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Personal viewpoint

Dying against conscience

We do not need nuclear power. It is dangerous for our descendants.

Public requirement is for heat, light and power for domestic and industrial purposes, provided as economically as possible. Hypothermia when heat is expensive.

We became accustomed to extravagant energy usage when we had very cheap coal. Our interests are now best served by fuel economy. Combined Heat and Power (CHP) doubles the fraction of the primary fuel which is utilised, yet we have ignored it.

A rational energy policy for Britain should involve:

(a) looking after the interests of our descendants by spending all available capital, not on new power stations, but on equipment for fuel economy; (b) converting gradually all old power stations to coal- or refuse-fired CHP systems. The installation of the distribution mains would create much employment; (c) diverting research money from nuclear power to the development of fluidised bed combustion to eliminate acid rain, and other methods of reducing air pollution; (d) the development of telechiric mining so that miners work from the surface, and seams accessible by present methods can be won; (e) more expenditure on research and development of all renewable energy sources.

Nuclear power is no help for the poor

One of the most important energy problems of the world is to satisfy the energy needs of the millions living in poverty. They do not want, and can hardly ever afford, the quantities of energy we use in the developed countries. Central power stations are nonsensical for them, for they can never afford the amounts of electricity needed to justify a station of nuclear size — let alone the distribution cost. I have recently finished* calculations showing that the minimum energy supply necessary to give the essential benefits of the industrial revolution (in a hot country) is less than 135 kWh/y or 15 W cts of electricity per person together with 0.18 tce of heat. Thus for a village of 1000 people only 15 kW of electricity is needed with some daily storage. Lowry† at Queen Mary College developed a cheap solar focussing system that could provide this energy with 'steam accumulator' storage and also ample boiling water.

Accidents can happen here

The belief that 'it couldn't happen here' is negated by the leaks at Windscale, the Flixborough disaster and the 'Friday afternoon car'. Accidents are almost always due to human error. We are no more free from human error than the Americans or the Russians. Chernobyl has shown the extent of how widespread the damage from escaping radioactivity can be.

There is an error in the argument that if escaping radioactivity is at a level lower than the natural background radiation then we need not worry about it. Natural background radiation is mostly from the noble gas radon, which is not retained in the body. Radiation escaping from nuclear power stations contains certain elements (eg caesium, iodine, strontium, and plutonium) which remain in our bodies, or are concentrated in the animals we eat, and so have their effect multiplied many times. I quote 'because caesium is chemically quite similar to potassium, the same mechanism concentrates caesium (in fish) from such a freshwater source approximately 1000 times.'** Again, 'Cancer and leukaemia begin to appear 5 or more years after the radiation has been received'.***

What I find against *conscience* is that in order to continue extending our consumption of electricity we are bequeathing to our descendants dangerous tasks for them to carry out, with no benefit to themselves:

- 1 Many tons of high level waste stored in expensive tanks will be 'cool' enough after 50 years to be converted into glass and buried.
- 2 Intermediate and low level waste must be kept safely isolated until it has decayed to a harmless level.
- 3 Old power stations must either be dismantled (dangerous even with telechiric) or left as concrete mausolea.

Nuclear energy and emotionalism

Quote from my evidence to the Sizewell B Inquiry (App V):

'No doubt when Wilberforce and his friends fought against the slave trade 150-200 years ago they were similarly accused of emotionalism and told that the slaves were essential for financial and economic reasons. They fought against slavery because of an emotion coming from their consciences that human beings should not be treated as having fewer rights than animals'. 'I am convinced, therefore, that for these reasons of conscience the emotional objections to nuclear power should be given weight comparable to that given to 'scientific' and economic arguments against the expenditure of further large sums of money on a line of research and development which is now only propelled by its own momentum'.

M W Thring FEng

(President)

Scientific Acad Sci Scripta Varia 57 1986 p358

Ambient Energy April 1983 4 3 p153

Worley and Tamplin *Poisoned Power* 1971 Rodale Press p54

Ibid., p113

Technological aspects of fluidised bed combustor design*

J S M Botterill BSc PhD CPhys CEng FInstP MInstE MInstMC†

A hot fluidised bed provides an advantageous environment for the combustion of very varied fuels. Efficiencies higher than those obtainable in conventional stoker-fired steam-raising plant are readily achievable and designs can equal those attained by efficient pulverised fuel plant. The technology has unassailable advantages in the area of gaseous pollution control. For realisation of the full versatility of the technique, however, careful attention must be given at the design stage to a number of important aspects. These are considered in relation to the development of coal burning beds. Aspects principally considered are: possibilities for handling dirty fuels of high ash content without the need for preliminary coal treatment; the implications of the very good bed thermal properties when it is necessary to be able to follow widely varying loads and the general interactions between the operating parameters. Fast circulating beds offer operational advantages over ordinary bubbling beds for large units which need to have the capacity to burn low-grade and very varied fuels and when sorbent utilisation is an important economic consideration. The different aspects of solids handling involved constitute an area where more basic work is required

Introduction

It is so easy to carry out combustion in a hot fluidised bed that the first experiments seemed to be discouraging. There was ample fuel and the oxygen to burn it was available but mixing within the bed was inadequate. Consequently the reaction went vigorously but the bed sintered. In a fluidised bed combustor the fuel is introduced into an environment of high heat capacity which is maintained at a suitable temperature for the sustenance of combustion; the fluidising air provides the combustion oxygen. Combustion of solid, gaseous or liquid fuels can then be conducted stably from temperatures only a little in excess of 600°C although a temperature of at least 800°C is required for efficient combustion of most fuels.

In a coal burning combustor, the designed operating temperatures are typically in the range 800 to 950°C. The maximum temperature in this range is determined by the danger that the ash will soften and foul the heat transfer surfaces and/or lead to bed sintering. This is related primarily to the alkali metal impurities in the coal or ash, which are indicated by the chloride content. Thus the maximum temperature is limited to 850°C for some very high chloride content UK coals and as low as 750°C for reactive lignites with even higher chloride content from some other countries. Combustion efficiencies higher than those obtainable in conventional stoker-fired steam-raising plant are readily achievable and designs can equal those attained by efficient pulverised fuel plant. The technology has unassailable advantages in the area of gaseous pollution control. Because the exposed surface of the burning carbon is at a comparatively low temperature, production of nitrogen oxides by oxidation of atmospheric nitrogen is much lower than in a conventional furnace, although some oxides are formed from the nitrogen in the coal molecule. Even so, conventional FBC does not directly meet the pollution limits of some countries and it is then necessary to stage the air. The ash in the bed has some capacity to absorb pollutants, depending on its calcium content, but sulphur retention can be markedly increased by adding limestone or dolomite to the bed. The

optimum retention temperature is about 850°C for atmospheric pressure combustor and about 950°C for working at elevated pressure, although operation at upper level is likely to be precluded by alkali vapour considerations.

The book *Fluidised beds — combustion applications*, edited by Howard (1983), well reviews background to this field and was offered as a tribute to the memory of the late Prof Douglas Elliott, who can justly be credited with having been primarily responsible for stimulating interest in the potential of fluidised combustion. In his recent review, La Nauze (1985) specifically considers 'Fundamentals of coal combustion' and the 2nd edition of the NCB report, *Fluidised combustion of coal* (1985) outlines their contribution to the range of British technology. In the present paper the author focuses on some challenging problems which remain if the full versatility of the technique is to be realised in the field of coal burning technology.

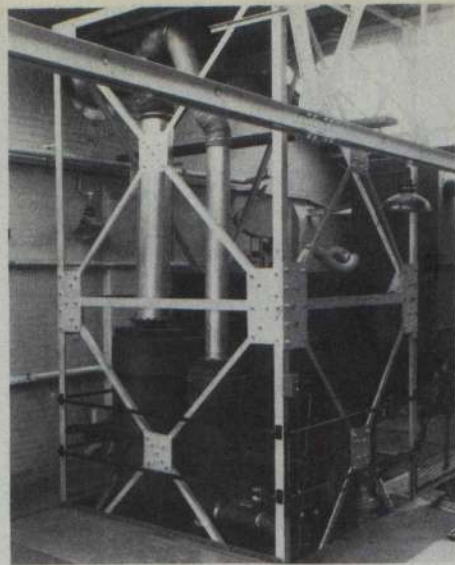
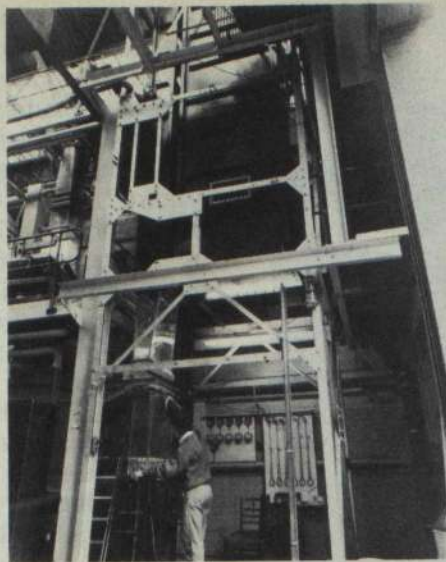
Inherent coal type flexibility

Because the necessary fuel concentration in the bed is low and mixing rates within the vigorously bubbling bed so high, a wide range of fuels can be burned in a given design of combustor although special designs are required to burn very low-grade fuels. Provided an appropriate maximum bed temperature is selected to deal with high alkali salt concentrations, sources of fuel may be identified which would have posed severe combustion and corrosion problems to conventional technology.

The ash produced in burning the fuel may contain sizeable lumps of mineral matter, burned-out shale which is friable and readily breaks down into fine particles, and fine ash which is released when the carbon in the coal is burned. The fine particles are elutriated from the bed, it may be necessary to arrange to remove the larger particles periodically to prevent a change in the mean particle size with a consequent change in the operating characteristics of the bed. Thus the larger stones may segregate and form a static layer at the distributor whereas large, low-density shale, through its effect in increasing the mean particle size of the bed, could lead to reduced mixing within the bed and the development

*Paper presented at international seminar on *Frontier areas in applied chemical and engineering sciences*, Assam, April 1986

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temperature gradients. Satisfactory operating techniques have been established but it may be simpler to crush all coal to be less than 6 mm in size if the coal has a high shale content.

Current British industrial washed coals generally contain less than 10% ash and have a top size of 25 mm. They can be fed to the combustor 'as received' and burned with combustion efficiencies of up to 99% but some of the larger stone particles will inevitably be present and those above 6 mm will tend to segregate and settle on the distributor. Cooke *et al* (1984) have shown that the fluidisation stability with standpipe air distributors is increased by increasing the fluidising velocity and bed depth, by using directional air jets and by inclining the air distributor. The size of material can then be withdrawn either continuously or intermittently by circulating the bed material through a simple pneumatic classification stage. The large particles still have a significant carbon content, and segregating material can be recirculated to the fluidised

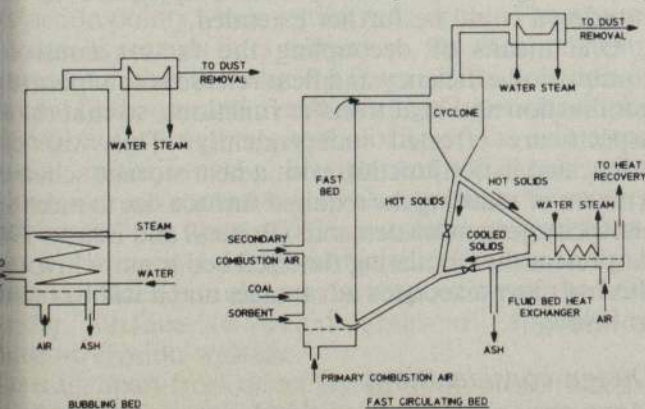
bed. This would be particularly advantageous to be able to fluidise coal of a size up to 50 mm as mined and, with the higher grades of coal, this inevitably means that there will be a proportion of relatively hard shale particles which have to be removed from the bed. The suggestion is that spouted bed techniques could be used to overcome the very strong segregating tendencies and maintain a fluidised bed in the combustion zone, but to take advantage of the natural segregating behaviour to remove the larger stone in another region of the bed (Rogers and Cooke, 1984). There remains the challenge of designing an air distributor in order to effect this removal in a controllable manner. A paper by Bemrose *et al* (1986) outlines some preliminary work aimed at trying to understand the factors which are important in generating

the required movement of large segregated particles across the distributor.

Heat removal and boiler turndown

A bubbling fluidised bed has very advantageous heat transfer properties. The intense bubble-generated solids mixing prevents the development of local hot spots as the fuel burns, because the heat is so quickly transferred to the inert particles and carried by them through the bed. All the heat is removed from the bed by the fluidising gas in hot gas generators and smaller steam-raising units. Such units have to be operated with high excess air ratios to maintain the heat balance. When the heat transfer surface is immersed within the bed, it is possible to take advantage of the very high heat fluxes obtainable compared with those of conventional radiant and convective heat transfer units, to reduce the size of a unit for a given duty. It is also possible, then, to optimise the excess air ratio. This is also true for units with an external heat transfer section immersed in a separate bed, such as with fast recycling beds. The overall environment for in-bed tubes is less severe than with conventional equipment, although tube corrosion and wear remain matters of some concern (Rademakers *et al*, 1984; Stringer and Minchener, 1984; and Swift *et al*, 1984).

