the past 15 years, a second generation of gasifiers has come into being, able to gasify a wide range of coals, at much higher rates. Even so, the fundamental obstacles facing coal-gasification for more than two decades has been the cut throat competition from cheap natural gas. In the 1980s, however, engineers have developed a new way to use fuel gas from coal – a way that is at once more versatile, more efficient and cleaner. As a consequence, commercial interest in coal-gasification has once again begun to burgeon. The companies now active in coal-gasification include not only major fuel-suppliers like British Gas, Shell and Texaco, but also many of the major engineering firms of Europe the US and Japan.

Large coal-gasification plants are now in service in several countries. One in particular stands out, as a striking example of the latest thinking about coal gasification. Located in the desert near Daggett, California, midway between Los Angeles and Las Vegas, the plant rejoices in the name of Cool Water. The Cool Water plant is the most impressive demonstration to date of integrated gasification combined cycles, or IGCC.

In general, fuel gas produced by coal-gasification has a lower energy-content than natural gas, and so is uneconomic to transport over long distances. Boosting its energy-content requires a further stage of processing, and is at present likewise uneconomic in competition with natural gas. IGCC offers a way around these difficulties.

An IGCC plant gasifies coal, then burns the resulting fuel gas in a gas-turbine, turning an alternator to generate electricity. The hot exhaust gases from the gas turbine, and the excess heat from the gasifier, are used to raise steam, to power a steam turbine and generate additional electricity.

The concept is called 'combined cycles' because it couples gas and steam turbines in tandem as part of a single process. The gasification process also allows the use of conventional chemical plant to remove sulphur and nitrogen compounds from the fuel gas before it is burned.

The Cool Water plant was built by a consortium led by the utility Southern California Edison and the Electric Power Research Institute [EPRI]. Although it was a demonstration plant its entire capital cost was met by private industry, with no government subsidy. The plant was completed in April 1984 – ahead of schedule and under budget. It was soon outperforming even its design specifications.

At its heart is a Texaco gasifier, feeding a US General Electric gas turbine and steam turbine. Some electricity is used on site and by the oxygen plant next door; the net output delivered to the grid is 94 megawatts. The plant has been able to gasify a range of different coals without difficulty, and achieve combustion efficiencies of 98.5 per cent. It has proved to be reliable, flexible, and resilient.

But the really astonishing feature of Cool Water is its environmental performance. Even when using Illinois number 6 coal, 3 per cent sulphur, its sulphur emissions have been only 10 to 20 per cent of the stringent New Source performance Standards [NSPS], decreed by the US Environmental Protection Agency. Nitrogen oxide and particulate emissions are even lower, some 10 per cent of NSPS.

Cool Water, festooned with major engineering awards, has been called the cleanest coal-fired power station in the world. It has attracted attention from utilities all over the US. IGCC, as exemplified by Cool Water, is inherently modular. A utility needing additional capacity can begin with a gas turbine burning natural gas or fuel oil; can add a steam turbine to use the heat from the gas-turbine exhaust; and can finish with a coal-gasifier to burn the cheaper fuel and complete the integration of the unit - all in three or four years, rather than a decade or more.

The utility can then repeat the process, incrementing its system capacity in close accord with customer requirements and comparative fuel costs. Several US utilities are now studying the commercial use of IGCC, as are others outside the US.

In Britain, British Gas and Lurgi [BGL] have a distinctive design of gasifier in operation at the British Gas site at Westfield in Scotland. In the BGL 'slagging gasifier' almost all the heat released in gasification is recovered within the gasifier itself, rather than by raising steam. BGL argue that this makes the slagging gasifier even better for IGCC than the Texaco design used at Cool Water; a BGL IGCC plant would not necessarily require a steam turbine to achieve high combustion efficiency.

In Britain, however IGCC has yet to make any impact on the thinking of electricity planners. Perhaps it should. The prospective private owners of Britain's electricity supply will be hard pressed to recall the last time a British power station was completed ahead of schedule and under budget, and worked even better than expected. Cool Water offers the prospect of a refreshing change.

*Walter C Patterson is the author of Advanced Coal-use Technology, the latest Management Report from Financial Times Business Information, published in October 1987.*

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