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Personal viewpoint

The privatisation of the electricity supply industry

In the debate on the privatisation of the electricity supply industry different views have been argued most strongly. What must be recognised is that there is no ideal fault free structure for an essential monopoly like electricity. Some countries have integrated monopoly suppliers owned by the state on behalf of the consumer, others have a multiplicity of privately owned utilities in 'competition' with each other. Both structures work and both have advantages and disadvantages.

It is easy to make the argument for a fully integrated structure working for the best interests of the consumer. The inefficiencies that tend to build up in any monopoly and the damaging effects that short term political influences have had on nationalised industries are however now well recognised. What is important is how well things work in practice rather than theoretical arguments about how they should work.

The private sector solution also has its problems. Any monopoly operating for profit must have some regulatory system to ensure that the customers have their interests safeguarded. This leads to a regulatory framework which in some countries is effective but which in others is more damaging than direct government control.

The solution that has been chosen by government has been heavily influenced by the existing structure of the supply industry. The structure in Scotland will remain very much as it is — a structure essentially the same as in most other countries where the industry is in the private sector. The proposed joint ownership of the Scottish nuclear generating capacity will create few operating problems and is a common feature abroad.

The structure south of the border, in England and Wales, is less easy to understand other than on the basis that there was insufficient time to create a more appropriate structure before the privatisation

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deadline. 'I wouldn't start from here' comes readily to mind but this is where a start has to be made and my comments on the structure reflect this fact.

The grid company is an interesting concept. It has similarities with 'power pools' which are fairly common among private operators abroad. Most important, it will provide an anchor of stability at a time of great turmoil in the industry. Responsibilities can be transferred at the stroke of a pen but the ability to do anything concrete to implement these expanding responsibilities may take some years to acquire.

The distribution companies will, I am sure, want to build their own generating capacity and, if it became clear that fewer bigger companies were desirable, mergers could take place in the future. My principal concern is the way the CEGB is to be divided into Big G and Little G, Big G having some two thirds of all the present generating capacity including all the nuclear plants in England and Wales. I feel that this will cause great problems in the future. Big G in particular will have a very difficult road to follow.

Nuclear power will either be economic in the future or it will not. If it is — if it is allowed to be — then Little G and the distribution companies will want to build their own nuclear power stations. If it is not Big G will have inherited a problem that its competitors will have avoided. The South of Scotland Electricity Board is substantially smaller than Little G and has run an extremely successful nuclear programme high in the world list of performers. While fragmentation is to be avoided it is difficult to see the logic or advantage of keeping all the nuclear capacity in England and Wales within one organisation.

The very size of Big G may also cause problems in the future. The understandable desire of managements to control their own operations and destinies will lead to strong pressure to build generating capacity in other than the two successors to CEGB and particularly other than in the dominant partner.

The structure which is being set up will almost certainly change in terms of balance of size and industrial strength. The parts of the industry that lose market share could have a different and frustrating period ahead of them.

Sir John Hill
Past President

The potential of Northern Ireland's lignite

G McKay*, S J Allen* and C T McBride*

The characteristics and properties of the lignite deposits in Northern Ireland have been discussed. The methods of drying and the problems associated with the drying methods are reviewed. Lignite offers a whole new industrial base in the Northern Ireland community; its potential uses range from electricity generation, the production of pulverised fuel and briquettes to the manufacture of activated carbons, chars, synthesis gas, liquefied fuels and waxes

Over 18 countries have reserves of lignite coal in excess of one billion tonnes, the most important being: Russia, America, Australia, Germany and Poland. Also included are: Canada, Yugoslavia, Czechoslovakia, Chile, Bulgaria, India, Japan, Greece and Hungary. Smaller, though still significant amounts have been found in 25 other countries, for example, Turkey, Spain, Burma, Austria, Italy and Pakistan. The world's present minable reserves are estimated at 549000 M t for hard coal and 431000 M t for lignite. The world annual output figures are 1200 M t of lignite and 3200 M t of hard coal showing that hard coal reserves are exploited much more rapidly. The three major producers are East Germany (*circa* 250 M t per year), the Soviet Union (*circa* 170 M t per year) and West Germany (*circa* 130 M t per year).

Extensive deposits of lignite have been proven in Northern Ireland and these are shown in Fig 1. The deposits have been known since the nineteenth century and the Crumlin deposit was first recorded in 1757[1]. Exploration within the last 10 years spurred on by the energy crisis and the search for clays resulted in the proximate sizing of some of the deposits. The three major reserves are Ballymoney (500 M t), Crumlin (420 M t) and Coagh (400 M t), where the figures are estimated recoverable reserves.

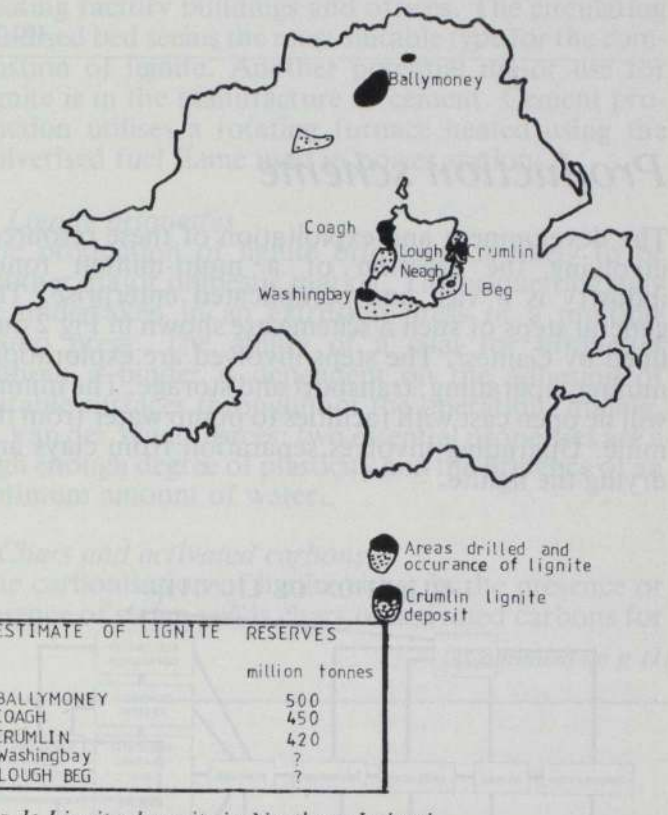

Fig 1: Lignite deposits in Northern Ireland

What is lignite?

Lignite is a straightforward member of the solid fuel family and is often known as 'brown coal'. Geologically it is a young fuel which falls in rank between peat and ordinary bituminous coals as shown in Table 1. Mined lignite is drier than peat and has a higher calorific value. Both lignite and coal are formed from decaying trees and plants by biochemical and geochemical transformation. The Antrim lignite contains 67–70% by wt carbon, about 5% by wt hydrogen and 25–30% of oxygen. Lignites, depending on location, have a rich and varied chemistry, and consist of a rigid, complicated lattice in which molecules are trapped. Lignites contain a little paraffinic material, some waxes and resins, but mainly they are composed of aromatic structures based on benzene and naphthalene rings.

Table 1: Comparison of fuels

	Moisture %	Carbon %	Ash %	Approximate CV (kJ kg^{-1})
Peat	75+	50–60	12	7000
Lignite	40–60	60–70	7	10500
Bituminous coal	10	50	9	26000
Anthracite	2	85	85	33300

The properties and characteristics of lignite are of the utmost importance in terms of the uses to which it can be applied. To assess the fuel characteristics of a lignite a proximate and ultimate analysis is required and those values are shown in Tables 2 and 3 for dried Antrim lignite containing 50–52% moisture (as mined) and having a bulk density of around 600 kg m^{-3}. The low sulphur content helps to maintain low sulphur gas emissions on combustion. The percentage carbon is high for a lignite and the moisture content is similar to that in many of the West German lignites.

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*Chemical Engineering Division, Queen's University of Belfast

Table 2: Proximate analysis of Antrim lignite

% Moisture	14.0	% Sulphur	0.2
% Ash	10.5	% Chlorine	0.05

Gross CV 20700 kJ kg^{-1}

Table 3: Ultimate analysis on dry, ash free basis (% wt)

Carbon	69.33
Hydrogen	6.43
Nitrogen	0.65
Sulphur	0.21
Chlorine	0.044
Oxygen (by difference)	23.3
	100.00

Production scheme

The development and exploitation of these resources involving the creation of a multi-million tonne industry is a vast and complicated enterprise. The general steps of such a scheme are shown in Fig 2 outlined by Gaines[2]. The steps involved are exploration, mining, upgrading, transport and storage. The mining will be open cast with facilities to pump water from the mine. Upgrading involves separation from clays and drying the lignite.

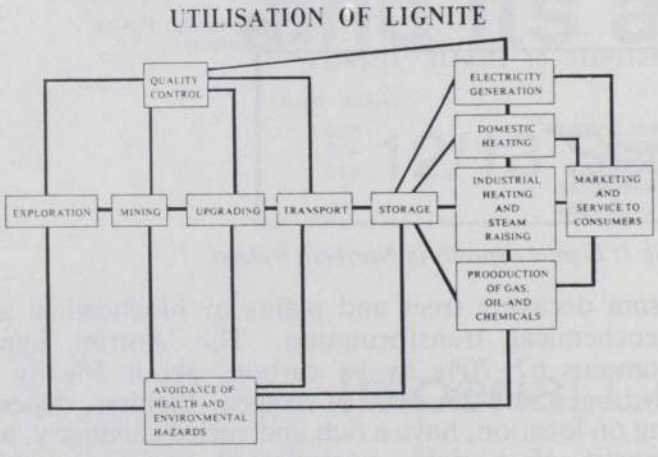

Fig 2: Processes in the utilisation of lignite

Lignite drying

Drying lignite is a major factor in processing due to the costs of plant and energy to remove up to 50% of the weight as mined in the form of water vapour or liquid water. A number of important drying techniques have been developed but only the major ones are reviewed here.

i Indirect rotary tube heating
This method has been widely adopted in West Germany and involves mined lignite being forced through the tubes of a tube handle contained in a shell. The shell side is heated usually by steam (5 bar steam from back pressure turbines) and this drives off water (as vapour/steam) from the lignite.

ii Direct rotary drying
Lignite is fed via a conveyor into a large horizontal, cylindrical rotary drier fitted with 'baffles' or 'lifters'. Hot flue gases pass upwards through the rotary drier and the lignite passes countercurrently (sometimes co-currently) through the drier until at the outlet it has been dried.

iii Fleissner and Coppelman processes
The largest producer of lignite in the world is East Germany where the Fleissner Process is used extensively. The process is based[3] on dewatering (liquid phase) under pressure (10–20 bar) and temperature (180–220°C) thus reducing costs for vaporisation. The Fleissner Process was proposed in 1927 and a modification was proposed by Coppelman in 1977. The Coppelman Process involves the addition of other chemicals to facilitate dewatering. The dewatering processes are currently operated batchwise while the rotary drying techniques have the benefits of continuous operation.

Potential uses of lignite

Figure 3 shows a block diagram for the development and production of several products from lignite and

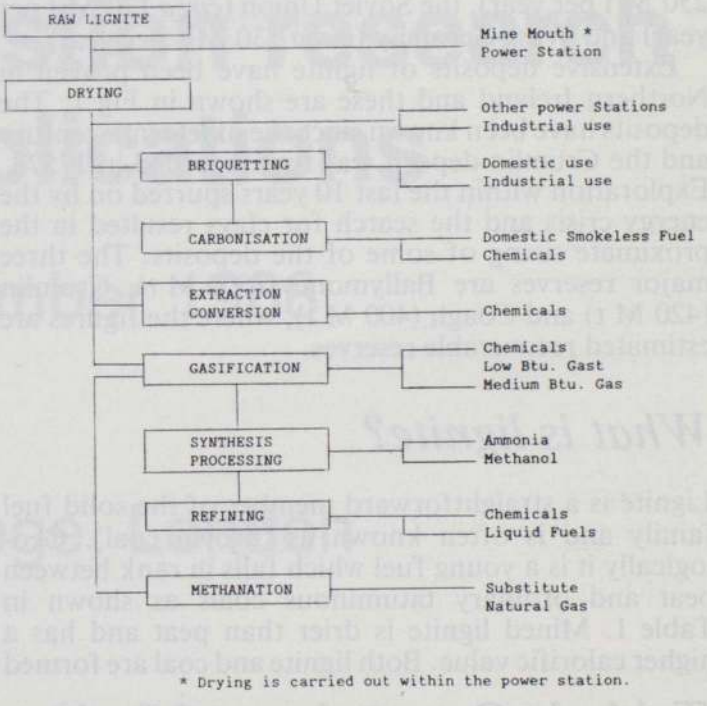

Fig 3: Technically possible uses of lignite

Fig 4 gives some typical yields of products from a base of 1000 kg lignite.

i Industrial fuels
The major and most economic use of lignite is for combustion in a power station that is situated close to the mine. The modern power stations burn 'pulverised fuel' whereby crushed lignite is injected into a blast of air which is directed into a furnace. Such a pulverised fuel/air blast ignites readily to form a large hot flame at temperatures in the range 1500–2000°C.