The very high efficiency of heat removal when the heat transfer surface is directly immersed within the combustion bed has, however, required the development of operating techniques to counter this when it is undesirable, such as at start-up and in order to extend the turndown so that the bed can be operated to meet greatly reduced demands. In the former instance, the bed could never be raised to combustion temperature if it were bubbling vigorously and unregulated heat removal was permitted through the tubes. But, of course, this is not attempted. The achievement of a wide range of turndown is the more interesting aspect because of the range of options available to the designer. One option has been to sectionalise the bed and to defluidise parts, so that the effective volume of the bed and the immersed heat transfer surface area in use may be progressively reduced. A consequence of this is that there will be some local temperature excursion but successful operation is readily possible on this basis. However, it is essential to have dividing walls between bed compartments, otherwise sintering could occur at the interface between the static and fluidised beds. Another alternative or adjunct, as it can also be employed with slumping zones of the bed, is to vary the immersed heat transfer surface area by changing the bed level. In an atmospheric pressure



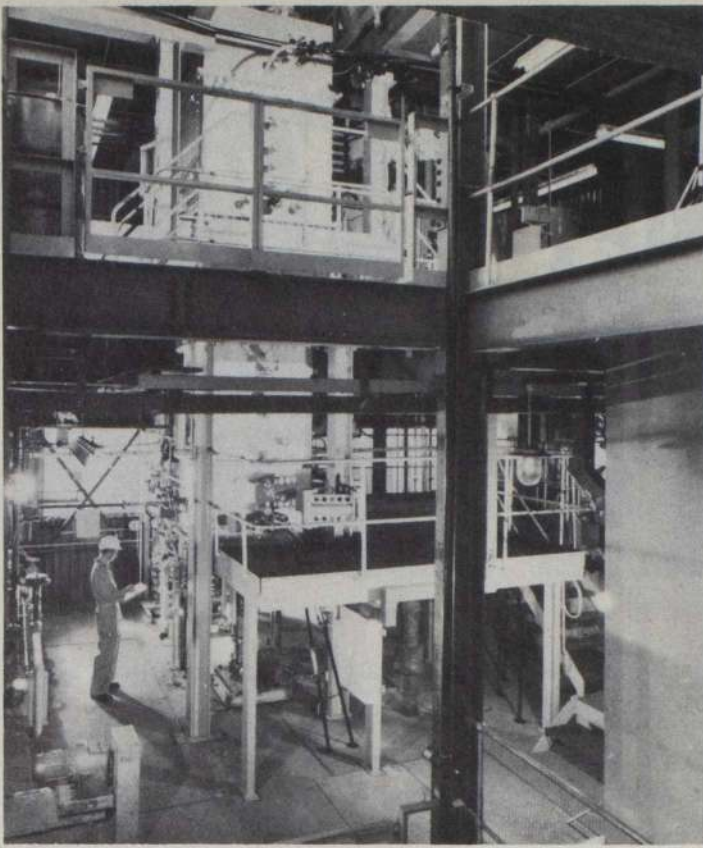


Fig 3 Fluidised bed test plant for burning low-grade fuels, CRE, Stoke Orchard

combustor, this can be done by varying the fluidising air flow rate so that the bed is operated in a more or less expanded condition according to the bubble hold-up within it. Then, as the expanded bed height is allowed to vary, the number of tubes exposed in the splash zone above the surface of the bed can be adjusted to match the heat output from the bed to the steam demand. A concern with the adoption of this mode of control is that there may be unacceptable rates of wear of the tubes thus exposed in the splash zone; there is also the need for careful selection of fluidising velocity, tube layout and materials for use in the splash zone but the mechanism of metal loss is different from that from in-bed tubes. With the latter it is mainly due to sliding abrasion whereas in the freeboard it is mostly erosion by particle impacts.

The designer needs to know the effective heat transfer coefficients to the tubes exposed in the splash zone. In a conventional atmospheric pressure combustor, coefficients decrease with increasing height above the expanded bed level and finally approach the value of the coefficient for forced gas convective heat transfer at the operating velocity. Temmink and Meulink (1983), for example, report an approximately linear decrease in bed-to-tube coefficient from a value of $330 \text{ W/m}^2 \text{ K}$ for an in-bed tube to $150 \text{ W/m}^2 \text{ K}$ for a tube at a height of 300 mm above the expanded bed surface, from pilot plant tests with a unit burning coal $< 25 \text{ mm}$; further discussion of the implications of this was given by Kortleven *et al* (1984).

Work at the NCB has been directed towards the development of a model which may be used in planning the disposition of the heat transfer surface, bearing in mind other interacting factors involved. Thus, in order to obtain optimum efficiency and boiler response over a wide range of fluidising velocities, it is desirable to minimise changes in bed temperature, excess air and static bed height. To achieve this, it would be desirable to be able to design the heat transfer surface so that the same proportion of heat is extracted from the bed at any given output. This would require the cooling surface profile to be matched to the degree of bed expansion, but Moodie and Vickers (1984) point out that there are limitations to

the degree to which this can be achieved in practice. This is because of limitations on the arrangement of cooling surface that can be installed. Thus, whilst it is possible to position tubes vertically above one another in steam boilers (for outputs up to $\sim 10 \text{ MW}$), it is much more difficult for larger units where water tube boilers are required and there is a limitation on the amount of tubes that can be installed because each tube in the bed has to be connected to one tube in the membrane wall and it is not readily possible to place the in-bed tubes vertically above one another. Consequently some variation in bed temperature has to be accepted. In the former instance bed temperature variation can be reduced to within a range 850 to 900°C but a range of 800 to 950°C would more likely have to be accepted with larger units. Another factor that has to be appreciated is the possibility of above bed burning of volatiles with shallow bed combustion burning high-volatile coals (Chakraborty and Vick 1984).

A substantial reduction in bed area can be achieved by operating at elevated pressure so that there is more combustion oxygen per unit volume of fluidising gas. The rate of heat release then is so great that it is necessary to have a very large area of immersed heat transfer surface within the bed. In these circumstances, adequate turndown cannot readily be achieved by the degree of expansion obtainable so the direct control of bed level and the transference of material to and from the bed has been proposed (eg Byam *et al*, 1981). The solids circulation may be impaired, however, if too much heat transfer surface is inserted within a given volume of bed and this may give rise to the establishment of significant temperature differences between the upper and lower bed region as in the early Exxon pilot plant tests (Nutkis, 1976). This condition in that experiment was alleviated by replacing a horizontally coiled heat transfer element by a vertical one. However, the upper bends suffered severe abrasion damage. With the larger Grimethorpe experiment, the vertical spacing between the original horizontal coils was increased at the price of working with a deeper bed in order to reduce the impedance presented to overall particle circulation (Wright and Steinbauer, 1984). At the desired higher solids circulation rates then obtained, the ensuing metal wastage from the lower tubes was excessive and longitudinal fins were added to the horizontal tubes to protect them (Swift *et al*, 1984).

In an earlier design of small package boiler operating at atmospheric pressure, control of local bed fluidity was the technique used to control the quantity of heat removed through the in-bed tubes (Virr, 1980). The tubes were packed in a tight triangular format immediately above separately fluidised panels. A turndown with very rapid response was obtainable from adjustment of the fluidising air flow to the panels as the in-bed tubes were responsible for up to 60% of the total boiler output. By allowing bed temperature to vary, turndown could be further extended.

One means of decoupling the factors controlling combustion efficiency and heat release is to separate combustion and heat transfer functions, so that the two aspects are effected independently. This was advocated in conjunction with a heat storage scheme as a means of reducing the required furnace size to meet peak electricity generation demands (Botterill and Elliott, 1984). At present the circulating fluidised bed is more favoured but this has other associated advantages and it will be referred to below.

Design considerations

Many options are open to the designer. The challenge, though, is to provide a more economic option than

peting technologies. The designer of the 'conventional' atmospheric and pressurised fluidised beds, though, has to deal with a unit which involves complex interacting factors. A great advantage of the circulating fluidised bed is the decoupling of the principal operating parameters. This is achieved by the separation of the combustion and heat transfer functions.

The size of a unit for a given duty is approximately determined by the amount of tubing and its arrangement. If the air supply rate is also fixed by the combustion requirements, the higher the fluidising gas velocity and combustion chamber pressure, the smaller will be the necessary cross-sectional area of the bed. A corresponding increase in height will be necessary but this is generally economic. The limitation on fluidising velocity is set by an acceptable rate of bed material loss by elutriation from the bed which, in turn, is dependent upon the mean particle size and the fines content of the bed material. Elutriation losses are aggravated if there is inadequate freeboard available above the bed and this poses problems in the adaptation of other boilers to fluidised bed operation. Although satisfactory modifications have been made, it is not clear, then, with the choice of design fluidising velocity and the choice of mean particle size. Atmospheric pressure circulating bed boilers are usually designed to operate with fluidising velocities in the range 0.9 m/s to 2.5 m/s and a suitable bed particle size for this is 1 mm. This can be achieved by feeding coal and sorbent with a maximum diameter of about 3 mm or by selectively removing ash above the bed. Efficient combustion can be carried out with an excess air supply in the range of 20 to 50% with bed depths of between 0.2 and 0.5 m. When, however, sulphur retention is of the highest priority, deeper beds of 1.0 m or more are necessary and there is a cost of the consequent increase in bed pressure drop from applying the fluidising air. Typical sulphur retention in atmospheric pressure beds is 60 to 80%, requiring an air/sulphur (A/S) ratio of between 2 and 4.

The loss of fines by elutriation from the bed obviously increases with an increase in the fluidising velocity. Consequently there is the need to make provision for their return in units operating at high superficial velocities, for otherwise there will be a reduction in combustion efficiency from the direct loss of carbon from the bed and sorbent capacity, because the limestone or dolomite sorbents possess a relatively high available free surface. Carbon loss tends to be higher thereafter with an increasing particle size than with a bituminous coal because of the well-known greater tendency of the former to decrepitate (Meroy *et al*, 1984).

In-bed tube corrosion should not be excessive if prudent design and operational policies are followed but erosion, as noted above, can be a matter for concern (Stringer and Minchener, 1984). Tubes should not be positioned where they may be subjected to bombardment by 'high-velocity' particles. This means particularly that they should be clear of injection points where jetting may occur. The danger is greatest as regards fines reinjection, the situation being aggravated in that there are far fewer recirculation ports in coal feed ports and a relatively high injection velocity is desirable to promote good mixing of the reinjected material. In their review, Stringer and Minchener refer to the apparent complexity of the processes occurring which lead to tube wear, and this is certainly an area where more work is required to enable the designer to have greater confidence in the precise disposition of the heat transfer surface to avoid areas of aggravated corrosion/erosion wastage.

Overall, apart from direct loss of combustible material from the bed by elutriation or through incomplete combustion of volatiles and carbon monoxide,

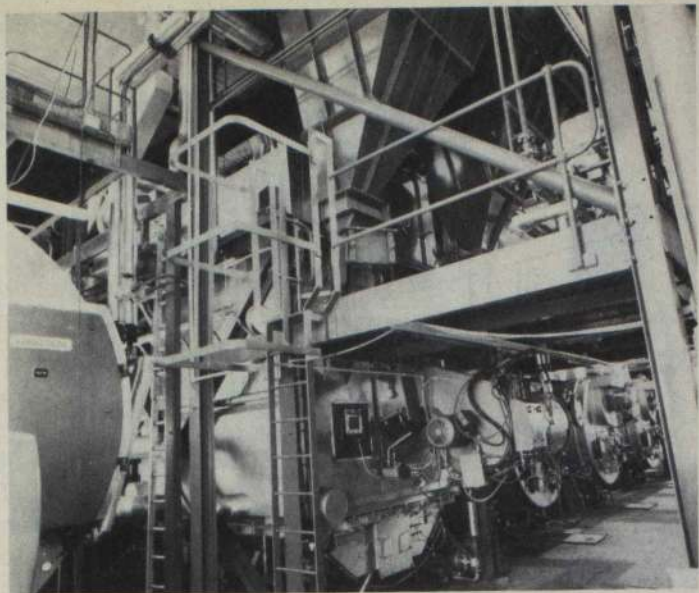


Fig 4 10 MW fluidised bed boiler at CIBA GEIGY, Cambridge (courtesy Babcock Power)

combustion efficiency depends upon bed temperature, local oxygen excess and the depth of the combustion bed. Gas and solids residence times are directly affected by the bubbling behaviour of the bed and the fluidised bed combustor is a reactor which will certainly need to be operated over a range of throughputs with consequent variation in overall bed behaviour. Thus there is the need to maintain a match between the fluidising gas flow rate and the fuel input rate and reference was made above to the desirability of so designing the disposition of the heat transfer surface that the in-bed surface for different outputs is consistent with the maintenance of the desired bed temperature for efficient combustion over the operating range (Moodie and Vickers, 1984).

Whilst offering an advantage in overall cycle efficiency for electrical power generation, the pressurised combustor does pose the challenge of more extreme operating conditions. A consequence of the combustor being more compact and operating with higher volumetric rates of heat release is that the local rate of fuel supply needs to be greater and high bed circulation rates are required in order to prevent the development of significant internal temperature gradients. Because of the high rate of fuel supply per unit area of bed, there is some danger of the production of reducing conditions close to the fuel feed points, which could lead to aggravated tube corrosion in that region and the higher bed circulation rates necessary to disperse the heat may lead to increased tube erosion (Swift *et al*, 1984). There is evidence, too, that SO₃ emission may be greater than from a conventional PF boiler (Burdett, 1984). Successful operation of a pressurised cycle requires the recovery of the pressure energy by expansion of the hot, high-pressure exhaust gases through a turbine. The corrosive potential of the SO₃ gases is then of importance, as is also the erosive potential of any entrained particulates. The possible methods for the removal of the latter have been reviewed by Rubow (1984) and Mukherjee *et al* (1984), but an adequate system still has to be proven.

The 'Gordian knot' of interacting operating parameters is successfully cut by the adoption of a circulating bed system. As noted earlier, this alternative turns the problem of solids elutriation into an advantage by deliberately arranging for there to be a high degree of solids entrainment and using the entrained particles as the vehicle to effect heat transport between the furnace (which may have a water tube lining) and the principal separate heat transfer section. Thus decoupling is achieved between the combustion and heat transfer functions. Advantage is

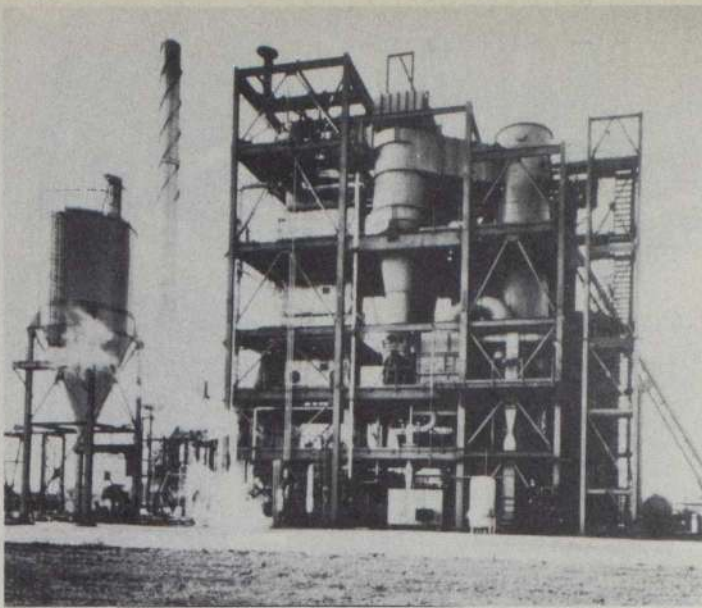


Fig 5 Multi-solids fluidised bed boiler, Kerry Co-op, Eire, (courtesy Foster Wheeler Power Products)

taken of the fines present in a natural size distribution or fine limestone is recirculated (Anders and Plass, 1984 and Kobro, 1984). Battelle advocate the use of additional dense, large (8-16 mm) particles in the bed to give greater thermal stability (Lyons *et al*, 1984). Because of the high gas velocities, bed mixing is intense and this alleviates possible problems of coal dispersion into the bed so that a single feed point only is required. By deliberately operating the dense combustion bed under fuel-rich conditions and completing the combustion in the zone of entrained solids above that region simply by injecting further air, low NO_x concentrations are achieved. SO_2 retention is achieved with less sorbent through the use of finer sorbent particles with their greater effective available surface. Bed temperature is now independent of load and the multi-fuel capability of the circulating bed is enhanced compared with ordinary bubbling fluidised beds by its greater capability to handle wide load variations while maintaining the desired combustion conditions. Kobro (1984) reports that erosion of the tube walls, an initial matter of concern, did not prove to be a problem over the duration of their trials and he suggested that this was probably because the tube surface was aligned parallel to the predominant flow and was cloaked by a generally downward and slowly moving flow of solids. Nevertheless, solids handling is an obvious key aspect of design in order to ensure controlled solids circulation and the avoidance of unacceptable rates of erosion in the duct work etc.

Conclusions

Highley (1985) reviewed the present European position and concluded that large coal-burning fluidised beds were competitive with conventional pulverised fuel systems without flue gas desulphurisation. Fast circulating beds offer operational advantages over ordinary bubbling beds but at the cost of some greater complexity. They are particularly attractive for burning low-grade and very varied fuels and when sorbent utilisation is an important economic factor.

The author has particularly concentrated in this paper on aspects of flexibility for handling dirty coals, load following and bed thermal properties and the general interactions between the operating parameters. There is much satisfaction to be obtained in gaining better insight into the, at times, apparently capricious behaviour of fluidised beds. Already, much design information is as good as that available in other areas of engineering but

people still ask for the i's to be dotted and the t's crossed. Nevertheless, solids handling remains a key area on which increased attention could properly be focused; introduction of the fuel and bed materials, disengagement of hot entrained solids from the gas stream, recirculation of the elutriated bed material, if necessary, and the factors governing the overall bed circulation with its implications for corrosion/erosion are all areas where more basic understanding is required so that the designer may more successfully cooperate with nature to take fuller advantage of the versatile technique of fluidised bed combustion.

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Although the author is entirely responsible for the content presented in this paper, he would acknowledge the stimulus of opportunities to collaborate with members of the National Coal Board in his work generally and is particularly indebted to J Highley for helpful discussions on broader issues involved in the application of fluidised bed combustion.

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Development is slower than anticipated, but...

more than two years since I wrote enthusiastically in *Newsletter*, these pages, about a new fuel preparing to enter the market place. What has happened in those two years?

I regret to say that it is only about half of what should have happened. Both the large plants for producing gasified WDF at Castle Bromwich and Huyton on Merseyside have, after considerable delays, been put into operation, but neither has reached its specified design capacity.

The process flowline is quite sound and the shortfall in capacity stems largely from materials handling problems. In particular the main trouble at Castle Bromwich comes from a fairly elementary design error. At the Merseyside plant, which was bought by Urban Waste Energy Power after the abolition of Merseyside County Council, is subject to litigation between the new owners Newell Dunford and is currently *sub judice*.

When visited recently the Castle Bromwich plant, which is now run by Birmingham City, was producing about 100 MW working two shifts, about two-thirds capacity. They are a prospective customer at Cadbury's Birmingham works where burning trials are currently being monitored at Warren Spring Laboratory. Birmingham City say that they have other, short-term supply contracts, but it is

understood that an appreciable part of their output is going into store.

WDF with bark

Merseyside County Council had Associated Heat Services signed up to take up all the output of the Huyton plant, but this agreement has been annulled and Merseyside Waste Derived Fuels are having to start their own marketing effort. They have found a customer in the form of the Shotton Paper Mill which burns bark to produce process steam in an 18.4 MW fluidised bed boiler made by Tampella Oy of Finland. The bark is a bit wetter than the 60% moisture content anticipated, and is not autothermic, so a proportion of WDF pellets is added to the bark and the boiler operates very satisfactorily. It is interesting to note that when burning bark alone the fluidised bed was prone to fuse if the temperature was allowed to rise above about 900°C. In early WDF burning trials bed fusion tended to be attributed to the glass particles in the pellets but it seems that there are many other factors at work. The bed temperature is even more critical at Shotton when WDF is being added to the bark but the fineness of the ash, sodium content, and possible high temperatures within the burning pellets, may well have more to do with it than glass.*

It will be appreciated that it has been difficult to get much feedback from users of WDF whilst they are still trying it out with official monitoring taking place.

(continued on p 8)

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□

Not an authorised fuel

The situation is complicated by the fact that, under the terms of the Clean Air Act, it is illegal to sell or burn WDF pellets in a smoke-controlled zone because it is not an 'authorised fuel'. They can, of course, be burned in all sorts of unsuitable appliances outside smoke-controlled zones.

The procedure that has been devised by the Department of the Environment is that the customer, or his boiler manufacturer, has to apply to the Local Authority for a temporary exemption under the Clean Air Act while trials are carried out. These are monitored by Warren Spring Laboratory (at a cost) and if they are satisfied the Department of the Environment issues a permanent exemption for that type of boiler burning that particular WDF. It is ironic that they are worrying only about particulates and smoke; but WDF is an easy fuel to combust without making smoke. The EHO and the Industrial Air Pollution Inspectorate worry about acidic gas discharges and there are no standards for heavy metal emissions. So it is hard to see why they do not just approve it as a fuel under the Clean Air Act; after all it has been burned for the best part of five years and we ought to know all about it, and let the operators comply with the law. It only needs civil servants to take a decision and answer for it — perhaps that is the problem! After all, more than £5.0 M, at today's prices, of the tax payers' money has gone into developing this fuel and it is extremely odd that it is basically illegal to burn it!

It is understood that no permanent exemptions have yet been issued though one is in the pipeline for Castle Bromwich's fluidised bed furnaces which supply hot gas to the dryer.

In the past year two more WDF pelleting plants have been announced: one is to be in the Isle of Wight, and the other will be at Hastings. Both plants are being designed by East Sussex Enterprises (owned by East Sussex County Council) and are based on both Buhler equipment and the existing pilot plant at Eastbourne which has been in production since 1979. The Isle of Wight plant is due to commission in January 1988, and Hastings about eight months later. It is not known what markets these two plants will be supplying.

Implications of the Energy Act

Looking at the wider energy from waste scene the implications of the Energy Act 1983 have been recognised and several schemes are currently under consideration for using wastes as a fuel for power generation. One large scheme, for which a proposal is currently being prepared, stems from a feasibility study initiated by the late Merseyside County Council and carried out by Foster Wheeler, with Merseyside County Council's assistance, and which was 50% funded by the Department of Energy. The requirement is for processing 1000 t/d of mixed wastes. The favoured method is to process these wastes in a similar fashion to that employed preparing refuse for burning in Blue Circle's cement-kiln at Westbury and

firing it in a Foster Wheeler multi-solid fluidised bed boiler to raise enough steam to generate 23 MW of electricity.

The first phase of the feasibility study indicated that this scheme could be an economical waste disposal option but final judgement must await the submission to Merseyside Waste Disposal Authority of a commercial package which is being put together by Urban Waste Power. The economics of electricity generation as a waste disposal method will depend on alternative cost of disposal in any particular situation and, as it is most likely to be (due to the high capital cost) that such schemes will be carried out by the private sector, they will charge a 'gate' fee. They must show a worthwhile saving to the Waste Disposal Authority over the alternative cost of disposal. The Merseyside situation is a stiff test for power generation because the alternative disposal cost is that of a cheap, bulk road transfer system to a landfill site some 15 miles away. If it is economic there it will be so almost anywhere where a transfer station is justified by the collection vehicles having to travel more than 10 or 15 miles to the landfill site.

Boilers with high turndown ratio

This all makes for an interesting exercise in efficient combustion, boiler and turbo-generator efficiency and an important one to extract the maximum amount of energy from a tonne of refuse for the least capital and operating cost. A prime objective is to be able to generate power when the electricity boards need it and pay a correspondingly higher tariff for it. This requires boilers with a high turndown ratio, which can be achieved by circulating fluidised bed boilers — such as those made by Foster Wheeler, Ahlstrom, Lurgi and Babcock. Another very interesting boiler is the Superburn revolving combustor which stems from a Power Gas patent (now held by Sterile Disposal Products) that has been developed under licence in Australia and Japan where no less than 29 plants of varying sizes up to 390 t/d have been built. I see this as a very interesting area of combustion technology as various designs of large fluidised bed boilers challenge the mass-burning incinerators as means of burning refuse.

The other important parameter is funding. Generating electricity in a power plant is not a suitable way of making quick profits, with a short pay-back period. It is essentially a long-term investment but, as such, should be able to show a handsome return on capital invested over a long period.

One of the great attractions of generating power from waste is that the market for the product is currently guaranteed by Act of Parliament; tariffs are subject to the level of energy prices, but they apply to waste marketing as well.

I expect to see some very interesting developments in this field over the next two or three years.

R G LORAM (Associate)

Leader, Energy from Waste Special Interest Group

South Wales and West of England branch

Thursday 18 June 1987

Annual lunchtime lecture

See Special Announcements, page 25

Luton international airport

David H White ARIBA MBIM*

Last year the Electricity Council launched a new award scheme aimed at the commercial sector — the Beta Award Scheme. Awards were presented, in two categories, for the greatest reduction in total energy costs, or the most cost effective improvement to a building's amenities and environment. Luton International Airport won the 1986 award for buildings of more than 1000m². Here we publish a case history of the work carried out at the airport which led to the award.

Luton Borough Council's Architects Department were responsible for managing a contract of some £11.1 M for the extension and remodelling of Luton International Airport. The major features of the development were the energy saving measures that were a part of its design and construction.

The project entailed the rebuilding of the departure lounge of the airport which at that time was in timber framed system building construction with extremely low energy efficiency. The development also involved the total remodelling of the original terminal completed in 1966 and again the department tried to incorporate energy saving measures although the steel framed structure gave little opportunity for additional weight to be added. The new departure lounge building which was the new extension to the rear of the existing terminal measures approximately 90m wide which is west facing and 40m deep. A ceiling height of some 6m was adopted in order to accommodate in certain sections two storeys of office accommodation could be incorporated. The fabric of the steel framed building was insulated with 200mm of expanded polystyrene thermal insulation to the roof giving a U value of 0.15 W/m²°C as compared with 0.6 W/m²°C, the building regulation standard at that time. A thermocavity fill was also provided to the external brickwork walls and 1m deep edge insulation to the ground floors. The glazing to the building is Pilkingtons ultra float bronze heat reflecting glass in double glazed units of 6mm sheets of glass and a cavity. A third pane of glass for sound insulation was also added which again added towards the thermal insulation of the building. The design criteria were, that the building would be in use 24 hours a day, 365 days a year with a maximum throughput of 1400 passengers per hour.

The maximum instantaneous heat gain was achieved in July and can be summarised as in Table 1 and illustrated by Fig 1.