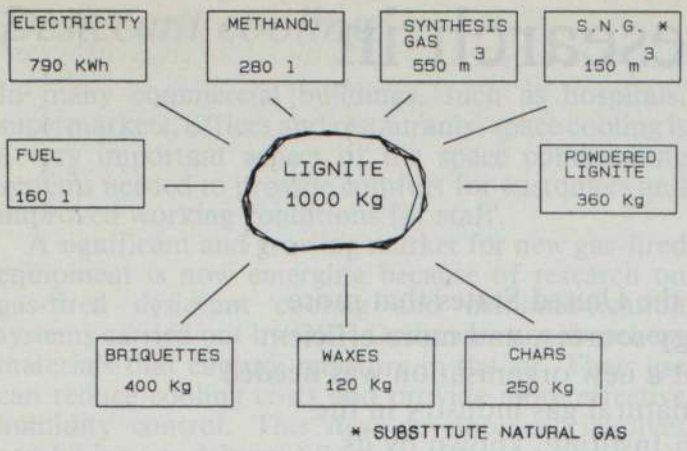

Fig 4: Potential uses of lignite

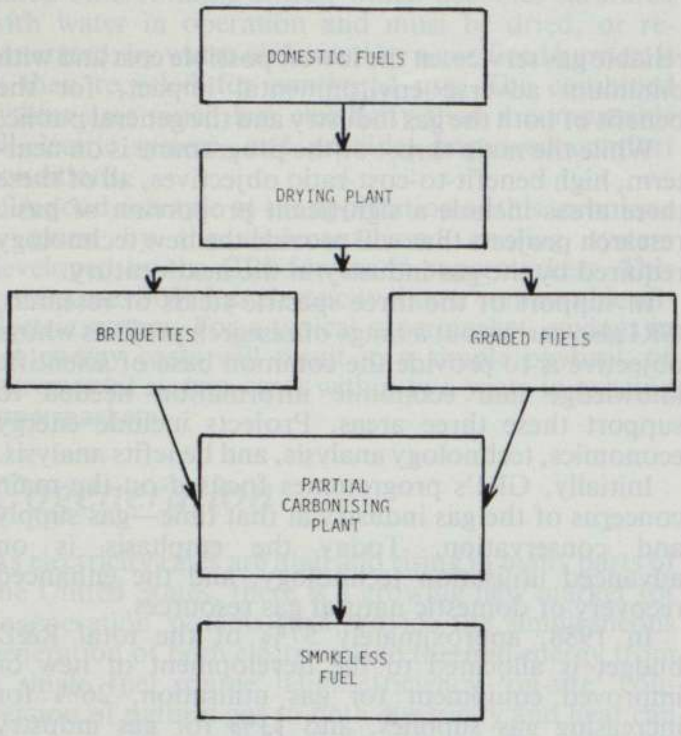

Fig 5: Domestic fuel

ii Domestic heating

A schematic diagram for the production of domestic (sometimes industrial) fuels is shown in Fig 5. Unfortunately an ordinary domestic grate burns lignite very smokily but there are two ways of burning lignite without causing significant pollution:

a conversion of the lignite to smokeless briquettes
b the use of special stores which burn lignite smokelessly or in the home or in district heating schemes.

Millions of tonnes of smokeless briquettes are sold in West Germany annually and they are formed by heating wet lignite straight from the mine so as first to dry it and then, at 300–600°C, to drive off the tarry material which gives smoke.

iii Energy for industry

A range of industrial applications is shown in Fig 6. The fluidised bed combustion of lignite is ideal for heating factory buildings and offices. The circulating fluidised bed seems the most suitable type for the combustion of lignite. Another potential major use for lignite is in the manufacture of cement. Cement production utilises a rotating furnace heated using the pulverised fuel flame used in power stations.

iv Lignite briquettes

The production of lignite briquettes is likely to be another major domestic market. The briquetting may be undertaken in an extrusion press or a multiple stamp press. The ability of a coal for briquettes without a binder is dependent on the adhesion of suitable surfaces throughhout the operation, mainly, of Van der Waals forces; two essential properties are a high enough degree of plasticity and the presence of an optimum amount of water.

v Chars and activated carbons

The carbonisation of lignite either in the presence or absence of steam yields chars or activated carbons for

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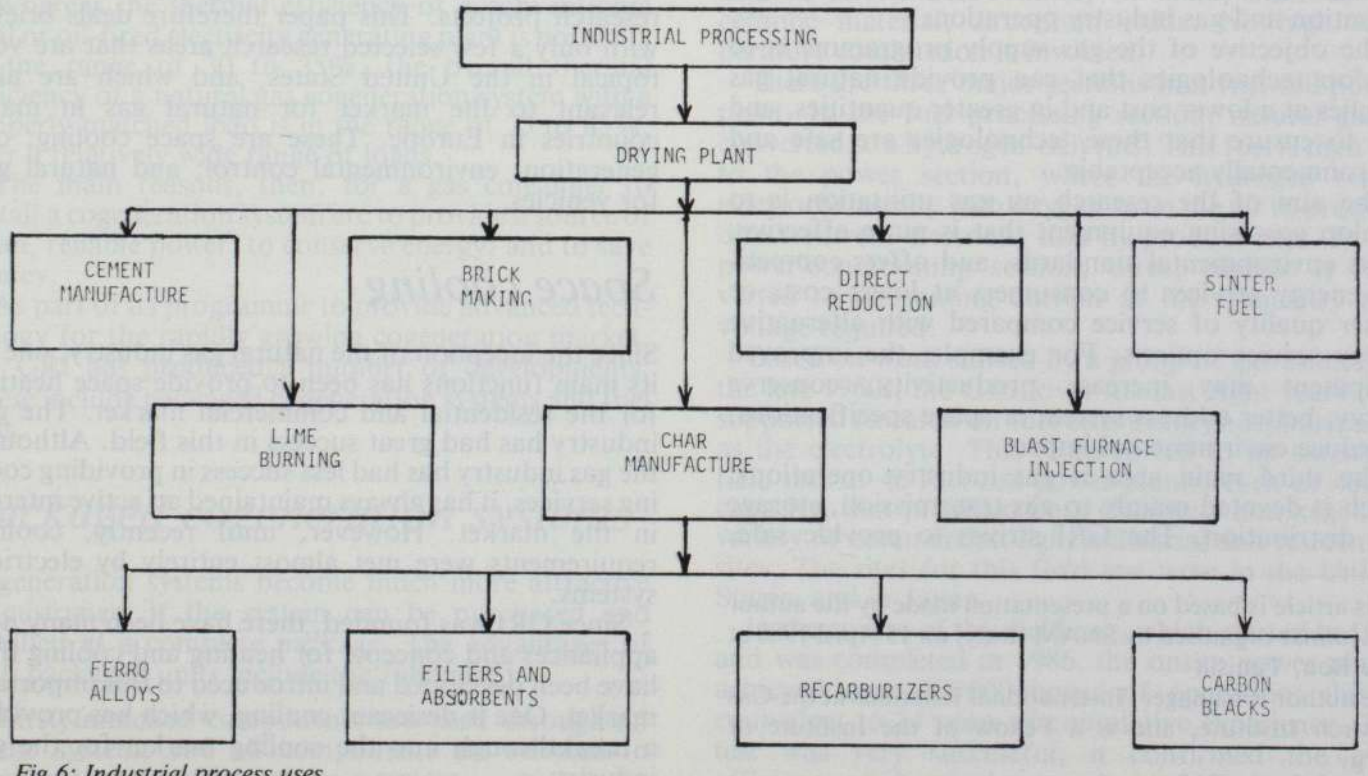

Fig 6: Industrial process uses

GRI — gas industry research in the States*

Eric Thronton†

The energy crisis in the 1970s led to the recognition in the United States that more attention needed to be given to developing future energy sources, and more efficient utilisation technologies. As a result, it was decided that a new organisation was needed to take responsibility for an R&D programme for the natural gas industry in the United States on a nationwide basis. The Gas Research Institute, known by its acronym GRI, was formally established in 1976, with headquarters in Chicago. It had its first full year of operation in 1978

The GRI is a non-profitmaking membership organisation. Its role is to plan, manage and develop financing for a gas-related R&D programme on behalf of its members and their customers. Members include producers, interstate pipeline companies, privately owned gas distribution companies, and municipal utilities. Together they serve nearly every major population centre in the United States.

The GRI also has an Associate Member programme that provides close and effective links with the major organisations involved in gas related research and development outside the United States. Most of the GRI's funding is obtained through a surcharge on gas sold or transported by its member companies. This surcharge is fixed each year by the Federal Energy Regulatory Commission (FERC).

The 1988 budget is $172.9 M. The total is made up of $144.7 M for contract research plus a further $28.2 M for project management, general expenses and capital purchases. In addition, coordinated funding from government and other industrial organisations is expected to provide another $84.9 M for the R&D programme during 1988. This adds up to a total of $258 M for research projects.

The general thrust of GRI's current R&D programme covers three main areas: gas supply, gas utilisation and gas industry operations.

The objective of the gas supply programme is to develop technologies that can provide natural gas supplies at a lower cost and in greater quantities, and also to ensure that these technologies are safe and environmentally acceptable.

The aim of the research on gas utilisation is to develop gas-using equipment that is more effective, meets environmental standards, and offers competitive energy services to consumers at lower costs or higher quality of service compared with alternative energy service options. For example, the improved equipment may increase productivity, conserve energy, better address system or space specifications, or reduce environmental impact.

The third main area is gas industry operations, which is devoted mainly to gas transmission, storage and distribution. The GRI strives to provide safe, reliable gas service, at the lowest possible cost and with minimum adverse environmental impact, for the benefit of both the gas industry and the general public.

While the main thrust of the programme is on near-term, high benefit-to-cost-ratio objectives, all of these three areas include a significant proportion of basic research projects that will provide the new technology required by the gas industry in the next century.

In support of the three specific fields of research, GRI also carries out a range of research projects whose objective is to provide the common base of scientific knowledge and economic information needed to support these three areas. Projects include energy economics, technology analysis, and benefits analysis.

Initially, GRI's programmes focused on the main concerns of the gas industry at that time—gas supply and conservation. Today the emphasis is on advanced utilisation technology, and the enhanced recovery of domestic natural gas resources.

In 1988, approximately 57% of the total R&D budget is allocated to the development of new or improved equipment for gas utilisation, 26% for increasing gas supplies, and 13% for gas industry operations. This emphasis on utilisation technology is expected to continue for the next five years.

Currently the GRI is funding over 500 active research projects. This paper therefore deals briefly with only a few selected research areas that are very topical in the United States, and which are also relevant to the market for natural gas in many countries in Europe. These are space cooling; co-generation; environmental control; and natural gas for vehicles.

Space cooling

Since the inception of the natural gas industry, one of its main functions has been to provide space heating for the residential and commercial market. The gas industry has had great success in this field. Although the gas industry has had less success in providing cooling services, it has always maintained an active interest in the market. However, until recently, cooling requirements were met almost entirely by electrical systems.

Since GRI was founded, there have been many new appliances and concepts for heating and cooling that have been developed and introduced to this important market. One is desiccant cooling, which has provided a breakthrough into the cooling market for the gas industry.

*This article is based on a presentation made by the author at a seminar organised by SNAM (Italy) on 15 April 1988 at Cape Bon, Tunisia

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Desiccant cooling

In many commercial buildings, such as hospitals, supermarkets, offices and restaurants, space cooling is a very important aspect of the space conditioning systems needed to provide comfort for customers and improved working conditions for staff.

A significant and growing market for new gas-fired equipment is now emerging because of research on gas-fired desiccant cooling and dehumidification systems carried out by GRI. Desiccants are absorbent materials that capture moisture in the air. Their use can reduce cooling costs and provide more effective humidity control. This new development involves combining gas dehumidification with electric air conditioning. The desiccant, lithium chloride, is impregnated on a rotating wheel, which becomes saturated with water in operation and must be dried, or regenerated, by warm air heated by a gas-fired burner; it is then recycled for continued use. The combined system uses much less electricity than a comparable all-electric system, and provides improved comfort conditions.

A good example of the application of this technique is given by the desiccant-based cooling system developed by the GRI for use in supermarkets. This system uses 30% less electricity than a comparable all-electric system. For a typical supermarket, savings in net energy costs will result in a simple payback of incremental system costs within two years in existing supermarkets.

Cogeneration

As electricity rates are high and rising in many parts of the United States, there is a growing new market for cogeneration systems that provide the simultaneous generation of both electrical and thermal energy from a single fuel source. High-efficiency 'on-site' conversion of natural gas to both electricity and heat can translate into substantial savings for the gas consumer. The heat produced can also be used in a heat-driven chiller to provide space cooling.

Whereas the thermal efficiency of a conventional coal or oil-fired electricity generating plant is normally in the range of 30 to 35%, the overall thermal efficiency of a natural gas cogeneration system with a properly matched load is in the range of 75 to 85%, over a relatively wide range of loads.

The main reasons, then, for a gas consumer to install a cogeneration system are to provide a source of clean, reliable power; to conserve energy; and to save money.

As part of its programme to provide advanced technology for the rapidly growing cogeneration market, the GRI has produced a number of developments. These include packaged cogeneration systems and fuel cells.

Packaged cogeneration systems

Cogeneration systems become much more attractive to customers if the system can be purchased and installed as a complete package. The advantages of such packaged units include the following:

- First, matched components are used throughout the system, and all components are selected to operate most efficiently as a system.
- Second, packaged units are pre-assembled, and all components are assembled and tested before leaving the factory.
- Third, the unit is designed to be environmentally acceptable, all components are housed in a sound-insulated and environmentally controlled enclosure.
- Finally, large scale production of packaged units minimises manufacturing costs and leads to standardised lower-cost maintenance procedures.

As an example of this approach, the GRI tested its original packaged cogeneration system at a 250-bed medical centre in Houston, Texas in 1984. The unit supplied 100% of the electricity requirements, and most of the space heating and cooling requirements for the centre. On the basis of this pioneering work, hospitals are now one of the largest single markets for gas-fired packaged cogeneration systems in the United States. These systems are operating at overall efficiencies of 75 to 80%, and are providing a payback rate of approximately three years on equipment costs.

As another example, more recently a small cogeneration package has been developed for the GRI which features a simplified design that minimises equipment and maintenance costs. This micro-cogeneration technology (systems less than 30 KW) is of particular interest to commercial energy users who demand quick paybacks. This development is a good example of how the concept of using low-cost automotive engines converted to be fueled by natural gas, rather than the expensive diesel-derived engines used previously, is starting to gain momentum. Typical applications of this system are restaurants, laundries, motels and health clubs.

Fuel cells

A second aspect of cogeneration is the fuel cell. A fuel cell is a device in which natural gas is converted to electricity and heat via a highly efficient electrochemical process in the presence of a suitable electrolyte. Electrolytes may be liquid, such as phosphoric acid or molten carbonates, or solid, such as the ceramic material, zirconium oxide. No high temperature combustion is involved.

There are three major sections in a fuel-cell power plant. In the fuel processing section, natural gas is converted to a hydrogen-rich fuel. This fuel is then fed to the power section, where the hydrogen reacts electrochemically with oxygen from the air to produce direct current electricity and by-product heat. In the power-conditioning section, direct current is converted to alternating current at the frequency and voltage required.

Based on work started by a group of gas utilities in the late 1960s, the GRI, over the last eight years, has supported research on fuel cells using phosphoric acid as the electrolyte. This research led to an extensive field test of 46 fuel cell power plants, each of 40kW capacity, that provided both electricity and heat to a variety of commercial, light industrial and residential sites. The sites for this field test were in the United States, and in Japan.

In the course of this field test, which started in 1983 and was completed in 1986, the onsite power plants achieved over 300000 hours of operation; this is equivalent to 34 years of cumulative experience. The test was very successful; it confirmed the high efficiency of electrical generation at 36%, and demon-

strated rapid and stable response to load changes. The tests also highlighted the benefits of fuel cell co-generation systems, namely that they are extremely quiet, environmentally acceptable, easily installed and have a potential for long-term unattended operation with relatively low maintenance.

As a result of the successful development and field test of the phosphoric acid fuel cell system, the manufacturer, International Fuel Cells Corporation, is now offering an initial on-site fuel cell power plant to the gas industry on a commercial basis. A 200kW power plant has been selected for this initial commercial offer. For the initial years of commercial production, these power plants will be manufactured at low production rates, starting at 100 units per year. The success of this commercial offering will provide an essential first step towards the economic availability of fuel cell systems for the energy efficient buildings of the future.

With the successful completion of the field test of the phosphoric-acid-based system the GRI is now redirecting its programme to address advanced, higher temperature fuel cell systems, which use molten carbonate or solid oxide as the electrolyte. The main advantage of these two higher temperature systems is their potential for electric generation efficiencies in the range of 45% to 60%, and system simplification which results from the direct use of natural gas without a reforming stage. The higher temperature by-product heat from these advanced fuel cells would be usable for high pressure steam generation, which could make fuel cells more applicable for industrial applications and for cooling in the commercial sector.

The GRI supports the view that fuel cells using natural gas will offer great opportunities for on-site energy systems in the future for a very wide range of applications.

Environmental control

In response to increasing public concern about the emission of pollutants from all sources, the GRI has funded considerable research on gas technology to reduce pollution from systems using less clean fuels, such as coal and oil.

For example, acid precipitation has emerged as an environmental issue with international implications. Although the process of acid rain formation and deposition is quite complex and poorly understood, it is known that, at least in part, emissions of sulphur oxides and nitrogen oxides from large coal and oil boilers play a key role.

Several conventional environmental control techniques are now in use to reduce emissions of sulphur oxides and nitrogen oxides from existing industrial and power plant boilers. These techniques include: switching to coal with the lowest possible sulphur content; separating out the sulphur and other heavier mineral matter; and removing sulphur oxides with 'scrubbers' in a flue-gas desulphurisation process. These methods generally involve considerable expense, and therefore cost-effective solutions are still being sought to control sulphur oxide emissions from existing plants.

As natural gas produces essentially none of the sulphur oxide that comes from burning coal and oil, and only a fraction of the nitrogen oxides, it can be used to reduce emissions from existing boilers at a lower cost than conventional control technologies.

Substituting natural gas for part of the primary fuel burned in power plants and industrial boilers, known as natural gas co-firing, reduces emissions, improves operation and boosts economic performance. In many cases, replacing part of the coal or oil used with limited amounts of natural gas could enable power plants to meet air-quality standards without reducing power output or installing equipment to clean-up flue-gas.

However, greater reduction of pollutant emission per unit of gas used can be achieved by the use of 'reburning' techniques in which gas is injected above the main, or primary, combustion zone for coal or oil. When the technique is combined with the injection of a dry powdered calcium-based sorbent material, such as limestone, much higher SO_2 removal from the flue gases can be achieved cost-effectively.

The GRI has sponsored pilot scale tests on this integrated technique, which have shown promising results. As a result it is supporting full scale tests at three operating coal-fired power stations in Illinois. The GRI is confident that the results will be very encouraging for the use of natural gas to improve the quality of the environment.

Natural gas for vehicles

For many years, natural gas has been used as an engine fuel in stationary prime movers for driving natural gas compressors, liquid pumps, and similar equipment.

More recently, the clean-burning characteristics of natural gas have made it an attractive option for vehicle use. Ambitious programmes in New Zealand, Canada and Italy, encouraged vehicle owners to convert gasoline-powered automobiles and diesel-powered buses and trucks to natural gas.

In the United States, storage and economic issues have, until now, constrained the widespread use of natural gas in vehicles. However, new federal regulations limiting particulate emissions from large diesel powered vehicles will become mandatory for new urban buses in 1991 and for heavy diesel engines in other new vehicles in 1994. The probability of meeting the 1991 urban bus particulate standard with a conventional diesel-fueled engine is low. In addition, local regulations in some regions may force modification of diesel engines in existing vehicles at an earlier date. These new regulations, therefore, provide a significant opportunity for natural gas.

To make the most of this opportunity the GRI is supporting research on advanced natural gas engines and on improved fuel handling technologies. Specifically, research to reduce emissions focuses on using natural gas in diesel engines to satisfy all or part of the fuel requirements. New and existing urban buses are the initial application. This research on diesel engines will be followed by work on large gasoline engines, such as are used in school buses, highway-maintenance trucks and fleet delivery vehicles.

In addition to this research on engines the GRI is carrying out research on selected ancillary components, in particular, new lightweight cheaper materials for vehicle storage tanks. Advanced sorbent materials to provide gas storage equivalent to today's high-pressure systems but at a significantly lower pressure are also being developed. The new storage system must have acceptable cost, lifetime, and gas release rates. Successful efforts in this area promise not only functional and economic benefits, but may

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Computer modelling for the analysis of fluid flow, heat transfer and combustion in industry

K A Pericleous*

It would be hard to dispute the benefits afforded by the ability to create and test models on computer, especially of large-scale components or novel technology where accumulated knowledge is scarce. The advantages of cost reduction and speed to be gained by avoiding costly model building have already been recognised in finite element structural analysis, a technique which is now widely used.

Computer programs for modelling fluid flow in or around various objects have met with varying degrees of success in the past. Where the application of the program has remained close to that for which it was written, there have been good results, but new applications have often been difficult, even for experienced users. This is particularly true for combustion applications, or heat applications in which heat transfer between the fluid and various building solids takes place, the flow properties vary making their simulation a complex task. In mathematical terms, the equations to be solved are markedly non-linear, in contrast say to those encountered in stress analysis. These equations are well established, but it is the method by which they are solved which causes difficulties and determines the accuracy and efficiency of the program.

General purpose codes

The part of a computer program that deals with the solution of the equations and the part that represents a particular application, type of device or even type of fluid must be identified. The first part is universal while the latter is specific to each problem. Possibly the only way to make computational fluid dynamic (CFD) techniques economic and to encourage their use, is to have a general purpose program suitable for all situations which can then be easily adapted by non-experts for specific problems.

One such program is PHOENICS (parabolic, hyperbolic or elliptic numerical integration code series) a Euclidean acronym that implies motion and which describes a program that solves problems involving flow, heat transfer and chemical reactions. Local property variations in the flow present little difficulty to the program, and problems can be handled in one, two or three dimensions; steady or unsteady; laminar or turbulent; single or two-phase; subsonic, supersonic or transonic.

Program structure

The central core of PHOENICS (Fig 1) that solves equations is called *Earth* and is common to all applications. The user defines each specific problem in a *Satellite* program which then relays the information to

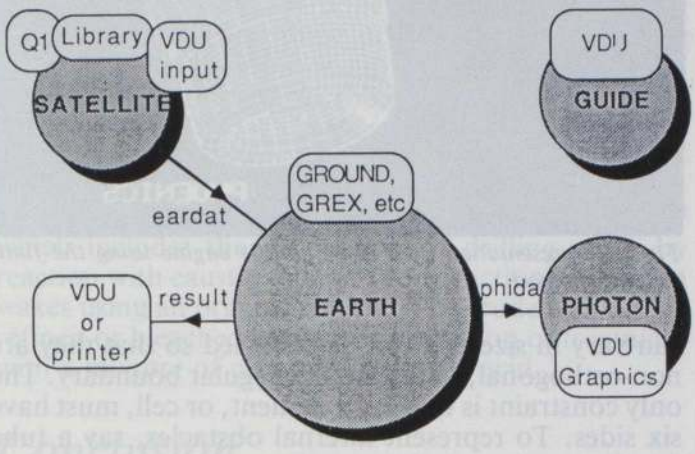

Fig 1: Structure of PHOENICS

Earth via a datafile. Where the input needs to interact with the calculations, for example the density may vary with pressure and chemical composition, the two are linked by a *Ground* sub-program. This is a very powerful addition which adds great flexibility to PHOENICS, allowing even problems with strange fluid properties to be tackled.

The complexity of simulating fluid flow patterns means that the solution of even simple three-dimensional problems may require quite substantial computing power. The software was developed originally on Apollo work-station computers, but it can run on almost any computer ranging in size from an IBM-PC to a CRAY supercomputer. Obviously the type of computer being used depends on the type and complexity of the application. For even the simplest combustion problem differential equations must be solved for three velocity components, temperature, pressure, fuel, oxidant and product concentrations; additional equations which characterise velocity and temperature fluctuations have also to be solved. Indeed, compared to experimental techniques the amount of information produced by a single calculation can be enormous since field values for each variable can be obtained at thousands of points in the domain of interest.

A three-dimensional representation of the modelled subject can be created by PHOTON, the PHOENICS graphical post-processing program which makes interpretations of the results much easier. PHOTON will operate on most graphical terminals such as the Pericom MX2000 or the Tektronix 4107. It gives the system the ability to draw the geometry of the problem, velocity vectors, temperature contours, streamlines and so on.

(Continued overleaf)

*Manager, CHAM, Wimbledon

Finite volume method

PHOENICS uses a finite volume method in which the calculation space is divided into cubic elements that

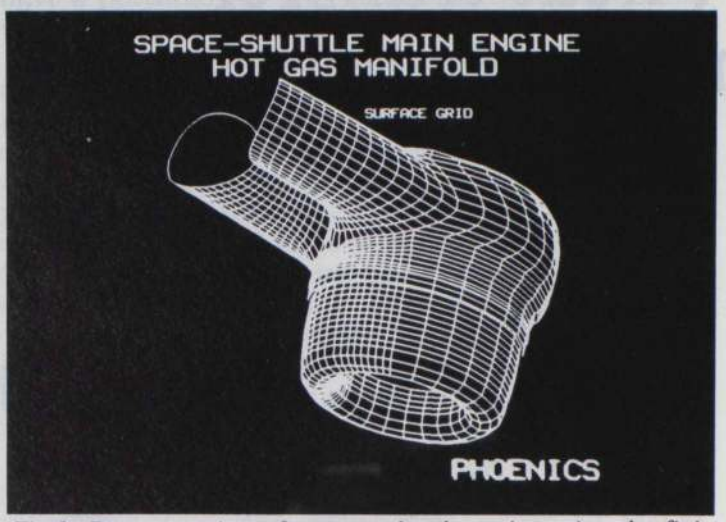

Fig 2: Representation of a space shuttle engine using the finite volume method

can vary in size and can be distorted so that they are non-orthogonal, to follow an irregular boundary. The only constraint is that each element, or cell, must have six sides. To represent internal obstacles, say a tube bundle in a heat exchanger, or even a porous packed bed each face of the cell and its volume can be partially blocked. A typical grid of cells representing a space shuttle engine component is shown in Fig 2.

Equations must be solved for each variable, at each cell in the domain using an iterative guess-and-correct procedure. The number of iterations necessary will depend on the non-linearity of the problem.

Applications

The key factor behind the rise of CFD techniques is their universal appeal; fluid flow and heat transfer occurs in most processes in nature or engineering. After a slow start in the so called high-tech industries such as nuclear and aerospace, applications have now spread down the technology scale to the processing, chemical engineering, metallurgical and food industries. CFD techniques can help to pin-point the sources of pollution in rivers, seas and the atmosphere.

For example, we are all familiar with the problems of acid rain, ozone layer depletion and the greenhouse effect. These are all man-made problems with coal-fired power stations often being the main culprits.

In the US, Europe and Japan, strict constraints have been placed on burner and furnace manufacturers and users to limit atmospheric emissions of harmful nitrogen and sulphur oxides which contribute to these effects. In order to comply, users of older units have resorted to costly retrofits and flue gas cleaning packs. The cost in some cases runs into many millions of pounds, as in the case of the Central Electricity Generating Board where close to £200M have been earmarked for nitrogen oxide reduction in its power stations.

One way to reduce costs is to use CFD techniques to eliminate pollution at its source, by improving the combustion process in the burner.