Table 1

	Sensible heat	Latent heat
Occupants	217	130
Fabric	118	
Lighting	100	
Casual	10	10
	445 kW	140 kW
Heat loss at 21°C internal		
Fabric	109 kW	

In respect of the detailed designs in relation to the energy saving measures the loads show that the heat loss of the building was very much counteracted by the lighting gains

Luton Borough architect, Luton Borough Council

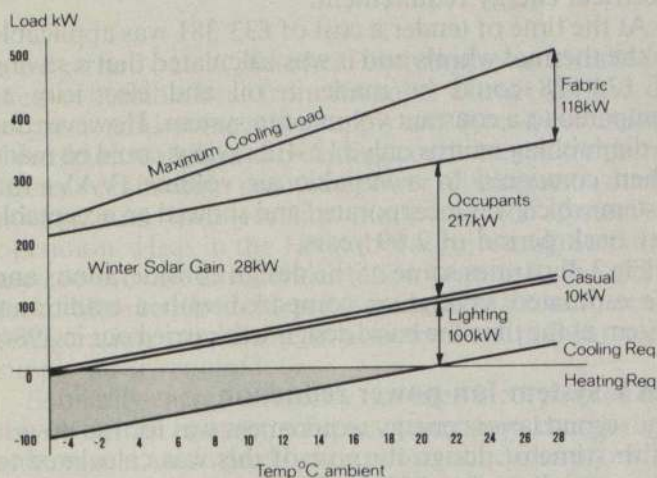


Fig 1: Total building load lines, sensible fabric only

and therefore only perimeter heating was required to offset the radiant cooling and the down draught effects in front of the glazing. Therefore it became a requirement for constant cooling in order to cater for the internal loads from both occupants and solar gains.

The perimeter heating which is in the form of a variable temperature water circuit is again depressed when the ambient air temperature rises and was installed to reduce running costs to a minimum. Water circulating pumps are isolated above 19°C ambient air temperature again in order to conserve pumping power. The annual perimeter heating energy uses 340 MW hours with an annual pumping power of 2.5 MW hours.

The supply air volume for the minimum fresh air requirement of the occupants equalled 40.5 m³/s which is 80% of the supply air quantity for the air conditioning.

The running cost for a conventional constant volume supply and extract system for air conditioning was estimated at £49 000 pa and a variable air volume system was chosen for the new design which reduces the estimated running costs. The conventional air conditioning systems vary the temperature of a constant volume air supply to counteract the building costs whereas a variable air volume system varies the volume of the constant temperature air in order to satisfy building requirement thus saving fan power although it is important that minimum fresh air requirements for occupants are maintained and terminal devices are used in order to prevent cold air 'dumping'.

Thermal-wheel heat exchangers

The large fresh air quantity required for the design occupancy of 2200 people provided the largest energy requirement for pre-conditioning. This could be reduced by recovering the energy in the exhaust air stream. Two 3.8 m diameter total heat wheels were installed in order to provide pre-heating or pre-cooling of the fresh air

supply. The wheels provided have an efficiency of 75% at 20 rpm. These are driven by variable speed dc motors and exchange both sensible and latent heat from the building extract air system to the fresh air supply or *vice-versa* dependent upon temperature differentials.

The installation of such wheels required an additional electrical energy input for motive power and the added air flow resistance from the wheels therefore increased the fan power requirements. However the dc motors' consumption was only 0.55 kW at maximum speed and needs to be compared with the fact that an additional depth of pre-conditioning coil would become necessary if no wheels were present. This would in fact re-introduce an airflow resistance factor. Therefore the wheels produced a proportionally very small and justified electrical energy requirement.

At the time of tender a cost of £33 381 was applicable to the thermal wheels and it was calculated that a saving of £36 628 could be made in oil and electricity as compared to a constant volume fan system. However due to diminishing returns only £12 412 savings could be made when compared to a variable air volume (VAV) fan system which was incorporated and showed an acceptable pay back period of 2.69 years.

Fig 2 illustrates some of the design considerations and the estimated savings as compared with a traditional system at the time the basic design was carried out in 1984.

VAV system fan power reduction

The second largest energy requirement was for fan power. At the time of design the cost of this was calculated to be as much as £46 720 pa for a constant volume air conditioning system handling 41 m³/s. 80% of this volume is fresh air necessary for the design occupancy. However for 19 of the 24 hour day occupancy fluctuates and is greatly dependent on the holiday seasons, the remaining five hours being periods of peak travel times whatever the time of year. Substantial electrical energy could therefore be saved by reducing the volume of supply air at times of low occupancy, due to the fact that fan power reductions are to a square law (ie a reduction by a factor of two in volume provides a reduction factor of four in fan power).

The constant internal cooling load varies in proportion to the occupancy and therefore a rise in the number of occupants produces a rise in temperature. Temperature controlled (VAV) terminal units were installed together with variable speed thyristor controlled dc fan motors to supply constant air temperature in varying quantities to suit the internal cooling loads. This saved energy in both fan power and pre-conditioning loads.

At the time of design the additional cost of VAV units over and above conventional diffusers plus inlet guide vane (IGV) volume control for the fans was estimated at £45 880. Fan power savings with IGV's was calculated at £20 330 pa giving a 2.26 years pay back. However by installing dc motors with thyristor converters at a further cost of £15 180 fan power costs could be reduced to £10 060 pa giving a payback period of 1.67 years.

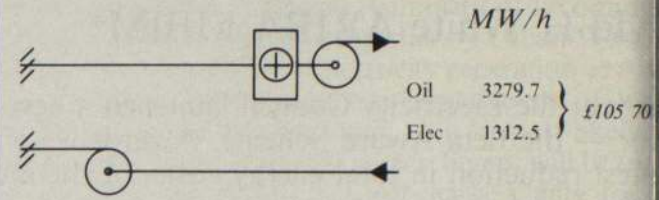
Double bundle chillers — heat recovery

It is well known that large quantities of heat are thrown away through the cooling tower water circuits of refrigeration machines. By suffering a 25% reduction in the COP (the efficiency of reciprocating machines in order to raise refrigerant condensing temperatures to a level where they can provide a sufficiently high heating water temperature) the heat can be recovered whenever the machines are running and re-used within the building.

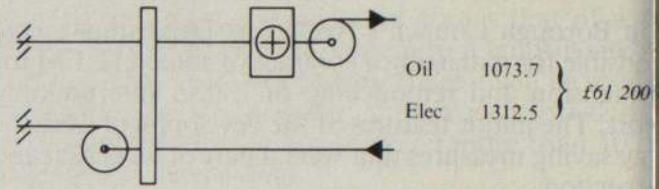
The additional cost of the second set of heating condensers is more than offset by the reduced size of the

Oil (35 sec) 17.74 pence per litre (20.1 per MW/h)
Electricity: day rate 3.54 per kW/h. £35.4 per MW/h
Electricity: night rate 1.76 per kW/h. £17.6 per MW/h

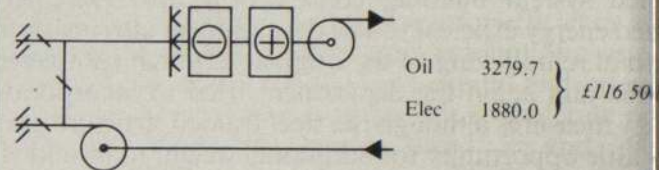
1 Constant volume (CV) (min fresh air) — heating on



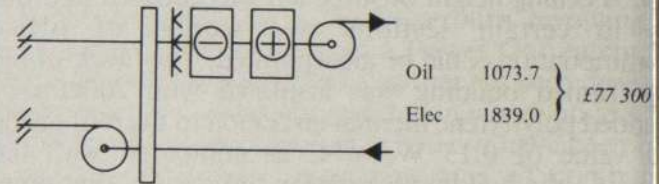
2 CV (min fresh air) — heating with thermal wheel



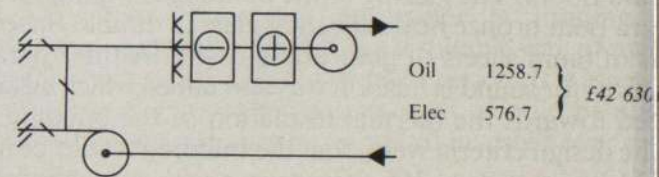
3 CV (recirculation) — heating and cooling



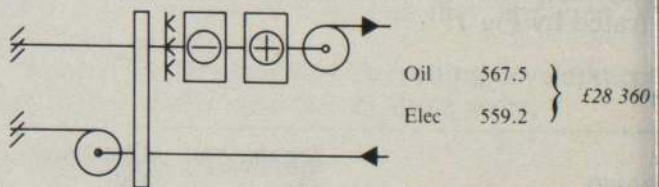
4 CV — heating and cooling with thermal wheel



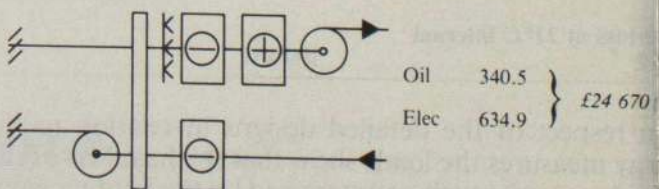
5 Variable air volume (recirc) — heating and cooling



6 VAV — heating and cooling with thermal wheel



7 VAV — heating and cooling with thermal wheel and double bundle plus heat reclaim coil



Note: All systems 24 h 365 d continuous

Fig 2: Annual energy usage and cost, February 1984

ing towers. The additional cost of the increased
ce areas required for the lower temperature heating
ents is more difficult to quantify. However at the time
esign it was estimated that 1044 MW hours pa of
imable energy was available, saving £30 100 pa in oil
ing costs. Again it is difficult to estimate if all this
could be used but the estimates for hot water (HWS)
irements indicated that £8050 could be saved during
pring, summer and autumn when the machines may
unning.

urther, by adding a heat reclaim coil in the exhaust
stream a false load could be induced into the chillers
ng the winter months between midnight and 7 am
n the cheap rate electrical tariff is available. Therefore
a COP of 3.28 in this heat recovery mode and the
ropriate night time tariffs an effective COP of 7.04
chieved equating to 0.442p per kW/h for electric
ing compared to 1.69p per kW/h for oil heating at
time of design.



on international airport

There are of course additional energy implications with
system which would reduce the overall effectiveness.
e air flow resistance of the heat reclaim coil will increase
power requirements. Chilled water circulation running
es will be extended, increasing the pumping power. The
roval of heat from the exhaust air stream reduces the
ility of the thermal wheels to preheat winter ambient
and this must now be preheated with a pre-heat coil
d with heating water produced by the heat reclaim
tem.

However at a cost of £6780 at the time of design, the
at reclaim coils showed a potential calculated saving
oil costs of £3190 pa at minimum VAV flow rate. This
tem was therefore considered a viable proposition with
added advantage of providing a back-up energy source
ould the oil fired boiler plant fail.

her energy saving features

sides the three major energy efficient systems described
viously other small scale but equally effective measures

Table 2

	Old building	New complex
Floor area	7 000m	9 810m ²
Cubic volume	28 033m ³	52 770m ³
Fuel costs (ie total running expenses for heating, lighting and power)	£	£
Oil	61 580	85 030
Electricity	68 250	116 840
Maintenance	37 760	59 710
	167 590	261 580
Corrected to 85/86 price base	215 460	261 580
Cost per m ²	£30.77	£26.67
Cost per m ³	£7.69	£4.96
(savings in costs per m ³)		£2.73 ie 36%

were carried out. A plate heat exchanger was installed to recover sensible heat from the toilet extract air in order to pre-condition the toilet supply air. Two-speed motors were fitted to chilled and heating condenser water pumps to ensure minimum pumping power requirements during normal and heat reclaim modes of the system of operation. Heat in the HV sub-station ventilation air is used to provide anti-condensation heating to the chiller room when required. Heat in ventilation air from catering refrigeration machinery is also used to preheat toilet supply air if required.

Similarly energy efficiency has been incorporated into the electrical lighting schemes using low energy light sources and automated lighting control besides providing environmentally and architecturally good design.

Results

The results appear to support the design conditions and show a 36% saving in energy running costs which are itemised in Table 2.

One must also bear in mind that the new buildings are fully air-conditioned whereas the old buildings relied on natural ventilation and some mechanical air extraction only. Even greater savings would be achieved if only phase II was considered.

Phase III of the development was the remodelling of the original terminal building which could not be developed in precisely the same way for energy saving measures due to the structural limitations of the steel frame. The opportunity was taken to improve insulation but there was no opportunity for large ducts to be provided for air movement.

In association with the Eastern Electricity Board a comprehensive monitoring exercise is currently being undertaken. Heat meters have been installed to the boiler water, heating condensers water and the chilled water circuits together with four Envirolog recorders in order to obtain a clear and concise picture of the energy distribution throughout the building.

The client, Luton International Airport, was more than satisfied with the savings being achieved and were delighted with the environmental conditions which have been provided.

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(in small-to-medium sized boilers)

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- Coal suppliers
- Members of academic institutions interested in, or involved in coal combustion



'Behind the Power' and 'Power to the People' are two of the most recent films from the Central Electricity Generating Board. 'Behind the Power' (27 minutes) illustrates the extensive research underpinning the Board's key activities. 'Power to the People' (24 minutes) includes extensive use of archive footage, and traces the fifty year development of the National Grid. Both titles are available in both Film and Video formats.

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Anglesey Marine Oil Terminal

1986, Shell UK announced that they intended to cease operations at their marine oil terminal which had been constructed in the 1970's.

The oil terminal located some 5 km offshore of the small fishing port of Amlwch on the north-west coast of the Isle of Anglesey is connected to a storage installation at Rhosgoch a few kilometres inland from the port. A pipeline runs underground some 132 km to Shell's refinery at Stanlow in Cheshire.

The terminal which normally employs 22 people is expected to close at the end of the year or early in 1988. Future imports of crude and feedstock to Stanlow will be made through the Tranmere terminal on the Mersey.