A parametric study of the Todd Combustion (Canada) burners was performed and the lessons learned were applied in a Californian refinery installation resulting in an 80% reduction of NO_x emissions. Fig 3 shows the flame structure in one of these

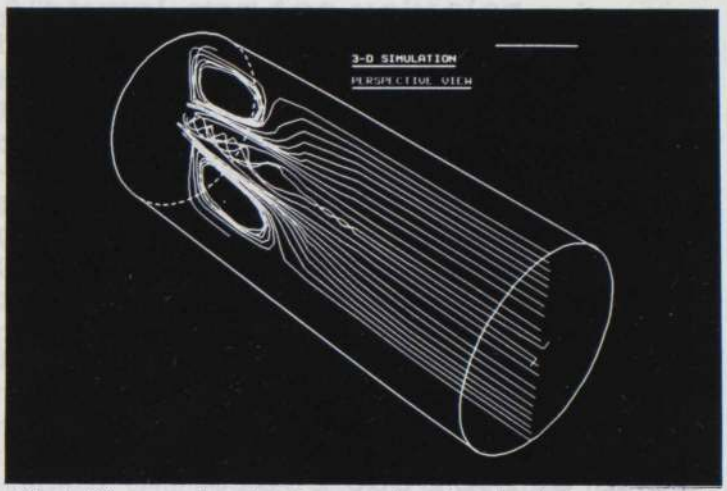

Fig 4: Diagram showing the complex air recirculation patterns in the burner

burners and Fig 4 the complex air recirculation patterns which feed air and fuel into the flame.

(Continued on next page)

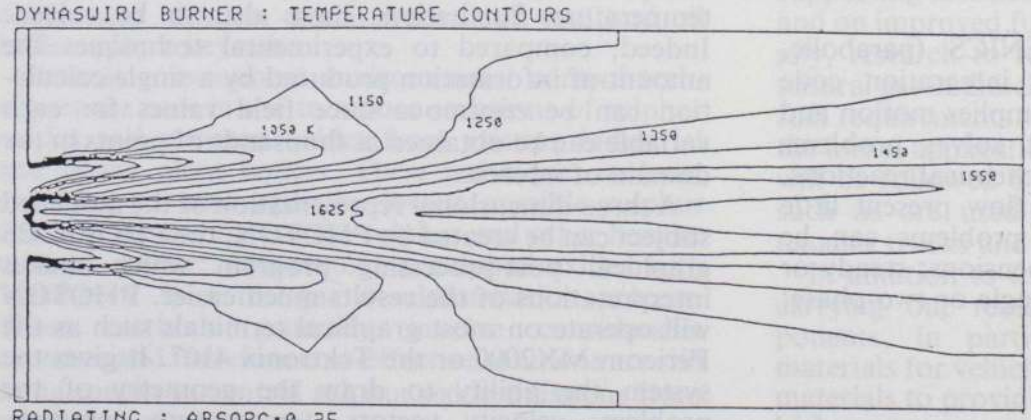

Fig 3: Flame structure in one of the burners in a Californian refinery

GRI — gas industry research in the United States *(continued from p 8)*

also help obviate the need for extensive research on advanced high-pressure compressors for natural gas for vehicles.

If natural gas is to be a viable, widely accepted, long-term fuel option for light fleet vehicles, research and development is needed to develop advanced compressors and fuel metering technologies for use in retail sales facilities for compressed natural gas. Research and development is also needed to develop medium and high-pressure, cost-effective and accurate quick-fill meters to measure the natural gas input to each vehicle.

More exciting developments

In conclusion, the importance of international co-operation in the gas industry should be emphasised. The production, marketing and transmission of natural gas are becoming increasingly international, the GRI believes that this international tendency should, and will, be extended increasingly to gas industry research and development, for the benefit of all natural gas customers. A good start in this direction has already been made. For example, the GRI is promoting a very active programme of information exchange and research cooperation on an international basis. The main objectives of this programme are to reduce unnecessary duplication of research, to facilitate the transfer of new technologies between countries, and to help maximise the value obtained from available research funds. Within this wide-ranging programme, the GRI is looking forward to future cooperation in research with many organisations involved in gas-related R&D outside the United States □

Computer modelling for the analysis of fluid flow . . .

(continued)

The ability to model flows with chemical reaction offers possibilities in other areas such as the modelling of fires in buildings of arbitrary size or shape. A program, called JASMINE has been developed in conjunction with the Building Research Establishment Fire Research Station, that has been applied to fires and smoke movement in domestic situations, hospitals, aircraft cabins, road and rail tunnels.

Another application is in the car industry. The mathematical models produced can be of benefit in body and engine design and lead to significant fuel reductions.

The potential of CFD techniques has therefore been recognised in many, seemingly unrelated, areas. The message is that anything involving fluid flow, heat transfer or chemical reaction can now be modelled mathematically with ease, using general purpose programs like PHOENICS. This is also recognised by educational institutions such as Thames Polytechnic which are now including CFD courses in their curriculum. □

The potential of Northern Ireland's lignite *(continued from p 5)*

odour removal, water filtration and purification and gas separation. The uses of lignitic coal as a metallurgical fuel includes: controlled carbonisation of the fuel as lumps or briquettes to make a suitable coke; carbonisation of the fuel for its use in direct ore reduction.

vi Chemicals production

In addition to its fuel uses, lignite can be gasified by reaction with steam, or liquefied by the addition of hydrogen. However, these products would be more expensive than their production from natural gas and crude oil. Gasification is the reaction of steam with lignite around 1000°C, in a Lurgi gasifier for instance, to produce a mixture of hydrogen and carbon production.

The production of other chemicals is shown in Fig 7 which includes the production of drilling muds by reaction with caustic soda or the extraction of montan waxes using an organic solvent. The crude wax can be refined or bleached by further extraction or treatment with a mixture of chromic/sulphuric acid.

Conclusion

Northern Ireland has an abundant and versatile natural resource. Its exploitation and development should be planned with care since it can be used for electricity generation, domestic and industrial heating and as a source of chemicals. The photographs show some of the products already produced on a small scale at The Queen's University of Belfast.

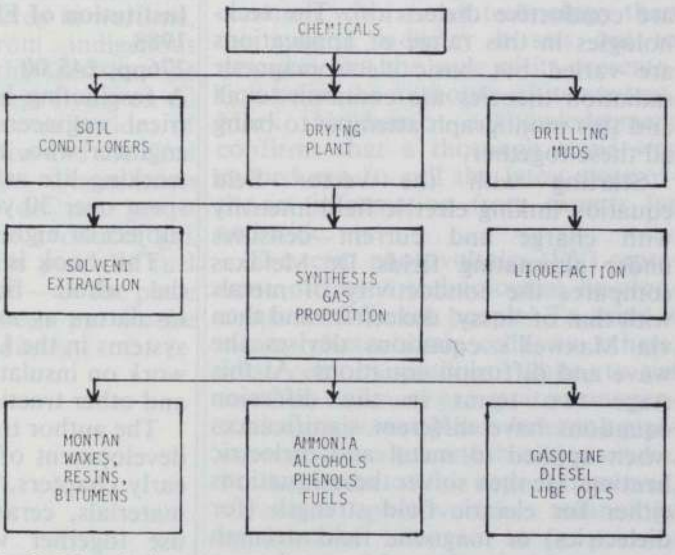

Fig 7: Chemicals

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Heating with electromagnetic fields — a unified approach

A C Metaxas
Electricity Council, 1988
32pp. £25.00

The Electricity Council is doing valiant work in promoting the teaching of electroproduction in engineering courses. It has already produced a series of teaching notes and monographs and accompanying slides on subjects such as arc furnaces, lasers, electric resistance heating. This is the latest monograph in the series and a worthy addition to the range.

Dr Metaxas is the Electricity Council Fellow in Electricity Utilisation at the Engineering Department of Cambridge University and is well known amongst workers in this field of electroproduction. It is, therefore, pleasant and informative to see his latest contribution; the monograph fulfils all expectations from someone of his calibre.

The text covers the mathematics of electromagnetic fields as applied to induction, direct resistance, radio frequency (dielectric) and microwave heating. These varied heating methods involve electromagnetic radiation in frequences from near dc (for direct resistance of metals) to a few GHz (for microwave heating of materials which are conductive dielectrics). The technologies in this range of applications are varied but basic electromagnetic radiation theories are common to all and this monograph attempts to bring all these together.

Starting with the vector field equation linking electric field intensity with charge and current densities under alternating fields Dr Metaxas compares the conductivity of metals with that of 'lossy' dielectrics and then via Maxwell's equations devises the wave and diffusion equations. At this stage two terms in the diffusion equations have different significances when applied to metal and dielectric heating. He then solves these equations either for electric field strength (for dielectrics) or magnetic field strength (for metals) starting with simple one dimensional cases and leading to 2-D and cylindrical shapes.

So much for the description of the mathematics. It is a complicated subject and you cannot explain it adequately in words. There are two tests for this book: has the author met the objective implied in the title? and how valuable is this as an addition to published texts in the subject?

Dr Metaxas has certainly described the mathematical treatment clearly and shown the applications. He summarises with the comment 'Electroheat is a multi-disciplinary subject which is very difficult to teach in a coherent way . . . no serious efforts have been made in producing a unified approach . . .'. There is no doubt that this is true and the material of this monograph makes a valuable contribution to teaching.

However, it is more difficult to measure this as an addition to already published texts. Dr Metaxas' work is known to, and respected by, other workers in the field, but is already available, in nearly the same form as in the monograph, from learned journals. The measure must be as a text book. At £25 for 32 pages it is extremely expensive and although there are few good texts in this subject it would not be considered by students as a valid text. It seems that The Electricity Council is publishing this at a price to deter students, and most workers in the field would already have received complimentary copies. The price seems irrelevant, it will not sell except in minuscule quantity. Would not the Electricity Council be better advised to concentrate its efforts on producing an authorative text book suitable for student purchase and use?

R G Herapath

Insulators for high voltages

J S T Looms
Institution of Electrical Engineers, 1988
276pp. £45.00

A fascinating book intended for electrical engineers and written by an engineer who, although he started his working life as a revenue lawyer, has spent over 30 years in research on the subject of high voltage insulators.

This book is an up-to-date guide to the whole field of high voltage insulators as used in electrical power systems in the UK and includes similar work on insulators for use on railways and other traction systems.

The author traces the history and the development of insulators and, in the early chapters, describes the principal materials, ceramic and polymeric, in use together with their method of fabrication. He explains in a precise fashion the physical principles of insulators, their design and manufacture, contamination and flashover characteristics. On the last point, the author devotes a whole chapter to the remedies for avoiding flashover, so in no way is this just a theoretical book.

Much of the book contains sound practical advice covering, choice of insulators for differing systems and conditions, including the many aspects appertaining to the environment. Real working practice is discussed in the precautions to be taken in live-line working and the avoidance of dangerous practices when undertaking such work.

The book contains many worked examples and clear illustrations. The latter are precise and certain of being easily understood by electrical engineers. The author, because of his first hand experience, is able to present to the reader a wealth of knowledge that will be of great value to present day and future development work on high voltage systems and their reliability under a wide range of conditions.

In many ways this book could be described as a fine reference work on the subject of insulators and is highly recommended, not only to those who are presently engaged in such work, but other electrical engineers and students alike.

F John L Bindon

Energy options

Institution of Electrical Engineers, 1988
£35.00

Energy options contains 56 conference papers that cover: policy and economics; energy efficiency; solar-thermal; solar and photovoltaic; wind; tidal; hydro, wave and OTEC; geothermal; advanced concepts and pollution control; CHP; biomass. It would be invidious to try to select the highlights. You are left wondering how the 'Call for papers' led to such a selection of papers.

The section on *Policy and economics* tends towards viewing energy conservation as an energy efficient means, in both production and utilisation. However, the papers do lead into the second section, *Energy efficiency*. Here, there are a number of interesting papers, some of which are useful case histories.

Renewable energy papers that capture most attention these days surround wind and tidal schemes. Nothing new seems to emerge on wind generation though those projecting its advantages do so with the same conviction. The same could be said for the four papers presented on tidal power. However, full scale development of this system of energy, looks more likely to be funded over the next decade than any large scale financial assistance for wind farms. Both have environmental problems to overcome, but the tidal schemes look more commercially viable as renewable energy sources.

Regrettably, the book contains only one paper on small-scale hydro-power. CHP (combined heat and power) is included in the book, but again the input is small. An interesting paper on the prospects of micro-CHP for individual householders was one of the few papers that was of particular appeal. The author showed a scheme capable of over 10000 h operation without main-

tenance, always a positive advantage for customers.

In conclusion, although the cross section of papers presented on the topic is very wide, it is difficult to imagine in a book on the subject of Energy Options this being otherwise.
F John L Bindon

Energy policy

Institution of Professional Civil Servants, 1988
94pp. Free

In May 1986, in the wake of the major accident at the Chernobyl nuclear power station, the National Executive Committee of the IPCS was instructed by its Annual Delegate Conference to undertake a comprehensive review of all aspects of the Institution's energy policy. This report is the outcome of that review.

It begins with a section setting the scene and assessing the significance of energy policy to the economy. It confirms the need for a policy on energy and that this is a proper concern of all governments, as the management of energy is concerned with economic prosperity and standards of living.

There is a general review of nuclear power generation covering the safety, health and environmental issues before dealing with all aspects of the nuclear power production cycle.

The following section examines the contribution and problems associated with other sources of energy — fossil fuels and the renewable sources of energy. The report then examines the relative costs of electricity generation, energy forecasts and the special position of the Third World. Finally, issues relating to secrecy, security and information are examined.

Despite the cost of producing their policy document the IPCS distributed it free of charge, no doubt to solicit a wide range of comment and attract publicity to the Institution's activities.
Andrew W Cox

The history of the British coal industry Volume 4 — 1913–1946

Barry Supple
OUP, 1987
733pp. £50.00

The title of this book sounds like a special subject for *Mastermind* and there is no doubt that anyone who has read this book from cover to cover would be able to answer almost any question thrown at them about the British coal industry from the start of the first great war to the setting up of the National Coal Board. The book is 'worthy', full of graphs and tables giving output, financial results, salaries, manpower to support a detailed account based on government and industrial records of the relations between mine owners, mine workers, government and market forces without, it must be said, much in the way of 'human interest' to lighten the narrative.

The narrative is, in many ways, depressingly familiar — a tale of shrinking markets, intensifying competition and lagging productivity; of miners and management locked in set behaviour patterns, unable to appreciate the harm they were doing to their industry. Even nationalisation when it comes appears to have been thought of as a last resort rather than the dawn of a new era.

I do not think I could cope with five volumes. I feel that, at least, volume 4 should be considered as a lead-in to the next volume, the story of the nationalised coal industry. No doubt it recounts the hopes and efforts of those who have worked for the modern and effective and efficient coal industry that this country needs and that is largely frustrated not only by the wild swings in relative fuel prices but also by the flexibility inherent in the structure of British industrial relationships and indecisive, political meddling.

To fuel technologists, this volume will be disappointing in giving no credit to the efforts of their predecessors to improve the technical level of coal mining and utilisation. There are a few pages on early attempts at mechanisation. There is a mention of the ICI plant to produce liquid fuels from coal, chiefly to emphasise its alleged lack of success. While the inevitable committee in the UK which declared that 'there could be no reliance, even in wartime, on oil produced from indigenous sources' is reported, the fact that the German airforce was kept flying on oil from coal is not. The contributions of the Fuel Research Station and the Coal Utilisation Research Association during the last war do not get a mention, not even the producer gas driven cars! Maybe this puts the fuel technologist in his place — or the place the technologist has been put in the hierarchy of British industry.
Dr G G Thurlow

Solar energy utilisation

Edited by H Yüncü, E Paykoc and Y Yener
Martinus Nijhoff Publishers, Dordrecht, 1987
753pp. £120.25

This large book contains 39 papers presented at a meeting of the NATO Advanced Study Institute on Solar Energy Utilisation: Fundamentals and Applications', held at Cesme, Turkey (June–July 1986).

The purpose of the Institute is to provide an international forum for the dissemination of information on solar energy. This meeting was primarily a high level teaching activity with the subject being treated in considerable depth by lecturers eminent in their field. The other participants were scientists, engineers and senior graduate students involved in related research.

Reviewing a publication of this sort is always extremely daunting. After briefly examining the one page preface the reader is plunged into a wide selection of papers on topics such as radiative heat exchange between surfaces, availability of solar energy, solar collector design, cooling systems, energy storage and solar ponds, solar drying plus industrial power systems.

I cannot understand why the organising committee and publishers did not publish a thorough introductory chapter describing this meeting; a list of delegates would also have been a useful contribution to the text.

The high standard of the papers is however generally high. This book should act as an update on solar utilisation technologies and be of value to researchers in the field.
Andrew W Cox

Photovoltaics: the sunrise industry

Mark Newham
Financial Times Business Information, 1986
117pp.

This soft covered, spiral backed, A4, 117 page publication has more in common with sunset technology than the sunrise industry it sets out to describe. But the style of its presentation belies the authority of its content. Mark Newham's acknowledgement confirms that a thorough trawl was carried out to cull the latest state-of-the-art information from experts far and wide.

The term photovoltaics (PV) represents different technological developments to different people. To some it means photoelectric cells, to others, solar cells in satellites, while, to yet another, visionary group, it means geostationary power plants beaming gigawatts of power to earth-based receivers. To the reader of this report, however, terrestrial photovoltaic technology applications have to be a priority interest.

The terrestrial market for photovoltaic power supply systems represents the largest potential market sector for photovoltaic technologies. It is not surprising therefore that the report deals primarily with the components and systems for power applications — cells, modules, arrays, concentrators — and with the developing market for these.

After an *Executive summary*, chapter 1 briefly 'introduces photovoltaics' and reminds the reader that photovoltaic solar energy technologies

deal with the conversion of solar light directly into electricity through electronic devices. Reference is made to Edmund Bequerel who, in 1839, discovered that when two metal plates were placed in an electrolyte and exposed to sunlight a small electric current could be measured. About 40 years later, an American, Charles Fritts produced the first cell made of selenium but very little of practical significance was achieved until the mid-1950s when engineers at the Bell Laboratories successfully developed a more efficient device using silicon which was taken up by NASA for satellite applications.

Chapter 2 deals with 'the technology of photovoltaics'. This summarises the devices which are available and outlines the manufacturing processes used. Improvements continue to be made and the production of a cell which will satisfy all the criteria required of a PV device could, it is suggested, be achieved by the early 1990s. This chapter also includes brief descriptions of the work to enhance the performance of PV cells by the use of concentrator systems.

The section on 'applied photovoltaics', chapter 3, emphasises the flexibility of PV. In principle, they can meet a wide range of electrical demands and it is possible to react swiftly to changing requirements by adding or subtracting modules or arrays. Set against this is the basic technological shortcoming that PV cannot generate without light, so that some form of power storage or back-up system must normally be installed.

Among the other applications reported are PV-powered medical centres, refrigeration, solar electrification in developing countries, telecommunications, cathodic protection, water pumping, and medium and large-scale grid-connected and stand-alone PV systems. An interesting reference is made to Japan's Sunshine Project which is being conducted under the aegis of the New Energy Development Organisation (NEDO), a branch of the Government's Ministry of International Trade and Industry (MITI). The work of NEDO is aimed at developing, testing and stimulating demand for PV devices and systems.

A large section of the report, beginning at page 39, is given over to reviewing PV projects around the world and the source of funding, public and private, followed by short essays about 'the major players' and some information about 'who is doing what'. A short section headed 'Prospects to 2000', concludes that a potentially vast market for PV devices and systems is on the verge of being opened up. It is likely to remain a sleeping giant however until PV device and systems prices decline to between a fifth and a tenth of their current level, particularly in the light of low oil prices. (The view of HM Government's Department of Energy is that a fall by a factor of between 10 and 20 would be required for large-scale electricity generation to compete in the UK). An extensive directory of major participants influencing the development of PV worldwide is included.

This report gives an easily assimilated international overview of the present state of PV technology for terrestrial power supply systems. Subject to a number of criteria being met in the next few years PV could, in the author's view, be supplying a significant proportion of the world's power by the end of this century.

L A N Tozer

Recently published

Heating, ventilating, refrigeration and air conditioning yearbook and daily buyers' guide (40th edition)

The yearbook is available from HVCA, Old Mansion House, Eamont Bridge, Penrith, Cumbria CA10 2BX. Price: £27.00 (UK and Republic of Ireland), £40.00 (elsewhere).

British Coal Operating profit — £216 M

'A year of solid achievement' was how Sir Robert Haslam, chairman of British Coal, described the past year's performance of British Coal. In presenting the 1987/8 Annual Report and Accounts in July he dismissed recent comments that described British Coal as a 'nice, cosy, monopoly'; 'nothing could be farther from the truth', he said.

Sir Robert went on: 'Last year (1987/8) our operating profit, which is industry's main financial performance indicator, was £216 M. The operating profit was reduced by two adverse factors: a loss of £100 M from industrial action by NACODS and the NUM and over £100 M in added price concessions to our customers.

'We also paid loan interest charges of £368 M, which is our equivalent of a dividend and most of it is paid to Government. We had "below the line" costs of £388 M arising from a faster pace of restructuring to survive the fierce market conditions. The underlying rapid improvement in the competitiveness of British Coal continued with another 10% gain in productivity. That paved the way for further gains in 1988/9. Results were on track to make an operating profit of £500 M for the year 1988/9'.

Source: British Coal

Cheaper coal needed says CEGB

Earlier this year Lord Marshall, chairman of the Central Electricity Generating Board (CEGB) said that home-produced coal faced a new challenge from natural gas for producing electricity. Gas would join low cost imported coal as a big competitor for British Coal's market for power station fuel, he told the annual conference of the Union of Democratic Mineworkers in Weymouth.

Until recently, there had been an EEC directive that in general gas should not be burnt to produce electricity, and there were strong arguments to 'save it'. That law was likely to change next year. Starting from 1989, it would be legal to burn gas to produce electricity. The process was very economical in terms of thermal efficiency.

The CEGB had already announced plans for new nuclear stations, which were needed for reasons of fuel diversity and economy in the longer term. The Board was also looking at opportunities for burning gas and was progressing plans to build new coal stations. New coal stations were proposed at Fawley on Southampton Water, West Burton in Nottinghamshire and Kingsnorth in Kent.

Under the Government's privatisation proposals for the electricity industry, it would not be for the CEGB to make decisions on whether to build any of the stations, but for its successor generating companies, currently known as Big G and Little G. It would have to be decided whether Big G or Little G would own the sites.

Proposals to build new nuclear power stations up to the year 2000 would do no more than compensate for the closure of the older ones. Although it was economically attractive to build more nuclear stations, the number planned was the best that could be achieved. Nuclear power would stay constant for the remainder of the century — rather than capture any market share from coal.

Lord Marshall said that 80% of electricity used last year was supplied by coal-fired power stations. Some 81 M t of coal was burnt, almost all of which was supplied by British Coal. 'What is absolutely clear is that we cannot keep on buying British coal at £46/t (delivered price) when imported coal is £20–£28/t. The stark challenge to the existing market is that at current prices, British coal is too expensive'.

Big G had the opportunity and intent to build nuclear stations but its interests were not limited to that. If the company, for example, was actually assigned two of the three new coal stations, it would be seeking contracts from the distribution companies to build power stations at both sites. 'To have a chance of winning contracts we must have the cheapest coal possible, taking one year with another. I cannot promise you that we will build any power stations, but I will promise you we will try to build both.'

Source: CEGB

PFBC Into the second generation

The potential of generating electricity from coal at costs up to 22% lower than with today's coal-fired power plants has led the US Department of Energy to authorise the second phase of a programme to design, build and test a 'second generation' pressurised fluidised-bed coal combustion system.

The first phase, completed earlier this year, called for the team to design the advanced process. The second phase will test individual components while the third phase will link the parts together in a complete system.

While a conventional coal-fired power plant with a scrubber typically converts only 35% or less of the energy in coal to electricity, a first-generation fluidised-bed system is expected to run at efficiencies of 40%. The second-generation version could boost the efficiency even more, to as much as 45%. Also, the pressurised nature of the combustor reduces its size and thus, its cost. Together, the improved efficiency and smaller equipment are projected to reduce the cost of electricity up to 22%, compared to today's coal-fired plants equipped with scrubbers.

The development team hopes to achieve the increased efficiencies by adding a 'carboniser' to preheat the coal before it enters the combustion chamber. In the carboniser, volatile gases would be released from the coal. The gases would then be burned in a separate, 'topping' combustor at the entrance to the gas turbine, increasing the turbine's 'inlet' temperature. The remaining coal would be burned in the main pressurised fluidised-bed system.

If the second phase testing is successful, in 1990, the Institute of Gas Technology (Chicago) will assemble and test all parts of the system except the turbines. The test facility will use 1.6 t coal/h, equivalent to five megawatts of electric power production.

Source: US Department of Energy

A new filter For dust free combustion

A nested fibre filter for advanced industrial coal combustion applications is being developed by Battelle for the US Department of Energy. The filter, made of alloy fibres formed by rapid solidification, is claimed to require less space than traditional techniques. Rapid solidification involves casting metal in sheet, ribbon, wire, or fibre form directly from molten metal poured onto a cold spinning cylinder.

In fabricating the nested fibre filter, the rapidly solidified fibres are placed onto a grid or screen, creating a mesh 'nest' with high throughput for gas flow at lower pressure. The gas passes through the filter and deposits dust particles on the fibres.

Results so far have shown that more than 99.5% of the dust coming into the filter is being captured.

The filter is intended for use in coal gasification, fluidised beds, and coal-fired turbine engines.

The next stage in the project will involve testing mechanical methods to incorporate the filter into equipment.

Source: Battelle Institute

(Continued overleaf)

Privatisation
Consumer guidelines called for

The Government must regulate the electricity industry strictly to prevent electricity prices rising and standards of service falling after privatisation. This warning comes from the National Consumer Council in the second in its series of papers on electricity privatisation and the consumer.

The paper says that there is very little scope for real competition in any part of the supply of electricity to domestic consumers. The local distribution companies which will take over from the existing area electricity boards after privatisation will have a virtual monopoly in their areas. So the costs entailed in buying electricity from the generating companies could simply be passed straight on to consumers.

'Unless positive steps are taken by government to prevent this, this could be no better than it is at present and possibly worse; consumers would be ripe for exploitation by the generating companies because there would be no incentive for the distribution companies to do anything but pass on the costs unless competition is introduced', said NCC chairman Sally Oppenheim-Barnes, commenting on the paper.

The paper recommends, among other things, that: Local distribution companies should be obliged to supply electricity whenever there is a reasonable expectation that the consumer will pay for current consumption (through a coin meter, for instance). An outstanding debt, though of course the company could seek its repayment, would not be grounds for refusal to supply, in these circumstances.

Clear standards of service that the customer is entitled to expect should be laid down and companies should have to pay consumers substantial compensation if they fail to meet these standards. So, if the supply of electricity were cut off, for whatever reason, customers affected would get cash compensation.

Geothermal
In the city

The United Kingdom's first geothermal district heating scheme is operating in Southampton's city centre. Southampton City Council Leader, Councillor Alan Whitehead, together with the director of Southampton Geothermal Heating Company, Charles Maillard, launched the city's project in July.

Brine that has been heated by the earth's hot interior for millions of years and lies more than a mile below the city, is being pumped to the surface to provide heat to the three civic buildings and other, commercial and industrial, buildings in the city centre are also to receive the hot water for heating.

The £3.8 M pioneering scheme results from a partnership between the public and private sectors. The project was begun by the City Council in conjunction with the Department of Energy after a research borehole found water at a temperature of 76°C at a depth of 5500 ft in 1981.