In a press release announcing the closure, Mr Peter Brown, manager of Shell UK's Stanlow Refinery said: 'As a result of the greatly reduced demand for oil products, the Stanlow refinery is processing significantly less crude oil than was planned when the terminal was built in the early 1970's. As a consequence the Anglesey facility is operating at only about 30% of its current capability. Despite strenuous efforts by Shell UK, the total cost of operating the terminal and the pipeline remain unacceptably high. Because of the low throughput the resultant very high port cost for each tonne of crude oil has given Stanlow a serious cost disadvantage compared to other UK refineries'.

The pipeline was designed to carry 25 Mt pa of crude oil. The throughput since the pipeline was commissioned has been in the range, 5-8 Mt pa. The fixed cost of operating the terminal and the pipeline was approximately £10 M pa.

The construction of the marine terminal at Amlwch and the pipeline from the terminal to the refinery at Stanlow commenced in 1973. The whole project which represented a major advance for the oil industry in the UK was commenced after the most extensive research, planning and legislation. In terms of the latter, the Anglesey Marine Terminal Act, 1972, was passed and

which allowed the Isle of Anglesey Borough Council to be established as the Terminal Authority. The Act further allowed the appointment of a committee, on which the majority of members were representative of the people of the island.

During the project construction time, a great deal of disruption occurred over the route employing as it did a considerable amount of civil and mechanical engineering in laying the pipeline.

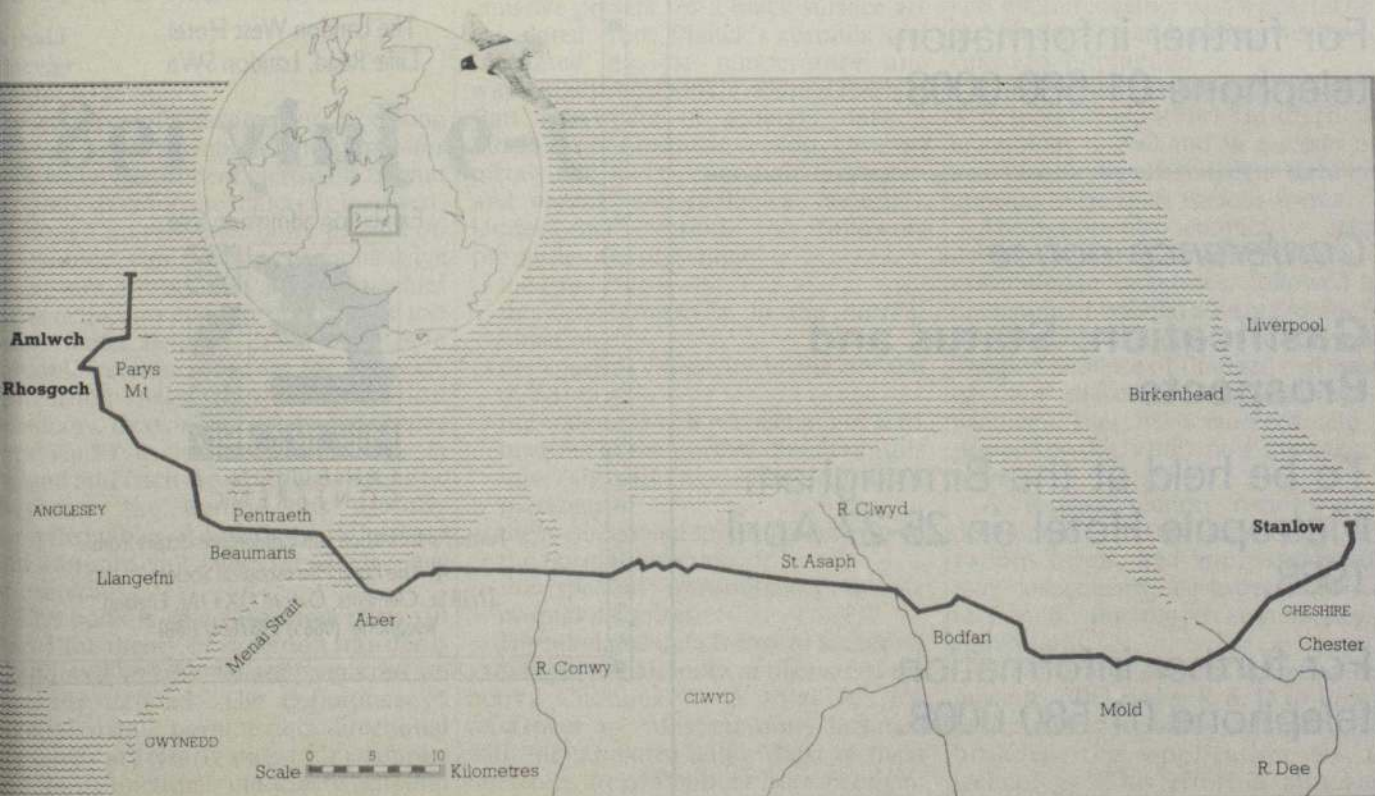
The single pipeline of some 90 cm diameter is a welded pipe covering the 127 km distance of the route and is laid below ground to a depth of about one metre. It was designed to provide a flow rate of 5000 m³ an hour.

Despite the fact that this pipeline had to be laid in the mountainous terrain of the Snowdonia Range and National Park, a great deal of attention was paid to the protection of the environment and the public's safety. Other major obstacles had to be overcome, such as crossing the Menai Straits and the rivers Conwy, Clwyd and Dee, as well as other high ground. Some 400 individual landowners and tenants had to be involved, and this involvement required easement payments along the route as well as compensation for loss of land usage during the construction period.

The terminal design included the installation of a single buoy mooring some 4.5 km distance from the shore. The buoy was 21 m in diameter and weighed 500 t. The main advantage of this type of buoy is that tankers are able to swing through 360° around the single point, thus being free to take up a position under the prevailing tide and weather conditions. The design of this particular buoy has allowed the discharge of oil cargoes from tankers of over 500 000 dwt.

The cargoes are pumped ashore through twin 1 m diameter submarine pipelines, the crude oil being received at a storage station of some 700 000 m³. The storage terminal was carefully designed, the 10 tanks positioned on the low-lying parts of the site, the overall landscaping

(continued on p 14)



The 127 km pipeline route that runs from Rhosgoch to Stanlow (By courtesy of Shell UK)

(Anglesey Marine Oil Terminal continued)

being completed by the planting of thousands of trees in the vicinity.

The Stanlow refinery has a capacity of 12 Mt per year. The need for building of the oil terminal at Anglesey came about because the mooring of the 'super' tankers was restricted by the small scale of the Mersey channel. With an 8 m rise and fall of the tide in the Mersey, tankers have to make a precisely timed passage to ensure adequate under-keel clearance.

The effect of the closure of this terminal just over a decade after its opening will have only a minimal effect of employment, but nevertheless was very regrettable. Built at a capital cost of some £65 M its closure by Shell UK has only been taken after a long and detailed investigation into the operating position. The company have not given any clear indication as to the future of the pipeline, although a number of discussions are taking place.

The future of many gasification schemes is looking brighter and this could be a possibility for some future scheme. British Coal at their Point of Ayr Colliery on the North Wales Coast are developing a liquefaction plant which if the development shows an economic viability, then some prospects may be possible for such a plant. Finally, given the correct chemical conditioning a water pipeline could perhaps be envisaged.

F John L Bindon (Member)

Conference notice

1st European Dry Fine Coal Conference

To be held at the Crown Hotel, Harrogate, Yorkshire on 23-25 June 1987.

For further information telephone 01-580 0008.

Conference notice

Gasification: Status and Prospects

To be held at the Birmingham Metropole Hotel on 25-27 April 1988.

For further information telephone 01-580 0008.

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MICROSCOPY FOR THE INDUSTRIAL AND BIOMEDICAL USER

Energy 2000

Guilmot et al
Cambridge University Press, 1986
51pp. £25.00

Energy 2000 is the product of research work on energy systems analysis and modelling under the first European Community Non-Nuclear Research and Development Programme in 1975. This led to the establishment of compatible energy models for the 10, at that time, member states of the Community, so that the links between energy and the rest of the economy could be investigated in a systematic way. This report of a study in 1983 of the energy outlook for the Community to the year 2000 provides detailed and consistent energy projections on a country basis using harmonised data.

Such an exercise is intended to provide a coherent perspective from which to frame long term energy objectives and policies, or to respond to changes in the external environment. It is of course vulnerable to error in the underlying assumptions for economic growth, availability of supplies and technical change. In the previous decade, the energy required to produce one unit of gross domestic product has declined by 10%, and with the development of the North Sea, oil imports have reduced from 100% to 30% of Community energy needs. Looking forward, the more

efficient use of energy is the most important factor, and uncertainties here far exceed those stemming from faster or slower rates of economic growth in the long term. Electricity should be the fastest growing energy carrier until the end of the century.

Energy related decisionmaking permeates all levels of the economy. National governments effect policy through taxes and subsidies, directives to nationalised industries and legal restrictions on the sale of fuel and exploration licences. Local government can decide on conservation, house insulation and heating and diversification of supply. Industry in addition can look for business opportunities in the broad trends and special situations, eg Greek lignite, and direct R & D into specific areas in conservation, coal use, pollution control and utilisation of electricity. This book, comprised largely of tables with statements of assumptions and explication, is very dry to read but can come alive when explored with a particular purpose in mind. The absence of a subject index is a defect in this respect.

Through its premises, the pragmatic projection of energy use over next two decades avoids the question where with depleting resources and mounting pollution we should be aiming in 2000.

Dr P J Foster

reproduces data which would otherwise be difficult to access or translate. All data are given in SI units.

The limited data on the emissivities of furnace ceramics and refractories in this compilation is disappointing particularly considering the recent interest in this area (Tucker and Docherty, *JInstE*, March 1986). This may simply reflect the difficulties inherent in measuring the emissivity of these materials. A subsection on some of the measurement techniques used to obtain this data, it is felt, would complement the book. It is also felt that the quality of the typescript, particularly of the mathematical formulae in Part I could be improved somewhat. These minor criticisms should not however overshadow the extremely valuable contribution this book makes to the subject of radiation transfer.

R J Tucker

Atmospheric fluidised bed boilers for industry

J F Thomas, R W Gregory, M Takayasu
IEA Coal Research, London, 1986
69pp. £20.00 member countries,
£60 non-members

The use of fluidised bed combustion (FBC) for industrial steam and hot water boilers has grown rapidly in recent years. Encouragement has been provided by apparent advantages such as the ability of fluidised bed systems to cope well with variable coal quality and other solid fuels (mixtures of various solid fuels and refuse), and the ability to reduce and control emission of oxides of nitrogen and sulphur together with a general image of modern coal-burning technology suited to automation.

This report provides a survey of how widely atmospheric fluidised bed technology is used and an assessment of how technically attractive the technology appears to be in its various forms.

The report also contains a detailed description of atmospheric fluidised bed boiler design categories, followed by a discussion of claimed advantages for FBC boilers and a summary of current usage. The performance of fluidised bed systems is then discussed, highlighting the problems that have emerged and the degree to which they now appear to be solved.

A further section reviews future development of the technology in its various forms, and improvements that may consequently be expected. A final section of the report summarises the conclusions.

Considerable effort is currently being put into FBC boiler R & D to improve performance, versatility, reliability and to broaden the application of this technology. This effort is also highly fragmented, being carried out by numerous companies and institutions

Radiant properties of materials — tables of radiant values for black body and real materials

A Sala
Elsevier
100pp. \$125

The accuracy of measurement, modelling or analysis of thermal radiation transfer is ultimately dependent on reliable radiant property data for the materials involved. Although no reference book of data on this subject can ever be comprehensive there are simply too many variables influencing too many properties for too many materials, this book must be a valuable reference source for anybody concerned with thermal radiation problems. Drawing on his own extensive experiences in infrared technology in Poland and from the worldwide scientific literature the author has usefully compiled tables of emissivity, reflectivity and transmissivity values for a wide range of materials.

The book is split into three parts. In Part I the theory of radiation transfer is introduced and the radiant properties are fully defined. The definitions of hemispherical, normal and directional emissivity are clearly stated for example, and the distinction is made between total and spectral properties. This is particularly useful for anybody new to

this field. A useful general chapter is also included describing the influence on these properties of temperature, state of oxidation, surface roughness, wavelength etc. In Part II, the spectral and total emissive powers for a black surface are calculated from Planck's formula and tabulated against temperature and wavelength. The book's *raison d'être* is in Part III where in property data is tabulated in three main sections covering metals and alloys, inorganic materials, and organic and biological materials. Under each section, the following properties are presented:

- the total emissivity.
- the total emissivity in the normal direction.
- the spectral emissivity in the normal direction.
- the emissivity at a wavelength of 0.65 microns in the normal direction (this has significance for optional pyrometry).
- the bi-directional spectral reflectivity in the normal direction.
- the spectral transmissivity in the normal direction.

The tabulated data is easy to access via a useful materials index at the rear of the book. Citations to a total of 160 references are conscientiously included with the tabulated data. Many of these references are of Polish or Russian origin. The book is particularly valuable to the western reader therefore since it

scattered over a large geographical area.

The authors conclude that no important breakthroughs are expected, but rather there will be incremental improvements. Optimisation of combustion, sulphur capture, NO_x control, turndown, bad following, fuel flexibility and other parameters are the focus of much R & D. Erosion and corrosion problems should also become infrequent compared with past experience. From the evidence in the report it seems quite likely that designs for FBC boilers which operate near the transition region between bubbling and circulating systems will be explored more thoroughly. Developers will have to combine the advantages of these two FBC systems. Also new design variations may further broaden the applicability of FBC systems for industry.

This is an excellent technical report which should be of considerable value to students and other individuals involved in fluidised bed combustion research and development.

Andrew W Cox

Monitoring for mine information and control

John Cope

IEA Coal Research, London, 1986

63pp. £15.00 member countries,
£30.00 non-members

This report provides a review of the recent literature relevant to the collection of data for the monitoring and control of coal mines. Emphasis is placed on data collection from underground mines although surface mines and coal preparation plants are also considered.

The report first identifies the need for monitoring (production monitoring and transport monitoring); the associated topics of transmission systems and data display and analysis are also covered.

Data have been collected manually from coal mines for more than 300 years. These data enabled simple records to be kept on production, supplies, wages and sales. Industrialisation caused an increased demand for coal, larger mines were developed, deeper seams were

worked and workings extended further than before. This growth, compounded by ignorance of both roof control and geological conditions, increased the hazards in the mine environment. Explosions, fires, floods and falls of ground caused heavy loss of life. The text systematically examines the areas of mine development and safety where new monitoring instruments have been introduced and the various design problems that were encountered.

The development of ear communication and transmission systems in the 1950s and 1960s is also discussed. These systems were expensive to install and could only pass a small number of continuous signals which in turn restricted the number of measuring instruments that could be operated. The author describes the development of the capacity of the communication channels which has permitted a rapid increase in the installation of measuring instruments. Mining engineers have recognised the potential of such systems and have

(continued on p 1)

Electric power — challenges and choices

A Wyatt

The Book Press, Toronto, 1986

286pp. £15.75 hardback,
£8.75 paperback

This book describes the world electric power industry with special emphasis on the North American scene — the British author now resides in Canada. It is well written, easy and pleasant to read with tables of data and information not available elsewhere.

The book starts from the correct premise that the electricity business, which has grown from its beginnings only a century ago, has an enormous impact on all of our life-styles but that, while it is taken for granted, few people know much about the industry.

The scope of the book is wide. It starts with Thomas Edison switching on the lights in Wall St, New York in 1882 for the first electrical distribution (although I always understood that the first public electricity supply was in Godalming in Surrey a year earlier). The situation at that time was that animal, machine and human power were the energy sources. Today, of course, at least in the developed world, human and animal power provide a negligible proportion of our energy. Electricity is available on tap and it is regarded as being as essential as air and water. Its use in the home everywhere has increased enormously since the Second World War. Of course, this extreme dependence on electricity brings problems when the supply fails due to weather, technical breakdown or industrial action. These are the only times (except perhaps for the controversy raised by proposals for nuclear power stations) that the electricity supply system and how it works is brought to the attention of the general public.

The price of electricity varies from place to place. In North America

industrial use of electricity is nearly six times as costly in New York as in Winnipeg. Because of its key role in industry electricity generation growth has to precede industrial growth to ensure that the power is available when it is required. The links between the economy and the electricity industry are close. High unemployment and a sluggish economy reduces capacity utilisation and hence utility profitability. There is a suggestion that countries with a high use of electricity (expressed per head) and growth in its use are those with greatest economic health and growth. Britain came out badly on these criteria. There is a reasonable amount of history in the book and an outline of many of the utilities and electricity systems in the industrial world (including USSR).

There are chapters on Energy Resources and Transport — including renewables; Load Forecasting and System Planning — here the special problems between the Canadian provinces particularly when these involve transmission across Quebec make interesting reading; Methods of Making Energy includes some interesting and reasonably up-to-date news on renewables. The speed of book production in Canada allows mention of the Chernobyl accident in the nuclear section.

There is a short and interesting section on the risks associated with the various forms of power generation, allowing for material and fuel, component fabrication and erection, transport and waste disposal emissions effects, etc. Natural gas electricity generation is safest, nuclear has three times the casualties of gas, hydroelectric 15 times, wind and solar 100 times and coal and oil 300 times. In the cost section figures are given for Ontario where conservation, small hydro and waste show slightly better returns per unit of power generated than large nuclear plant. Solar (photovoltaic) and wind are listed as being more than twice as

expensive as these.

The chapter on transmission covers route selection, direct and high voltage lines, underwater cables and even a section on possible health effects. A Canadian study indicates that there is no evidence for any medical or psychological effects from working close to high voltage lines.

The environmental chapter is rather less satisfactory than the rest of the book. There is no indication of how the various remedial measures measure up to the unspecified statutory requirements in various parts of the world.

The chapter on reliability emphasises the increasing importance of a safe supply of energy for hospitals, banks, computer systems, lifts in large buildings, etc.

The chapter on financing covers an area which is relatively unfamiliar to the British power engineer as it is written from the North American point of view. The utility ratings are of particular interest: the Canadian utilities except those on the Atlantic Coast rate well, the USA Consolidated and Southern California Edison rate well while Detroit Edison is a bit dodgy and Long Island Light is regarded as speculative. I wonder how the CEBG and the SSEB would come out of such an analysis. This is a long chapter covering an area which many engineers could find of considerable interest.

There are also chapters on the pricing, marketing and trading of electricity again they cover areas which do not normally receive much attention in Britain by engineers. The book concludes with descriptions of the history and present situation of many North American and European utilities. Some of this material is not readily available elsewhere and provides a most useful source of information.

Overall Mr Wyatt is to be congratulated on producing such a provocative and useful text.

N G Worley

Engineering Council Too much emphasis on IT

It was reported in *The Times* that the Government was considering a report from the Engineering Council which says that information technology is getting too big a slice of Government-funded financing.

Sir Francis Tombs, chairman of the Engineering Council, told Kenneth Baker, the Secretary of State for Education and Science that industry's worry is growing. Manufacturing companies fear that the Government's £3 M engineering and technology training scheme introduced in 1985 will fail to arrest Britain's decline in competition with Japanese companies. The council wants extra public money to be spent on more broadly based engineering courses, with a bias towards manufacturing systems. That would more closely reflect industry's needs, it says.

It points to a shortfall of 60% in the numbers of students which it is estimated industry needs if it is to stay competitive. The scheme, which provides 1700 first degree and postgraduate places in engineering, needs to double that number if it is to be effective, the council adds.

Dr Kenneth Miller, the council's director-general, said before the meeting that the present thinking did not envisage companies' putting money into a future scheme. The council did not want any increase in support for information technology; rather additional public money for other areas.

Source: *The Times*

Energy efficiency in West Up by 20%

Western industrial countries are using energy 20% more efficiently than they did in 1973, according to the Paris-based International Energy Agency (IEA), reports the *Financial Times*.

This has led to savings equivalent to 80 Mt of oil a year, although the trend has slowed because of the fall in real energy prices since 1982.

The agency, founded as a consumers' club after the four-fold increases in the oil price in 1973 to 1974, reached its conclusions on the basis of changing energy intensity — the amount of energy used to produce a unit of gross domestic product.

Its analysis of trends in leading Western countries between 1973 and 1985 shows the biggest improvement in energy intensity was in the industrial sector.

There were also significant improvements in the residential, commercial and transport sectors but little changed in the efficiency of electricity generation.

Rising energy prices and long-standing trends towards higher productivity were the driving force in bringing about

improvements, though they were supplemented by government policies and programmes to promote conservation.

The study concludes that energy efficiency could be raised by 30% if economically viable conservation methods were fully implemented by the year 2000. Efficiency could be raised most in the buildings sector, but there were also big opportunities in industry and transport.

Energy Conservation in IEA Countries, OECD Publications, 2 rue Andre-Pascal, 75775 Paris, or HMSO.

Source: *Financial Times*

Coal to oil UK and Germany cooperate

British Coal have signed a collaboration agreement which will enable the German mining company Ruhrkohle of Essen, West Germany to participate in British Coal's £36 M coal liquefaction project at Point of Ayr, Clwyd, North Wales.

The plant aims to establish the technical viability of the process and will be capable of converting 2.5 t of coal a day into petrol, diesel and aviation fuels. The project is already receiving financial support from the European Economic Community and the agreement with Ruhrkohle, which is one of the major European hard coal mining and energy companies, reinforces the European nature of the project.

Ruhrkohle will have the right to increase their participation in the future and to license technology when it becomes commercially viable. At the outset, their funding is 5% of total project costs.

As a result of this inclusion of an independent partner, the Department of Energy have confirmed that they will be supporting the project with funds amounting to about £3M in total.

Source: *British Coal*

Battery power US zooms ahead

A battery able to drive an electric van three times the distance possible with the best conventional lead acid battery of the same weight has been developed at the Argonne National Laboratory in the US, reports the *Financial Times*.

The laboratory has shown that 200 miles of non-stop city driving is possible without recharging. The tests were carried out in a General Motors Griffon van carrying a load of 900 lb.

The battery uses lithium and iron sulphide (Li-FeS), but has to be operated at 460°C. It is encased in high-efficiency vacuum insulation so that the heat it generates during discharge is not lost and

the temperature is maintained. The charge time for the van battery is about eight hours.

The Li-FeS battery concept is one of a number that have been suggested over the last decade or so. Others, like sodium sulphur and zinc bromine can yield very high power to weight ratios but have proved difficult to engineer into safe, cost effective units for vehicles.

According to the Electric Power Research Institute in the US, any battery giving a 100 mile range would allow the conversion to battery power of 3M to 4M petrol-powered vans in commercial service in America.

Source: *Financial Times*

Technology A new R & D trust

A new non-profit making company, to be known as the Technology Enterprise Trust, has been set up as an enterprise agency. Its aim is to promote the formation of new technologically based ventures in Manchester and the North West incorporating ideas, concepts and inventions emanating from universities, polytechnics, colleges of higher education, and research associations (collectively called Higher Education Institutions or HEIs).

Prior to the formation of the new businesses, the trust will promote R&D especially joint R&D between HEIs and industry. It will match funds from industry. Having achieved a situation where an invention has a practical use it will go out and market it by licensing the technology or setting up a joint venture.

Although based in Manchester the trust is not affiliated to any one Higher Education Institution and projects will be expected from a number of HEIs within the first 12 months.

Technology Enterprise Trust is already investigating more than a dozen ideas with the University of Manchester Institute of Science and Technology with whom it will have very close liaison.

The trust will operate by: arranging and managing the funding of applied research projects from HEIs; advising academics on the optimum resources to commercial exploitation of their inventions; assist in the promotion and marketing of academic resources from the HEI to the outside world; help to raise capital for prototypes.

Industrial companies liaising with the trust will gain the following benefits:

- Access to ideas coming out of HEI departments.
 - A close liaison with the HEI departments.
 - A knowledge of developments within academia, and those who are graduating in their disciplines.
- HEI's liaising with TET will gain the following benefits:

- An additional manpower resource complementary to their own industrial liaison facilities.
- Assistance in seeking ideas.
- A greater awareness in each department of the possibility of commercialising inventions.

'The founders of TET include leading figures in the financial, legal and marketing fields. It is this high level of professionalism and its total independence which will ensure that maximum potential is made of ideas and funding' said Robin Skelton, chairman.
Source: Burgess Daring Public Relations

Cavity insulation New association

The Cavity Reinforcement Urethane Foam Society (CRUFS) has recently been launched to govern the quality of materials, working practices and guarantees offered by its seven member companies nationwide.

CRUFS is an independent society that was set up to provide advice and information on a specially formulated urethane foam. The foam binds inner and outer wall sections together, in the case of cavity wall tie failure.

This British Board of Agrément (BBA) approved system offers a number of advantages over conventional remedies including a reduction in refurbishment time and virtually no inconvenience to the occupier. In addition, it is claimed, the system reduces heat loss from outside walls to less than 0.4 W/m²/K in most cases.

Source: CRUFS

Furnace ceramics new insulation development

A new development* has introduced savings in the manufacture of insulation for tube furnaces; and, it is claimed, these savings become significantly larger as the size of the furnace increases.

This new insulation development involved the precision moulding of concentric tubes of ceramic fibre. These incorporate at their ends highly exact mouldings which enable adjacent tubes to be interlocked. This moulding is so precise that heat leak paths are eliminated.

A number of features contribute to the significance of this new development in moulding technology. First, because the ceramic fibre materials are both light and inherently strong, size is virtually unlimited: by interlocking a number of tubes into a modular assembly, ratios greatly in excess of 6:1 (length: diameter) may be achieved, easily and economically. Furthermore, the strength and weight of the mouldings also means that they are self supporting. They are fast to produce, and significant production economies may be realised.

In addition to the stepped, interlocking tubes, versions are also produced plain at

one end. The tube furnace manufacturer therefore has access to a source of effective, efficient and low-cost insulation material to meet each precise requirement in terms of cost, thermal efficiency and size.

Source: Ceramic Fibreforms

World Bank loans for... ...hydropower in China

The People's Republic of China's hydropower potential is among the largest in the world, but only about 4% of it has been developed. A \$140 M World Bank loan will help the country tap into this energy source.

The loan for the Shuikou Hydroelectric Project will assist China in alleviating its acute shortage of energy and peaking capacity in the East China Grid (ECG), which now has a predominantly thermal capacity. It will also meet the growing energy requirements of Fujian Province. China is already the fifth largest producer of electricity in the world, 30% hydro, the rest thermal.

The area to be served by the project includes the provinces of Fujian, Zhejiang, Jiangsu and Anhui, and the Shanghai Municipality.

The project will help to develop a major hydro site to serve primarily as a peaking station for the ECG; to introduce modern technology for speedy construction of a large 101m high concrete gravity dam, power station spillway, and navigation lock; and to provide training for management in the Fujian Provincial Electric Power Bureau, a state-owned enterprise.

In addition, there is an environmental aspect to the project; it involves resettlement of 63 000 people in the reservoir area and includes a programme to identify substitute land and a diversified agricultural package designed to help reconstruct their production systems and social communities.

To be completed in 1995, the project will cost a total of \$1 087.8 M, with much of the financing coming from local bank and foreign exchange loans.