When the Department decided to terminate its research programme in this type of geothermal energy, the City Council pursued the idea of a private company taking it over rather than waste the time and money already spent and the expertise gained.

As well as using geothermal heat, the scheme also makes use of combined heat and power. A diesel generator provides power for the pumps and plant, and the heat from that process contributes to the scheme's heat supply. The scheme is designed to be flexible and can easily be adapted to provide other forms of energy, including other alternative energies.

Southampton's geothermal project, which is EEC grant-aided, will also provide the first opportunity in the UK to monitor the performance of an aquifer (a deep-lying, water-bearing, porous deposit of rock) over a long period. Monitoring and analysis for the first two years of operation will be undertaken by the British Geological Survey from data collected by the geothermal company, with the cost being met by the Department of Energy.
Source: Southampton City Council

Waste to heat
Warm recommendations

A seminar, organised jointly by the EEC, The Warmer Campaign and the UK Department of Energy to discuss state of the art and outstanding problems in the field of municipal waste combustion, including refuse derived fuel, was attended by 240 engineers and scientists from 18 nations.

At its closing session the seminar made the following recommendations for further action by the Commission of the European Communities and its member countries.

- There is a need for better information exchange. National focal points should be identified in all member countries and co-ordination organised within the Commission. Ideally these efforts should be broadened to an international scale, possibly under the auspices of the International Energy Agency.
- In view of growing concerns over environmental aspects of waste disposal, the Commission should give urgent priority to final drafting of the Directive on Waste Incineration. The Commission should also immediately support and stimulate the diffusion and take up of new and developing technologies.
- Effort is required urgently to characterise and evaluate emerging technologies in the waste to energy field on a consistent basis. The EC should lead in promoting assessments of economic and environmentally acceptable options so that the appropriate technical choices for different circumstances and in different regions can be made.
- There is a need to develop a consistent approach to the definitions of waste and waste derived products and to ensure that sampling and analytical procedures are harmonised as far as possible across the Community, and it is recommended that the Commission should take the lead.
- It is recommended that in view of the success and value of this first Waste Combustion International Conference, a further Seminar should be organised in 1990.

Source: The Warmer Campaign

Landfill gas
Another site to open

A new company* has been formed to develop the production, extraction and commercial sales of landfill gas from the Arpley landfill site near Warrington.

The site, which is due to open later this year, will be operated by Cheshire County Council mainly for the disposal of domestic waste. The biodegradation of the waste, once it has been deposited, will lead to the generation of large quantities of landfill gas. This will be mainly methane that will be sold as a low cost alternative energy supply to local industry.

When it opens the Arpley site will receive waste from Cheshire, Merseyside and surrounding areas. During its lifetime, expected to be 25 years, about 13 M t of waste will be deposited. It is expected that landfill gas output will exceed 6 M therms per year and the first gas is expected to be supplied in 1989.

The gas extraction process involves the construction of wells, in the deposited waste, from which gas will be drawn. The gas will then be processed and refined before being delivered by specially constructed pipelines to local industrial users several of whom are currently involved in discussions with the new company.
Source: Manchester Ship Canal Company

*Argos

Expert knowledge? You could be a witness

The British Academy of Experts was launched in June in the Parliament Chamber, Inner Temple, London. The Academy is both a professional society and a qualifying body providing, for the first time in Britain, a single source of independent experts in a wide range of professional, industrial and commercial disciplines.

The establishment of the Academy will provide reliable and cost-effective advice, not only in litigation proceedings, but in consultancy roles, investigative capacities, and any matter under arbitration.

Officials of the Academy include: Sir Denis Marshall, past president of the Law Society; Judge Lewis Hawser, QC, senior official referee; Sir Maurice Bathurst, QC, and other prominent members of various professions.

The Academy's prime purpose is to promote the use of independent British experts both in this country and abroad, and particularly within the EEC, both before and after 1992. To achieve this, it will carry out a range of given activities, including the provision of a formal institutional structure and codes of practice, the efficient exchange of information, training facilities and, most importantly, the maintenance of a comprehensive directory of members, enabling clients to identify the most appropriate expert for their needs.

Members of the legal profession have welcomed the establishment of the Academy, acknowledging its fulfilment of the long-felt need for a source of qualified, reliable and cost-effective expertise.

For further information please contact the Secretary, The British Academy of Experts, 90 Bedford Court Mansions, Bedford Avenue, London WC1B 3AE. Tel: 01-637 0333.
Source: British Academy of Experts

Windpumps For the Third World

An established Zimbabwean agricultural and engineering company* has acquired the licence to manufacture and sell the Intermediate Technology (IT) windpump to supply low cost water to farms, villages, schools and small scale industry throughout Zimbabwe. This is the third local manufacturing operation to be set up in Africa to make IT windpumps and its variant the 'Kijito' windpump. The countries are Kenya, Nigeria, and now Zimbabwe.

The general manager, Mr Greg Walpole, regards the IT windpump as a logical extension of the company's activities to provide reliable water pumping equipment for the huge and sparsely populated rural areas of the country.

Prospects for the IT windpump are excellent, with two windpumps already installed, another batch of 10 being fabricated, and export enquiries being received.

The windpumps are very much cheaper to operate than diesel or electric driven pumps and they operate even in medium to low wind regime areas. With their long-life, reliability and 'free' operation they are ideally suited to Zimbabwe.

The windpump for water supply was originally conceived of and developed by the Intermediate Technology Development Group for local manufacture and use. It was specially engineered to be made in workshops in developing countries. Modern design concepts were applied to produce a long lived, highly efficient and reliable machine with direct drive, requiring minimum maintenance. It will pump water from 200m depths or at 300 m^3/day from shallow wells.
Source: Intermediate Technology

*Stewarts & Lloyds

Australian oil New exploration rules

Western Australia could be in for an oil search boom if a Mines Department proposal to re-write the rules governing exploration are accepted by the industry and the State Government. Under existing law an oil explorer bids for onshore acreage with offers to drill a certain number of holes and spend a certain amount of money over a five-year period. The system, which has worked well for big explorers, has also seen big areas of land tied up for many years, often keeping small explorers out of prospective regions. Under the new concept, similar to one operating in the Canadian province of Alberta, an explorer would be allowed to identify a drilling target on any piece of vacant crown land and apply for the right to drill at a minimal cost. If successful, the explorer would then be able to apply for production rights. The proposal has been sent to about 80 explorers with the initial response from the smallest explorers and specialist drilling funds being highly favourable.

The director of the Department of Mines Petroleum Division, Ian Fraser, has emphasised that he is only seeking industry comment at this stage. Under the current system only two wells on average are ever drilled during the five-year period of an onshore permit. 'The ability to drill wells without the encumbrance of a five-year financial commitment but with the assurance of a production licence should represent a significant incentive to explorers,' he said.
Source: Western Australia Energy Review

Czechoslovakia New gas deposits

Geological research conducted in the central part of Czechoslovakia, Moravia, suggests new finds of gas fuel deposits in the region. Deposits have been found in South Moravia, giving new possibilities of search for natural gas at a depty of 3000 to 6000 m. Prospecting also continues in East and South-East Moravia where deposits are thought to be sufficient to make it possible, after the year 2000, to raise the present Czechoslovak production from 700 M m^3 to 2000 M m^3 annually.

In North Moravia, two oil deposits have been discovered, one with an influx of eight cubic metres and the other four cubic metres per day. Estimates of oil and gas reserves in the area are to be completed by the end of 1989.
Source: Czechoslovak News

Energy Users' Council 'Why you should join'

A new brochure, *Why you should join the Major Energy Users' Council*, that describes the objectives and achievements of the organisation since it was formed last October has recently been issued. The Council's main aim is to take action to encourage competitive and cheaper supplies of gas and electricity.

In the brochure the Council says that it has encouraged 40 large users of energy to work together. Its Gas Action Group has started negotiations with several producers and is devising a new, fairer Gas Contract background for commercial application; and the Electricity Action Group has provided detailed recommendations to the Energy Select Committee on the privatisation of the grid and is lobbying to ensure the best possible outcome for industrial and commercial users from forthcoming legislation.

The Council is represented in Brussels by the deputy chairman, Charles Ryder (Fellow), who attends regular meetings of the Economic and Social Committee's Energy Study Groups to which he is technical adviser.

Copies of the brochure are available from the Secretary, Andrew Bainbridge, 9 Cork Street, London W1X 1PD (01-439 3806).
Source: Major Energy Users' Council

New members

Fellow

George Sprott Morrison, South of Scotland Electricity Board, Fife (*transfer*)
John Michael Topper, British Coal Corporation, Cheltenham, Glos (*transfer*)

Member

Robert James Chisholm, Cameron & McIntosh, Aberdeen
Anthony James Drayton, British Gas, Bishops Stortford, Hertfordshire
David Jutton, Emstar, Staines, Middlesex
Adrian Paul Partridge, Whitbread & Co, Luton

Associate Member

Kevin Thompson, Bury Metropolitan Borough Council, Bury

Graduate

Paul Noel Booth, Redland Engineering, Redhill, Surrey
Timothy Malcolm Darrington, National Nuclear Corporation, Cheshire
Bin Majid Mokhtar, University of Sheffield
John Watson, British Coal, Edinburgh (*transfer*)

Student

Noel Christopher Diamond, Queen's University, Belfast
Mark David Gregory, Brighton Polytechnic
Annette Angelina Philip, Leeds University

Engineering Council *12 000 maths teachers short by 1995*

The Engineering Council, the Headmasters' Conference, and the Secondary Heads Association have published a booklet, *Securing the future: the shortage of mathematics and physics teachers*, following research they commissioned by Prof Alan Smithers and Dr Pamela Robinson, of the Department of Education at Manchester University.

Figures supplied by the Department of Education and Science show that in January 1984 there were 27200 teaching posts in mathematics and 7500 in physics. The three organisations say that, taking the optimistic view, the country will be short of 4141 mathematics teachers by 1995; taking the pessimistic view, there will be a shortage of 12232. In physics there will be a shortage of 2306 teachers in 1995.

In a foreword to the report the three organisations say that the results of the research show that a national educational crisis lies ahead unless serious action is taken by the Government, local authorities, industry and other interested parties to deal urgently with this problem.

A copy of the report has been sent to the Secretary of State for Education and Science, the Rt Hon Kenneth Baker. In a covering letter to Mr Baker —signed by Dr Kenneth Miller, director general of the Engineering Council, David Smith, chairman of the Headmasters' Conference, and John Sutton, president of the Secondary Heads Association, Baker was told: 'We are most concerned with the findings of the report and would be happy to meet you to discuss those features you consider most likely to have positive results.'

Nine recommendations to Government came out of the report, including:

- Give a far higher priority to secondary teacher recruitment, education and in-service training to solve the shortage of mathematics physics teachers.
- Establish and monitor up to date, accurate statistical bases including those for hidden and suppressed shortages, covering the demand, supply and retention of teachers. Set new targets for national teacher training.
- Investigate the reluctance of many trained mathematics and physics graduates to become teachers.
- Use financial incentives to benefit those actually entering the classroom rather than those entering Postgraduate Certificate of Education (PGCE) courses.
- Increase the number of girls taking mathematics and physics in schools, given the interest among women graduates in these subjects in becoming teachers.
- Attract more young people to the profession and retain experienced teachers in it by a vigorous programme of expenditure to renovate science laboratories, modernise equipment, and increase provision of laboratory assistants.

Two institutions merge

The Engineering Council has welcomed the announcement of an amalgamation between the Institution of Mechanical and General Technician Engineers (IMGTechE) and the Institution of Technician Engineers in Mechanical Engineering (ITEME).

The merger will give the new Institution, to be called the Institution of Mechanical Incorporated Engineers, a combined membership of 6500.

Sir William Barlow, chairman of the Engineering Council, said: 'The Council warmly welcomes this merger. The coming together of these two bodies will lead to greater benefits for their members and will give the new Institution a strong voice in professional matters'.

Both Institutions are Nominated

The International Committee at a meeting on 11 April 1988. Left to right: H B Locke, Prof B Brinkworth (president-elect), Dr E G Masdin (immediate past-president), W Tipler, J Clancy, Prof A Williams (hon treasurer), C McCarthy (education secretary), J E H Leach (membership officer) and the president, C E Pugh CBE

Bodies of the Engineering Council, approved to nominate suitable persons for inclusion in the Incorporated Engineer and Engineering Technician sections of the Register. ITEME was additionally authorised to accredit academic courses and industrial training programmes at these levels.

Branch report—North Eastern

Over 120 members and friends paid a private visit to the North of England Open Air Museum at Beamish on 24 June 1988. The weather was very kind to us and transportation around the site was by means of Sheffield Tram No 513 and an old open top Gateshead bus.

All the various areas were open except the drift mine. The evening concluded with a buffet in the tea rooms. This social evening was the first event for the new chairman of the branch, M G Burbage-Atter, and the immediate past chairman, Dr D Hall gave the introduction. The attendance, which was a record, was boosted by members of the local energy managers' group and the local branch of the Institution of Plant Engineers.

M G Burbage-Atter

Institute of Energy *1988 Branch conferences*

South Coast

8 Sept (Th). One-day symposium: *NO_x generation and control in boiler and furnace plant. The Crest Hotel, Southsea. In association with the Combustion Institute (UK section).*

North-Eastern

12 Oct (W). One-day energy conference and exhibition: *Energy efficiency in buildings.* Civic Centre, Newcastle upon Tyne.

Personal

Prof F J Weinberg FRS (Fellow) has been awarded the Royal Society's Rumford Medal in recognition of his pioneering work on optical diagnostics and electrical aspects of combustion and his fundamental studies of flame problems associated with jet engines and furnaces.