Source: World Bank News

...Indian oil sector

The World Bank has approved a \$140 M loan to assist India in its effort to decrease reliance on imported oil and to accelerate development of indigenous oil and gas resources.

Two public sector companies currently undertake petroleum exploration and production activities in the country. The smaller of the two, Oil India Limited (OIL), is the project recipient.

Specifically, the project comprises: the application of production improvement schemes; implementation of a gas reinjection scheme and associated gas supply network in the partially depleted Assam oil fields; exploration in OIL's new (and gas-prone) exploration area in Rajasthan and for deep gas in the

Kumchai area of the State of Arunachal Pradesh, involving acquisition and interpretation of high seismic data and drilling of about 10 exploratory wells, strengthening OIL's technical and institutional capabilities through technical assistance, training and the purchase of equipment for research and development.

Concerned about the adverse impact of energy shortages on economic growth, the Government of India has nearly doubled the energy sector's share of public investments in little more than a decade. And, at the same time, the country has been able to reduce its reliance on imported oil from 66% to about 25%.

The project will cost about \$584 M overall, with OIL providing \$384 million and cofinancing providing \$60 M. The project is expected to be completed in 1994.

Source: World Bank News

...energy conservation in Yugoslavia

Small and medium sized industries, principally in Yugoslavia's Republic of Slovenia, will benefit from a \$90 M World Bank loan to the Ljubljanska Banka, Ljubljana (LBL), the country's third largest bank. The loan is for an energy conservation and substitution project.

The project, which consists of a line of credit to LBL to finance energy substitution projects, aims at promoting energy efficiency by reducing consumption through conservation and by reducing the cost of energy consumed through the substitution of lower-cost energy sources. The project is expected to improve industrial competitiveness and reduce energy imports, alleviating some of the country's current balance-of-payment difficulties. In addition, the project will support development of technical capabilities for energy audit work and strengthen the financial and institutional capability of LBL.

The technical assistance component of the loan, \$600 000 will cover the foreign exchange costs of consultancy services, equipment and training abroad for technical and financial personnel.

Source: World Bank News

Energy efficiency New London centre

Residents of Islington, London have been given direct access to expert help and advice on heating and energy.

The Energy Centre offers a range of services (all free of charge) to individuals, tenants associations and local businesses. Using the latest computer software packages staff carry out domestic energy audits involving thorough surveys of complete estates, with analyses of energy wastage and suggested solutions. Similar

*Ceramic Fibreforms

programmes already completed have cost ratepayers over £200 000.

Training seminars for council staff and outside organisations such as pensioners' groups may be arranged at the centre or the group's base. Visitors will have access to a wide range of printed information and staff will always be on hand to give advice on heating benefits, grants, insulation and other matters.

Government offices such as the Energy Efficiency Office and utilities boards have worked in close cooperation with the council in helping to launch the centre and have assisted with funding.

Source: *Islington Borough Council*

Australia Heat from the earth

Heat from the earth's surface is being used to generate cheap electricity for remote settlements in an experimental power plant developed in central Australia.

The system is running off the thermal heat of an artesian bore to supply power for Mulka Station, a remote farming property in South Australia. It is also generating electricity from the heat trapped in a salt-filled solar pond.

At the heart of the plant is a patented Organic Rankine cycle (ORC) engine

developed by Australian Solar Ponds in Alice Springs. Likened to a 'refrigerator in reverse', the engine can run off any low grade heat above 80°C.

The company is scaling up the engine for installation in a \$750 000 government funded project at Birdsville in rural Queensland. Within two years the Queensland Electricity Commission expects to be generating 180 kW from the heat of a 99°C bore.

'This outback energy project could offer long-term economic benefits to countries on the earth's volcanic belt,' company director Mr David Frederiksen said. 'The system could be adapted to many Asian and Pacific conditions by burying the heat exchanger in hot volcanic ground. In Vanuatu, for example, there are places where one metre of earth varies in temperature by 100°C'.

The ORC engine converts heat into electricity by running hot brine or water through a heat exchanger which is full of freon. The freon boils and the high pressure gas that comes off drives a screw expander at 4000 rpm. This in turn drives an alternator.

Mr Frederiksen said the engine had run continuously at Mulka Station for seven months without a hitch.

Plans were also on the drawing board for a solar pond at Curtin Springs tourist development near Uluru, formerly Ayers Rock. This would be 10 times larger than

the Alice Springs pond and would represent a national effort involving \$2 M in government funds.

Source: *Australian Information Service*

Boiler maker... ...in management buy out

Beeston Boilers a long established commercial and industrial boiler manufacturer has been bought by its existing managers. The whole of the issued share capital of the company has been acquired by the managing director John Wells and six of his colleagues: giving them a controlling interest.

Arrangements are being finalised to resource casting supplies from foundries which manufacture boiler sections and provide the quality and delivery service which Beeston require. John Wells said 'There are adequate stocks of castings to meet customers requirements during the changeover. The fact that the company is being run by people with a financial interest gives us an added incentive to ensure high levels of product quality and customer service. We intend to continue with our product development programme and we aim to gain certification under BS 5750. The company will continue to operate from its existing premises'.

Source: *Beeston Boilers*

Books continued from p 16)

developed them for purposes other than safety. Transmission systems and technology have also been developed to cater for these additional demands. Surface equipment has been expanded and developed to collect, record, analyse and print out selected data from this data traffic. The author's central conclusion is that while equipment is sufficiently developed to meet many of the needs of monitoring, further development is needed in the collation, organisation and presentation of data for presentation so that a suitable management information service can be achieved.

This short report with its 283 references should act as an excellent introduction to the subject for students and individuals both inside and outside the coal industry. I am sure IEA Coal Research will publish further material on mine monitoring and control as the technology develops in years to come.

Andrew W Cox

Oil economists' handbook

Robert Jenkins
Elsevier Applied Science Publishers,
London, 1986
45pp. £95

The Oil Economists' Handbook grew out of British Petroleum's Statistical Review of the World Oil Industry, the first edition being published in 1977.

This fourth edition is considerably enlarged. It contains 266 tables compared with 180 in the third edition. There are 96

completely new tables and one-third of those in the previous edition have been revised and updated. The tables section covers a wide range of subjects, these being: crude oil prices; oil product prices; oil future prices; UK industrial energy prices; exchange rates; international oil trade; energy production; energy and oil products consumption; renewable resources; economic and demographic data; seasonal ratios of oil consumption and supply; climatic data; refining statistics; OPEC statistics; petrochemical data; energy reserves; shipping, pipelines and storage; and oil quality data and conversion factors.

The chronology section is composed of events, technical and commercial, which have had a significant impact on the oil and energy business. It provided a quick history and may be found useful for understanding discontinuities in the time series in the statistical section.

The book contains an excellent glossary and a thorough list of addresses of organisations that compile and supply energy and oil statistics.

This handbook, like the earlier editions, will undoubtedly be a standard text in reference libraries and should be of considerable value to researchers and individuals involved in the oil industry and energy forecasting.

Andrew W Cox

Publications received and noted

Technology for water supply and

sanitation in developing countries

World Health Organisation, Geneva, 1987

Nuclear energy and the nuclear industry A guide to selected literature and sources of information

British Library, Science Reference and Information Service

International Building services abstracts

Building Services Research and Information Association. Published bi-monthly.

The energy efficient home: a builder's guide

The Electricity Council, 1986

Energy managers' Lighting handbook

Lighting Industry Federation, 1986

World oil: coping with the dangers of success

Christopher Flavin
Worldwatch Institute, 1985
66p. \$4.00

The Worldwatch series has introduced a number of energy-related topics to the interested layman over the past few years and this paper continues their examination of important issues. Although written in early 1985 the author has quite correctly anticipated a fall in oil prices to well below \$20/b from the \$27 then experienced. At \$4 (or equivalent) this booklet represents good value.

Bag filter installation

Peabody Sturtevant recently completed a contract to design, manufacture and construct a bag filter installation for a recently converted fluidised bed coal-fired steam boiler at the Organics Division of Imperial Chemical Industries. Flue gases from the boiler can surge up a maximum of 1600 kg/h of fly-ash and, in this particular application, the filter specification called for an outlet dust burden not exceeding 75 mg/m³; equivalent to a collection efficiency in excess of 99%. In practice, however, the filter is achieving a much lower outlet emission.

The filter is designed for continuous automatic operation over long periods. In operation, flue gases enter the filter through a distribution plenum and are distributed to the RYTON tubular needle felt filter bags. Fly-ash collects on the outer surfaces of the bags and is dislodged at intervals by a pulse of compressed air injected in sequence into each row of bags. The resultant dust cake falls directly to hoppers beneath the plant and is discharged continuously through rotary valves and a screw conveyor.

Reader enquiry no 5/1

Extension of Senior Green's product range

Senior Engineering (Thermal) have now acquired Wallsend Boilers of Tyne and Wear. The Wallsend Maxecon range of quality boilers will significantly extend the top of Senior Green's existing range, which already includes an extensive number of coal-, oil- and gas-fired types and the names of G.W.B., Cradley and Spanner (acquired 1986). Senior Green will now be able to offer waste heat recovery boilers, water-tube or shell, small to large sized coal, oil, gas, fluidised-bed and waste-fired boilers, both water-tube and shell, electric steam raising and hot water boilers together with ancillary equipment and fabrication work including sectional tanks and economisers.

Reader enquiry no 5/2

Beeston's new package for cast iron boilers

Beeston Boilers have launched a new guarantee package for all their ranges of cast iron sectional boilers. Under the *Cast iron deal* Beeston-trained personnel assemble the boiler kit onto the prepared site, commission the boiler and gas or oil burner, and check the operation of all components. Provided the boiler is used within its design parameters and is correctly operated, Beeston guarantee all parts and labour for 12 months. After that the company strongly recommend that a maintenance contract is taken out with a recognised contractor.

Reader enquiry no 5/3

Three new diesel engine ranges

Three new ranges of industrial diesel engines — the 500, 1000 and 2000 Series — have been launched by **Perkins Engines**. Developed specifically for industrial and

construction applications, the new ranges comprise engines in a power band stretching from 28 kW (37 bhp) to 298 kW (400 bhp). They result from research programmes run separately but in parallel.

The three ranges, which include four and six cylinder units, naturally aspirated, turbocharged and aftercooled are aimed specifically at the needs of industrial and construction customers. The two litre four cylinder *500 Series* naturally aspirated engine, designed for the compact industrial market and equipment such as skid steer loaders, forklift trucks and mini-excavators, offers between 28 and 37 kW (37 and 50 bhp).

The *1000 Series* is a family of four and six cylinder, naturally aspirated, turbocharged and after-cooled engines. Aimed at equipment such as forklift trucks, compressors and backhoe loaders, the 1000 Series offers a power band from 45 kW (60 bhp) up to 130 kW (175 bhp).

The *2000 Series* — the most powerful of the new engine ranges — covers the 201 kW (270 bhp) to 298 kW (400 bhp) segment of the market. The series is also suited to applications in compressors, pumps and power packs for process plant as well as specialist mobile construction equipment.

Reader enquiry no 5/4

Agrément certificate for SC Ceramic chimney

Selkirk have been awarded an Agrément Certificate No 86/1710 for their SC stainless steel chimney with ceramic liner. Launched nearly two years ago, the Selkirk SC Ceramic was the first prefabricated metal chimney to have a true ceramic liner. The chimney was designed to be particularly resistant to damage from solid fuel or wood derived flue deposits and shows exceptional resistance to fire hazards, even at temperatures up to 1200°C.

The British Board of Agrément MOAT 4 compulsorily tests a range of primary performance criteria and at Selkirk's request included additional stringent tests on acid attack and porosity not yet applied to other chimneys tested under the British Board of Agrément Certification.

Reader enquiry no 5/5

New digital micromanometer

Air-Neotronics have announced an important breakthrough in velocity and pressure measurement. Replacing the old-fashioned and cumbersome liquid-in-glass test manometers is a compact and innovative instrument to be known as the MP Series 4 auto zeroing range. At the heart of the MP Series 4 is a special pressure sensor already field proven and providing good service in over 4000 instruments.

Among the new features, is the now improved direct velocity readout with an auto zeroing circuit added. An auto density correction programme ensures a true velocity display automatically adjusting for whatever temperature and barometric conditions prevail.

The additional functions are made possible by a new built-in electropneumatic auto zeroing valve



MP Series 4 Model MP6KS pressure and velocity, 8 range micromanometer

and timer together with a 'dial in' density selector and programmer. Operations are sequenced and controlled by the instrument's laser cut surface mount circuitry, which also performs the square rooting function necessary for velocity measurement. High accuracy, fine resolution measurements are made possible with the Air-Neotronics patented type 1172 differential capacitor transducer.

Reader enquiry no 5/6

New electronics unit

A new electronics unit for use with the zirconia oxygen probe type Z-GP2 has been introduced by **Kent Industrial Measurements**. Based on the Kent System 19 method of construction, and using standard System 19 modules, the unit is housed in a robust two-tone grey, moulded ABS enclosure which is weatherproof to IP 65 and has a transparent hinged cover. The case body can be hinged forward from the backplate allowing easy access to the rack wiring and terminations.

The Z-SN accepts inputs from the A-GP2 zirconia oxygen probe cell and thermocouple. These inputs are computed to produce an isolated DC current output, representative of the measured oxygen concentration, suitable for the operation of remote recording/alarm/control instrumentation.

It is claimed that the unit has a wide range of applications including: re-heat furnaces; sintering of metals; annealing furnace atmosphere monitoring; combustion measure-

ment and control in soaking pits. Multichannel applications can be catered for by mounting the required quantity of modules and related power supplies into a standard 19 in. rack system.