The Royal Society Esso Energy Award for 1988 has gone to a team from the research division of the Central Electricity Generating Board for their work in improving the combustion of heavy fuel oils which has led to increased use and mobilisation of scarce resources coupled with a decrease in air pollution from this particular type of plant.

The group, **A T S Cunningham** (Member), **Dr B J Gliddon** (Member), **Dr A R Jones, Dr C J Lawn, M Sarjeant, Dr R T Squires, Dr P J Street** (Fellow), and **P J Jackson** (Fellow), will receive the award, comprising a gold medal and a prize of £2000, from the president of the Royal Society, Sir George Porter, at a presentation at the Society in November following a public lecture on the team's work.

Ernest L Daman (Fellow), senior vice-president and director of research for Foster Wheeler Corporation, assumed office as president of the American Society of Mechanical Engineers (ASME) during its summer annual meeting on 15 June in Portland, Oregon.

A Member of ASME since 1947 and a Fellow since 1980, he has been active in the ASME research programme, its Council on Engineering and its new Industry Advisory Board.

Mr Daman joined Foster Wheeler in 1947, beginning as an engineer in the Research Division, engaged in development work on naval steam-generating systems. He progressed through the company to become senior vice-president for corporate research in 1980 and in 1983, a member of the Foster Wheeler Corporation Management Council. He is also chairman and chief executive officer of HDS Fibres, a high technology company developing metallic whiskers for composite materials.

Sir Robin Nicholson FEng FRS has been appointed chairman of the Confederation of British Industry's new Technology Policy Committee.

Sir Robin, who is an executive director of Pilkington Brothers, is also a non-executive director of both Rolls-Royce and BP. In 1981, he was seconded to the Cabinet Office as chief scientist in the Central Policy Review Staff. On the dissolution of that organisation in 1983, he became Chief Scientific Adviser in the Cabinet Office, until 1985.

John Baker, corporate managing director of the Central Electricity Generating Board (CEGB) and **Ed Wallis,** director of operations for the CEGB have been appointed respectively chief executives of 'Big G' and 'Little G', the two generating companies to be formed after privatisation.

Obituary

Desmond Napier, a conservationist, opencast protector and member of the North East branch died on 7 June 1988 after a long illness. He was 65.

Desmond was born in 1922 in the town of Adelaide, South Australia and was educated at St Peter's College. He joined the army at 16 only to be discharged because of his age a short while after. He then enlisted in the RAAF and was on active service for much of the war in Burma and Ceylon. It was during this time that he met his wife Sonia.

After the war he came to live in England entering engineering and eventually working as a managing director with Perga, a carton manufacturing company. After a takeover by Bowater he became redundant and set up his own, very successful engineering consultancy.

A member of many organisations, he was a founder member of the Derwant Valley Protection Society and minerals adviser to the Council for the Protection of Rural England. He had particular concern for planning and environmental issues and was dedicated to the protection of the countryside.

Desmond will, perhaps, be best remembered for his commitment to fighting opencast coal mining. He brought enthusiasm and expertise to many campaigns over nearly 20 years, being frequently involved in wider issues of policy making.

He was a man of complete integrity and, as such, won admiration from his countless friends and even from those whose views he opposed. He gave unstinting help to the many organisations which arose, as a result of opencast applications, in many parts of the country as well as locally and will be remembered from South Wales to Northumberland for the enthusiasm he injected into their campaigns.

It was typical that Desmond never let his long illness detract from his commitment and no one seeing him during this time could guess at the courage he needed to continue. Until the end he was endeavouring to influence the highest levels of government in an effort to modify the new guidelines on opencast coal mining. The presesnt awareness of the damage being wrought on the countryside by opencasting is due in great measure to the hard work put in by Desmond over the past years. The conservation movement has lost a great champion.

Desmond leaves a wife Sonia, sons Bruce and Geoffrey and daughters Caroline and Janet.

George Wilson and Andrew W Cox

REGISTER OF ENERGY COURSES

Course No 00-394

Title: Combustion of solid fuels.
Duration: 1 week.
Location: The Netherlands.
Starting: 19 September 1988.
Content: Solid fuels: sources, properties and impacts. Combustion aerodynamics. Devolatilisation of solid fuels. Coal ignition and extinction. Gas phase combustion of volatiles. Heterogeneous char combustion. Fundamentals of NO formation and destruction (gas and solid phase). SO_x fundamentals. Further combustion-generated by-products. Thermal radiation in coal-fired combustors. Mathematical modelling of coal-fired combustors. Research in the area of solid fuel preparation. Pulverised-fuel boilers. Non-utility application of solids combustion. Fuel-related problems in boiler operation. Removal of noxious components from flue gases. NO_x abatement during combustion. Fluidised bed combustion. Removal of solids from flue gases. By-products of solid fuel combustion.

Course No 00-411

Title: Energy management.
Duration: 5 days.
Location: Portsmouth Polytechnic.
Starting: 19 September 1988.

Course No 00-412

Title: Plant layout.
Duration: 5 days.
Location: Stakis Victoria Hotel, Nottingham.
Starting: 26 September 1988.
Content: Layout principles. Layout experiences. Safety and emergency considerations. Explosion and fire effects. Release and dispersion calculations. Hazard assessment exercise. Product packaging and storage. Bulk solids handling. Batch and housed plants. Modular construction. Layout organisation. Computer aided layout methods. Computer demonstrations and exercises. Area classification.

Course No 00-413

Title: Combustion fundamentals.
Duration: 5 days.
Location: Imperial College, London.
Starting: 26 September 1988.
Content: Flames in initially separate reactants. Fuels. Ignition, quenching and limits of flammability. Pollution from combustion. Flames in premixed reactants. Flame temperature and radiation. Kinetics of free radical and chain reactions. Combustion of hydrogen and carbon monoxide. Turbulent flames, shock waves and detonations. Characteristics and applications of practical combustion devices. Combustion of hydrocarbons. Shape and stability of flames on burners. Combustion of droplets and particles. Limits of detonability and the structure of detonations. Mixing and high intensity combustion. Additional principles for burner design. Dust and mist explosions.

Course No 00-416

Title: Economics and operations of bunkering.
Duration: 5 days.
Location: College of Petroleum Studies, Oxford.
Starting: 3 October 1988.

Course No 00-417

Title: Crude oil supply, transportation, refining and trading.
Duration: 5 days.
Location: College of Petroleum Studies, Oxford.
Starting: 10 October 1988.

Course No 00-418

Title: Creative international trading in crude oil and petroleum products.
Duration: 5 days.
Location: College of Petroleum Studies, Oxford.
Starting: 17 October 1988.

Course No 00-419

Title: A foundation course in petrochemical technology, markets and economics.
Duration: 3–4 days.
Location: College of Petroleum Studies, Oxford.
Starting: 23 October 1988.

Course No 00-393

Title: Understanding heat treatment.
Duration: 3 days.
Location: Aston University.
Starting: 25 October 1988.
Content: Basic metallurgical theory of heat treatment. Quenching principles and practice. Surface hardening theory and practice. Furnace types, materials and heating methods. Salt bath heat treatment. Atmosphere theory, production and control. Temperature measurement. Quality control and laboratory testing of heat-treated materials.

Course No 00-420

Title: International petrochemical marketing — the commercial factors.
Duration: 3–4 days.
Location: College of Petroleum Studies, Oxford.
Starting: 26 October 1988.

Course No 00-414

Title: Laser anemometry.
Duration: 3 days.
Location: Cranfield Institute of Technology.
Starting: 31 October 1988.
Content: Introduction to LDA. Introduction to fluids and turbulence. Doppler signal processing. Detailed setting-up. Laboratory practicals. Frequency shifting. Optical criterion. Seeding. Analysis of output. Reynolds stresses and turbulence. Scale of turbulence.

Course No 00-421

Title: Petrochemical markets and economics — the impact of feedstocks and costs on competitiveness and business strategy.
Duration: 5 days.
Location: College of Petroleum Studies, Oxford.
Starting: 31 October 1988.

Energy World Yearbook 1989

The editors (Alan Field and Gordon Webb) are now updating material for the next edition of the Institute's Yearbook and would welcome any input from readers, particularly on the following topics:

- Conferences/seminars planned for 1989 in the UK or overseas—subject, dates, venue, address for details
- Exhibitions scheduled to take place in 1989 in the UK or overseas
- Any new energy awards to be introduced
- New or revised energy-related courses at universities, colleges and polytechnics, or sponsored/organised by professional bodies and industrial organisations
- New/changed technical journals relevant to energy
- New energy databases or databases not listed in the current issue that members can recommend
- New energy organisations/trade associations, or changes in present listings
- Details of any firms not listed in the *Buyers' Guide* section with information on product lines or services

You can write to the Institute at 18 Devonshire Street, or contact the editors direct by phone (0705 580320) or by fax (0705 511633).

This is your yearbook and we want to make it as useful and as accurate as possible.

Coal science and its applications —14 September 1988

The aim of this meeting is to see how coal science can be applied to several areas of coal utilisation leading to improvements in the processes and in coal selection.

The speakers include Prof A Williams (Fellow), University of Leeds; Prof E Woodburn, UMIST; T Edwards, University of Newcastle; Dr A Williams, British Gas and Dr J Patrick, Loughborough University of Technology.

The conference will take place at the University of Leeds and will cost £25.00 (inc £3.26 VAT) for members of the Coal Utilisation Subject Group and £35.00 (inc £4.57 VAT) for non-members. Further details can be obtained from Fiona Williams, Conference Section, Institution of Chemical Engineers, 165–171 Railway Terrace, Rugby CV21 3HQ. Tel: (0788) 78214.

Smallpeice summer school— University of Exeter

The Engineering Technology course is being presented by The Smallpeice Trust, in conjunction with industrial and commercial establishments, on 19–22 September 1988.

This intensive four day course is open to girls and boys of 14 to 16 years of age, that are determined in pursuing an engineering career, from both maintained and independent schools.

A programme of seminars, films, 'design and make' projects, and a mini career convention—all aimed at introducing the fascination of design and production, coupled with the rapidly changing world of technology for girls and boys. The country needs first-class engineers to face the challenges of the manufacturing industries that help to create the wealth of the nation.

Full facilities are available. Accommodation will be separate for girls and boys. Administrative staff will be available 24 hours a day in case of need. For more information contact: J M Jack, Schools Courses Manager, The Smallpeice Trust, 27 Newbold Terrace East, Leamington Spa, Warwickshire CV32 4ES.

British Wind Energy Association one day seminar

Measurement techniques for wind energy will be held at King's College, Strand, London WC2R 2LS on Tuesday, 20 September 1988.

Measurement techniques form the basis of practical engineering developments and the wind energy field is developing very rapidly. This seminar will include presentations from major manufacturers, utilities, universities and other research groups; additional presentations are invited. It will be of interest to all those engaged in research in the wind energy field and to those concerned with detailed aspects of the technology, planning and development of renewable energies on land and offshore.

The registration fee is £40 (including VAT, lunch and refreshments) and £35 to BWEA and EWEA members. To register for the seminar or to offer a presentation contact: Prof D T Swift-Hook, Director, Centre for Applied Research, King's College, Strand, London WC2R 2LS. Tel: 01-836 5454 ext 2451.

The resistible rise of electricity usage — Exeter, 27 September 1988

The seminar will interest architects, engineers and energy managers concerned about efficient electricity use in public and private enterprises.

Efficient end-use of electricity obviously reduces the need for power station construction. Historically in the UK we have not accepted investment in end-use efficiency as a direct substitute for investment in the new supply. However, this is regarded as a realistic and economically attractive option by some US utilities. This means that the seminar will also be relevant to the wider debate about the future of the UK electricity supply industry. This debate is now focused on the South West because of the forthcoming Hinkly Point C public inquiry.

The seminar is organised by Exeter University's Energy Study Unit. For full details contact: Jim Penman on (0392) 264144.

(Continued overleaf)

Combustion instrumentation '88—18 October 1988

The Combustion Physics Group of the Institute of Physics, in association with the Combustion Institute and the Institute of Energy, is organising a technical meeting and exhibition on Combustion Instrumentation to be held at the Octagon Centre, Sheffield, on Tuesday 18 October 1988. Short technical presentations concentrating on the physical principles of instruments used for measurements in flames and flue gases will be followed by an exhibition in which both technical and commercial information on a wider selection of instruments will be available. The opening address will be given by Dr A M Godridge who has recently retired from a distinguished career in combustion research with the Central Electricity Generating Board. Technical presentations will be given by UKAEA (Harwell), Talentum Developments, Air Oil Flaregas, Peabody Holmes, Leeds University, Cambustion, Imperial College, Neotronics, Kane May, Kent Industrial Measurements, Servomex, Energy Technology and Control, Hartmann and Braun (UK), Land Combustion, Analytical Development, Signal Instrument, Analysis Automation, Thermo Electron, Erwin Sick Optic Electronic, Westinghouse Electric SA, Severn Science (Instruments) and Babcock Bristol, on techniques ranging from flame monitoring and fast ionisation detection to efficiency and pollution instrumentation. All these organisations (plus Bristol Industrial and Research Associates), will be exhibiting the techniques described in the presentations along with other relevant instruments from their product line. Further details of the meeting/exhibition which costs £14.00 for members of the sponsoring organisations and £22.00 for non-members can be obtained from Clive Herrod, NEI-International Combustion, Sinfin Lane, Derby DE2 9GJ. Tel: 0332 271111.

BSC Stainless competition

The Design Council and BSC Stainless have joined forces to launch a national stainless steel competition that aims to stimulate the innovative use of stainless steel in well designed marketable products. The *BSC Stainless Awards* are divided into two categories with an award for small firms and fabricators, and an award for professional designers. Both categories offer cash prizes of £2500 to the outright winner together with relevant practical assistance to commercialise their winning designs.

In the Professional Designer category, the winner will receive £2500, a tungsten inert gas welding kit, practical support in the form of nine three-day sessions at the BSC Stainless Workshop, and a certificate. The outright winner in the industrial company category will gain a cash prize of £2500, two tungsten inert gas welding sets, 12 three-day residential sessions at the BSC Stainless Workshop and a certificate.

The closing date for applications is 23 September and final judging will take place in mid November 1988. For more information contact: Terry Garner, Awards Office, The Design Council, 28 Haymarket, London SW1Y 4SU. Tel: 01-839 8000.

Working in the City—EC architectural ideas competition

The Commission of the European Communities is promoting an ideas competition for architects called *Working in the city*. The competition, which is for the design of non-domestic buildings in European cities or towns, has three objectives:

- To find new approaches to city building which emphasise the quality of the working environment, particularly with changes in information technology in mind.
- To stimulate designs which respond to their climatic and urban surroundings and provide comfortable conditions with economy.
- To emphasise the potential of natural lighting and other passive solar methods of reducing energy consumption.

The prize fund totals 40000 ECUs. All architects living within the EC are eligible to enter and a separate section is open to students. The judges are five of the leading architects in Europe: Günter Behnish, Stuttgart; Henri Ciriani, Paris; Edward Cullinan, London; Vittorio Gregotti, Milan; and Alvaro Siza Vieira, Oporto.

The registration fee for the competition is IRL£20 (Eurocheque or International Money Order, made payable to University College Dublin). The final date for registration is 30 September 1988. Send applications to: Shane O'Toole, Energy Research Group, University College Dublin, Richview, Clonskeagh, IRL-Dublin 14, Ireland.

Churchill Travelling Fellowships —the chance of a lifetime

Each year the Winston Churchill Memorial Trust offers opportunities for United Kingdom citizens to travel overseas to undertake study projects related to their trade, profession or interests. Thus they widen their experience, make contacts abroad and bring back knowledge to this country for the benefit of their work and the community.

Travelling Fellowships are available to applicants of any age from all walks of life, irrespective of academic or professional qualifications and others are diffident to ask unless they are encouraged.

Application forms, which must be returned by 17 October 1988, are available from: The Winston Churchill Memorial Trust, 15 Queen's Gate Terrace, London SW7 5PR. Tel: 01-584 9315.

CONFERENCES

September 1988

Wind power generation — an energy for today

One-day meeting, Belfast (Queen's University), 8 September 1988.
Details from Stan McWilliams, Primary Energy, Enterprise House, Little James Street, Derry BT48 7BG, Northern Ireland. (tel Londonderry (0504) 364015 and 54281).

The transport of hazardous materials

Conference, London (Gloucester Hotel), 12 and 13 September 1988.
Details from Katie Lye, IBC Technical Services, Bath House (3rd floor), 56 Holborn Viaduct, London EC1A 2EX (tel 01-236 4080; tlx 888870; fax 01-489 0849).

Power stations 1988

VGB conference, Dortmund (FRG), 13–16 September 1988.
Details from VGB Technische Vereinigung der Grosskraftwerksbetreiber, eV, Postfach 103932, D-4300 Essen 1, FRG (tel (0201) 8128-1; tlx 857507 VGB D).

Science and civilisation under William and Mary

Discussion meeting, London (Royal Society), 15 and 16 September 1988.
Details from the executive secretary, Royal Society, 6 Carlton House Terrace, London SW1Y 5AG (reference: DMII/CAJ); tel 01-839 5561 ext 278 or 277; tlx 917876. *Applications must be received by 5 September 1988.*

Energy

International conference, Hong Kong, 15–17 September 1988.
Details from May B Y Oh, c/o May Oh and Wee, 3 Shenton Way, 2102 Shenton House, Singapore 0106.

Oil and gas markets

Seventh CERI international conference, Calgary (Alberta, Canada), 18–20 September 1988.
Details from Conference Division, Canadian Energy Research Institute, 3512-33 Street NW, Calgary, Alberta, Canada T2L 2A6 (tel (403) 282-1231; tlx 03821545 (Univ of Cgy); fax (403) 284-4181).

Impact of atmospheric protection measures on thermal power plants

Seminar, Essen (FRG), 19–21 September 1988.
Details from Committee on Electric Power, UN Economic Commission for Europe, Palais des Nations, CH-1211 Geneve 10, Switzerland (tel (022) 346011; tlx 289696).

The structural integrity of nuclear reactors

Seminar, London (IMechE), 21 September 1988.
Details from Vanessa Whitehead, Institution of Mechanical Engineers, Power Industries Division, 1 Birdcage Walk, Westminster, London SW1H 9JJ (tel 01-222 7899 ext 222/223; tlx 917944).

Offshore information

Conference, Bergen (Norway), 21–23 September 1988.
Details from Anna Botnevik, conference secretary, FOP, PO Box 7, N-5049 Sandsli, Norway (tel (05) 22 89 10; fax (05) 22 91 39).

Energy and the environment

Newport and Nevern Energy Show, Haverfordwest (Wales), 23 and 24 September 1988.
Details from Newport and Nevern Energy Group, Feidr Fawr, Dinas Cross, Newport, Dyfed SA42 0UY (tel (03486) 431).

Environmental management of onshore oil and gas activities

Seminar, York, 25–27 September 1988.
Details from Dr David M Ord, Centre for Environmental Management and Planning, 48 College Bounds, Old Aberdeen, Aberdeen, Scotland AB9 1FX (tel 0224 272480; tlx 73458 UNIABN G; fax 0224 487658).

MIT environmental dispute resolution workshop

University of Cambridge, 26–28 September 1988.
Details from Environmental Resources, 108 Gloucester Place, London W1H 3DB (tel 01-486 1211; tlx 296359 ERL G; fax 01-935 8355).

The resistible rise of electricity usage

Seminar, University of Exeter, 27 September 1988.
Details from the secretary, South West Energy Group, County Hall, Topsham Road, Exeter, Devon EX2 4QQ (tel 0392 272878).

October 1988

European electricity: business opportunities in the 1990s

Conference, Geneva (Switzerland), 6 and 7 October 1988.
Details from European Study Conferences, Douglas House, Queen's Square, Corby, Northants NN17 1PL (tel (0536) 204224; tlx 347260 KM G; fax (0536) 204218).

Three decades of nuclear power safety

Lecture by Dr John Wright (corporate director of Health and Safety, CEGB), Royal Institution (London), 10 October 1988 at 1430 h.
Details from Miss Gail Pickering, Institution of Occupational Safety and Health, 222 Uppingham Road, Leicester LE5 0QG (tel (0533) 768424).

NSCA 55th annual conference

Conference and exhibition, Llandudno (Wales), 24–27 October 1988.
Details from: (*conference*) National Society for Clean Air, 136 North Street, Brighton BN1 1RG (tel (0273) 26313; fax (0273) 735802); (*exhibition*) Howard Phillips, Westrade Fairs, 28 Church Street, Rickmansworth, Herts WD3 1DD (tel 0923 778311; tlx 296689 WESTEX G; fax 0923 776820).

November 1988

Oil loss control: product handling and distribution

Conference, London (Cavendish Conference Centre), 17 and 18 November 1988.
Details from Miss Caroline Little, conference officer, Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR (tel 01-636 1004; tlx 264380; fax 01-255 1472).

April 1989

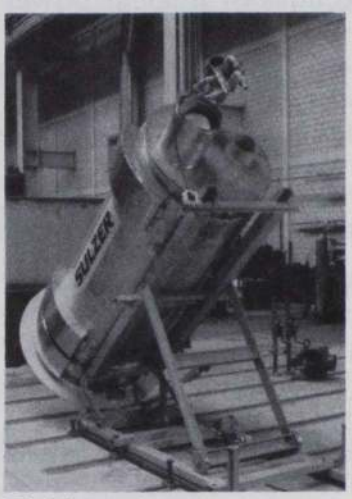
Municipal waste combustion

International conference, Florida (USA), 11–14 April 1989.
Details from Jack Greene, US Environmental Protection Agency, Air and Energy Engineering, Research Laboratory, MD-49, Research Triangle Park, North Carolina 27711, USA (tel (919) 541-2905).

New wire receiver

A new type of receiver (pictured) for the experimental solar power station at Almería, in Southern Spain, has been developed by **Sulzer.** The aim of the development is to achieve significant economies in the construction and operation of solar power stations by means of a simple, easy-to-service design.

The new component, with a diameter of 1 m and a length of 3 m, is designed as a compact receiver/steam generator module. Its lower face features a column of 120 rings made of fine wire mesh. This absorbs the solar heat focused by a system of mirrors, and transfers it to the air passing



The Sulzer receiver

through. The heated air flows through a throttling system (located downstream of the absorber) into the inside of the cylinder, where its heat is taken up by cooling tubes.

Using a small 3 kW experimental plant, a hot air temperature of 840°C was achieved in 1985. The present aim is to confirm that the wire receiver can produce hot air temperatures of at least 800°C and with good efficiency and at higher outputs. Moreover, it is expected that the wire receiver will pose far fewer problems during start-up and shut-down than receivers of other types.

The tests carried out in the second half of 1987 fulfilled expectations as regards temperature and simplicity of operation. Measured values of efficiency, 60 to 70%, were not quite up to the 80% anticipated. The efficiency is being raised to the required value by changes in the absorber construction. Plans are already in existence for a follow-up investigation using a receiver of 3 MW output.

Reader enquiry no 8/1

Self-sealing test plugs

As an alternative to expensive, permanently installed thermometers and pressure gauges being built into such products as vacuum chambers, sterilising units and similar equipment, **Binder twinlok** test plugs can be used to allow the manufacturer or eventual user to measure internal temperature, pressure and vacuum.

The manufacturers claim that once a test plug, costing about £2, is fitted all that is required is the use of a thermometer and pressure gauge with probe. The test plugs provide a self-sealing access point to allow pressure and temperature measurements to be made in a range up to 500 psi (35 bar) and temperatures up to 135°C.

By using one thermometer or one pressure gauge the user gets common data and therefore accurate measurements. It also avoids the possibility of comparative inaccuracies between numerous permanently installed thermometers and gauges.

Reader enquiry no 8/2

Oxygen monitoring with Zirconia analyser

Combustion control within tight limits is essential if fuel efficiency is to be maintained in a power station. At Staythorpe, near Newark, plant management has invested in analysis of flue gases to keep oxygen levels to an optimum of 3.8% in a large coal fired plant.

The power station has purchased six 760M **Servomex** Zirconia Analysers for the task, following a successful initial trial with the equipment, and has them attached 50mm off the flue walls in each half of the three main boilers, which drive three generating sets of 120 MW each.

Flue gases heavily laden with dust, pass from the combustion chamber, through the steam heating process to air heat exchangers via ducts from which a sample is drawn at temperatures of 300°–350°C before the dust is extracted by precipitators.

The Zirconia cells are treated with a special coating for protection against the hostile environment to ensure long cell life, typically in excess of 18 months. Routine calibration is carried out only once every six weeks and is a simple procedure.

Reader enquiry no 8/3

Burner produces significant savings

A multiplex burner fitted with silicon carbide combustion tunnels has enabled the brick industry achieve substantial cost savings.

Nu-Way claim that the use of these burners has produced major improvements in both fuel consumption and product yield. The silicon carbide combustion tunnel is ideal for fitting in the walls or roofs of high temperature kilns, particularly those constructed from ceramic fibre. The company has also solved the problem of refractory quarls being damaged due to wall movement in conventional refractory lined kilns.

A simple adaptor fixes the silicon carbide tube to the burner and enables extended tunnels to be supplied if required. The tubes are also easily fixed to existing multiplex burners and are available in both medium and high velocity versions.

Reader enquiry no 8/4

Infrared thermometer to replace thermocouples

Calex Instrumentation have announced a new line of non-contact infrared thermometers. Called the Thermalert IT line, the initial products are the IT-1, designed as a direct replacement for the type J thermocouples; the IT-2, to replace type K thermocouples; the IT-3 which provides a 1mV/°F or °C output; and the IT-4 which offers an adjustable set point so that users can assign a control function that can be monitored from a remote location. The IT-1, IT-2 and the IT-3 are the first products for fixed use in the Calex line to be priced below £400 and, the manufacturers claim that the products will last at least 10 times longer than a contact thermocouple.

Infrared thermometers read temperatures without touching the object being measured and so are not subjected to continual abuse and wear as are thermocouples and, therefore, have a much longer life.

The advantages of non-contact thermometers over thermocouples are:

- Longer life
- Ability to read temperatures of objects not accessible with conventional thermocouples
- The product and not its environment is measured
- Greater accuracy of measurement
- Enhanced repeatability
- Faster response time
- Protection of the material being measured.

Contact thermometers, in addition to becoming coated, can contaminate food being processed, will scratch, tear or smear in applications such as papermaking, converting and printing, and can contaminate chemicals.

Reader enquiry no 8/5

Trade publications

Management introduction to 100% total loss control by James Tye, director general of the **British Safety Council,** is now available at a cost of £5.00.

The new manual shows that there are simple ways to measure the total accident picture, and from that an action plan can be devised to control it. The technique of total loss control is concerned with any loss by accident to men, machines, materials or the workplace area.

The book is a step-by-step easy-to-read introduction to a complex technique. Cartoons, diagrams and a whole section of questions and answers simplify the concepts and key area grids are included to assist immediate action.

Reader enquiry no 8/6

Landfill gas services—from consultancy to commercial ventures is a free brochure describing the work of **Coal Processing Consultants.** The brochure describes aspects of landfill gas such as environmental control, resource evaluation and commercial utilisation.

Reader enquiry no 8/7

ENERGY WORLD—COMMERCIAL
(Photocopy acceptable)

Please send me further information against the reader enquiry no(s) listed below (please tick)

8/1 8/2 8/3 8/4 8/5 8/6 8/7

Name .....

Address .....

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Organisation .....