Reader enquiry no 5/7

Range of monitors

S.E.S., the Energy Conservation associate of Monarflex (UK), have recently developed a comprehensive range of monitors to analyse the flue gas of boilers, kilns, ovens etc, with a view to operating such plant at the highest levels of efficiency which are reasonably possible.

Of particular interest is the ability to send the information via a built-in output board to a building or energy management system. In most cases it is possible to operate the plant without permanent manual supervision.

Reader enquiry no 5/8

Trade publications

Electric heating elements (sheathed)/electric heating for metal finishing solutions. The use of sheathed electric heating elements can lead to benefits which are not obtainable with other techniques and consequently they are used in industry for heating an extensive range of liquids. The Teaching Information Note produced by the **Electricity Council, Electric heating elements (sheathed)**, deals with their design and application. Additionally, the Note contains information on conductive and convective heat transfer, and, it is suggested, would perhaps be suitable for use with the previously issued Teaching Information Note on unsheathed heating elements. Further applicational details are contained in the Technical Information Sheet *Electric heating for metal finishing solutions.*

Reader enquiry no 5/9

Natural circulation boilers

Examples illustrating the wide field of application of the **Sulzer** natural circulation boiler range for liquid, gaseous and solid fuels are given in the new 14-page brochure put out by Sulzer, Boilers and Nuclear Engineering Division. In addition, this brochure, available in English, French or German, provides information about Sulzer know-how in the development, design, engineering and construction of such installations.

Reader enquiry no 5/10

ENERGY WORLD — COMMERCIAL

(Photocopy acceptable)

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

5/1 5/2 5/3 5/4 5/5 5/6 5/7 5/8 5/9 5/10

Name

Address

Organisation

Institute of Energy 1987 June meetings

South Wales and West of England

June (Th). Annual lunchtime lecture. Speaker: Dr R J Cohen (Jodrell Bank, University of Manchester). CRE, Stoke Orchard at 12 noon. See *Special Announcements*, p 25.

National

10-25 June (Tu-Th). First European Dry
mine coal conference. Harrogate,
Yorkshire.

Council

Meeting of Council was held at 18
Devonshire Street on Thursday 26
February 1987.

Election of vice-president

The president's nomination of *Prof B J
Prinkworth* as a vice-president to take
office from the conclusion of the AGM
to be held in May 1987 was approved.

The president, *Prof J Swithenbank*,
mentioned that a number of members of
Council present were attending their last
formal meeting before leaving office at
the conclusion of the AGM. *C R
Coleman*, *B Lubert* and *W Tipler* were
thanked for their contribution as were *Dr
G Thurlow* and *Dr W A Simmonds*. *Dr
Thurlow*, who had been an *ex officio*
member of Council as a past president,
was thanked for his service as chairman
of the Executive Committee and *Dr W A
Simmonds*, who was leaving Council
after service totalling more than 20 years,
was thanked for the contribution which
he had made as honorary treasurer.

Executive Committee

Executive Committee chairman, *Dr G G
Thurlow*, emphasised the committee's
concern over the Institute's financial
affairs and thanked *B G Gills*, for his
useful financial report.

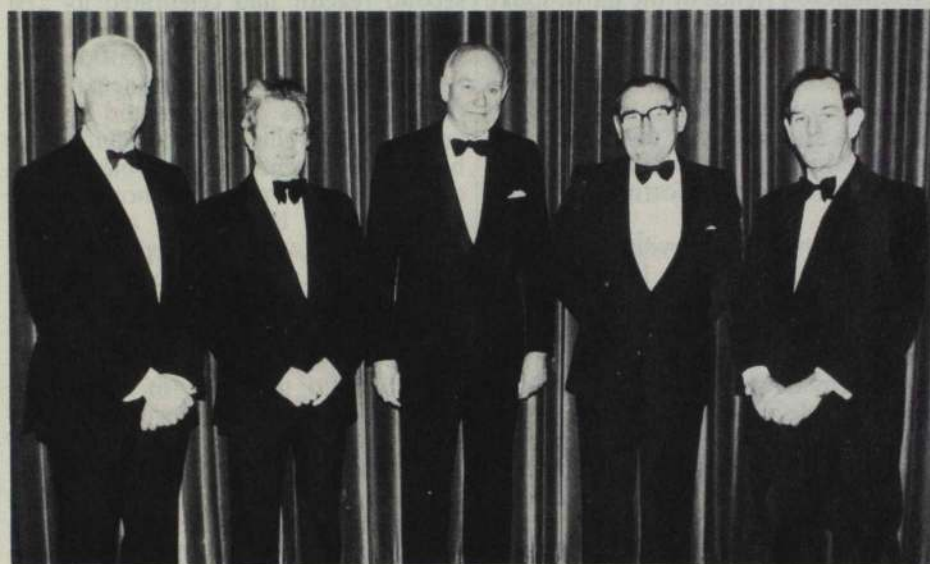
It was agreed that in future a summary
of the reports on the Institute's
investments should be circulated to
members of Council.

Membership Committee

Membership Committee chairman, *J P
MacCarthy*, reported that collective
membership packs were now available; it
was hoped that branches would actively
assist in recruiting such members.

L A N Tozer stressed the importance of
recruiting new members engaged in
energy utilisation and consultancy to
reduce the present bias towards energy
suppliers.

It was noted that student packs had
been successful; approximately 100 new



(Above, left to right): *Dr H M Lodge* (secretary, Institute of Energy); *Prof J Swithenbank* (president, Institute of Energy); *D V Patterson* (chairman, Northern Ireland branch); *D Fell* (Permanent Secretary, Dept of Economic Development); *F R McBride* MBE (hon secretary, NI branch)

(Below, left to right): *R T Stewart* (hon treasurer, NI branch); *D Chestnutt*; *P J Huggins* (NI branch committee); *C J Monaghan* (NI branch committee); *W Swindells* (vice-chairman, NI branch committee)

Around the branches Northern Ireland annual dinner

Nearly 150 persons attended the annual
dinner of the Northern Ireland branch in
the Culloden Hotel near Belfast.

The principal guest, proposing the
toast of the Institute, was *D Fell*,
Permanent Secretary of the Department
of Economic Development, who looks
after all energy-related problems in the
Northern Ireland Government. The

president of the Institute of Energy, *Prof
J Swithenbank*, replied to the toast.

The toast of the Guests was proposed
by *D Patterson*, chairman of the Northern
Ireland branch and responded to by *Prof
D McCloy*, Dean of Engineering at the
New University of Ulster.

Guests at the dinner included *Dr H M
Lodge*, secretary of the Institute of
Energy, *P Downie*, chairman of CIBSE
in Northern Ireland and *E Murphy*,
chairman of the Institute of Refrigeration
in Northern Ireland.

Around the branches (continued on p 22)

students had been recruited in the four
months since the pack was introduced in
contrast to the more usual recruitment
level of approximately 50 students a year.

The president advocated seeking to

recruit more female members to the
Institute.

W Tipler hoped to be able to chase up
lost members during the summer.

(continued on p 23)

The future of nuclear power in the UK

The December meeting of the North East branch was held at the Curtis Auditorium, University of Newcastle upon Tyne. The meeting was organised jointly with the Institution of Electrical Engineers and the University of Newcastle upon Tyne Public Lectures Committee.

During the afternoon prior to the meeting an exhibition on nuclear power was held with BNFL, UKAEA, the Green Party, NEI, Friends of the Earth, and the Institute of Energy taking part. The North East branch would like to thank all of the exhibitors for their cooperation and assistance.

The debate, which attracted an audience of over 350 people, was chaired by Prof Ian Fells. He chose the title of the motion, *There is no future for nuclear power in the United Kingdom.*

Mr Walter Patterson, energy consultant to Friends of the Earth spoke in favour of the motion. Dr Clive Smitton, manager of Hartlepool Nuclear Power Station, opposed the motion, he was acting as a late substitute speaker for Dr Bryan Edmondson, director of the CEGB Nuclear Operations Support Group, who had unfortunately been taken ill.

It was Dr Smitton who began the debate. In his allocated 12 minutes he explained why he saw nuclear power as being the energy source of the present and future. He said that the duty of the CEGB was to provide safe, secure and reliable supplies of electricity, with due regard to the environment. He thought that nuclear power generation fulfilled this duty.

During 1985 18% of UK electricity generation was provided by nuclear sources with coal providing the largest share. Looking forward, it was Dr Smitton's view that nuclear power's contribution would stabilise at about 22% by the end of the decade and be approximately 30% at the turn of the century if present trends continued.

Dr Smitton described the long delay between the conception of a new power station and its final commissioning — a period of eight to 10 years. Electricity supply planning has to take into account construction delays, ensuring that there is sufficient capacity available to replace the ageing Magnox reactors and fossil fuel stations plus any growth in electricity consumption (currently in the order of 5% pa).

The choice of power station depends upon the security of fuel supply, the economics of use, safety factors and the effects upon the environment.

Reference was also made to the rapidly increasing requirements of the developing countries for fossil fuels. During his summing up Dr Smitton stated that he would expect the construction of one or two new nuclear power stations over the next few years, with an additional indeterminate number of further large coal-fired stations being built before the turn of the century.

Mr Patterson began his presentation by asking the audience to consider the past history of nuclear power before deciding on its future. He thought that the civil nuclear programme's early years had been a series of unrealistic and uneconomic proposals. An assortment of different plant designs had been constructed so quickly that there had been no time to take into account problems and shortcomings before the next was built. These plants not only took longer to build than expected but were usually well over budget. The earliest Magnox stations suffered from corrosion problems far sooner than expected and, as a result, had their peak outputs cut — to two-thirds in the case of Oldbury.

With the advent of the AGR stations, new problems arose. Mr Patterson described Dungeness B as having the most advanced design, and told us that its second reactor had celebrated its 21st birthday without producing electricity.

In the 1970s the Government decided to build two more AGRs, principally for political reasons. Heysham and Torness were initially built to schedule and under budget but recently new problems have occurred. Mr Patterson thought that Westinghouse had turned against the PWR design and as no acceptable safety case had been presented to the Nuclear Installations Inspectorate (NII) he could see no reason for Britain to take up this option.

Turning to the issue of apparently uneconomic spent fuel reprocessing, Mr Patterson questioned its necessity with the current uranium glut, and with plutonium only being useful for fast breeder reactors and bombs. As no completely safe methods of storing spent fuel and decommissioning nuclear plant have been developed the speaker thought it would be folly to continue building new reactors, thereby creating new problems.

Mr Patterson concluded by asking the question, 'Will future generations be able to cope with the past mistakes of the nuclear industry, or will we give them new ones?'

Before opening the debate to the floor, Prof Fells presented some statistics from the World Energy Conference to outline the development of the civil nuclear industry throughout the world.

The first speaker from the audience thought that the UK was not yet ready for the large scale use of nuclear power and would not be until the urgent waste disposal and decommissioning problems were settled. Several other issues were raised by various speakers. One thought that Britain's reactors were all incapable of a Chernobyl-type accident, while another said that the number of deaths as a direct result of Britain's nuclear industry was low in contrast with fossil fuel extraction.

A Green Party spokesperson questioned this point, claiming that uranium extraction was also a dangerous mining operation. She also claimed that

the risks associated with the use of nuclear power were considerable and the consequences of a worst possible accident were overwhelming.

Dr Smitton was questioned on the legal powers of the CEGB to build nuclear power stations without a public referendum. He said that the CEGB was a statutory body set up to provide electricity; they were licensed by the NII to install nuclear plant and they had been controlled by successive governments.

When he was questioned about the extensive French nuclear programme which produces more than 50% of the electricity requirement, Mr Patterson presented an alternative viewpoint. He said that the French had chosen one reactor type and had commenced a rapid construction programme. This had led to them having an excess of generating capacity and has forced them to sell electricity abroad. France has the world's third largest national debt, a fifth of which was due to international borrowing by the electricity utility, Electricité de France. France's electricity was currently cheap because it still had to be paid for.

Following demands from the audience Prof Fells amended the motion to: *There is no future for more nuclear power in the UK.*

In their five minute summing up periods both speakers tried to answer the points raised by the audience. Mr Patterson thought that the views of the World Energy Conference (which were mentioned by Prof Fells) were somewhat biased due to its membership being largely from the energy supply and distribution industries. He favoured the development of new coal-based technologies such as fluidised bed combustion, a field in which Britain used to be a world leader. He stressed the benefits of improved energy utilisation as opposed to the development of nuclear power.

Dr Smitton reminded the audience that carcinogens and environmental pollutants were not exclusive to the nuclear power industry. He compared the disaster at Chernobyl with the incident at Bhopal where over 2000 people had died as a result of a major industrial accident.

The audience were told that decision making can be easy with 20 years of hindsight, and that it was the task of the CEGB to balance the merits of one energy source against another for use in 10 or more years time. After stressing the advantages of nuclear power, Dr Smitton thought that there were still doubts over the technical and economic viability of the alternative energy sources.

Prof Fells conducted a vote on the alternative motion. It was defeated. The meeting ended after Mr Trevor Bedford of the Institution of Electrical Engineers had proposed a vote of thanks for an interesting and well-conducted debate.

Wayne R A Zakers/Andrew W Cox

(continued on p 2)

Walter C Patterson was born in Canada in 1936. He took a postgraduate degree in Nuclear Physics at the University of Manitoba. In 1960 he moved to Britain, where he became involved in environmental issues. He joined the staff of Friends of the Earth in London in 1972, as their energy specialist until 1978 and as their lead witness at the Windscale inquiry. Since 1978 he has been an independent commentator and consultant, dealing with energy and nuclear policy issues.

Dr Clive Smitton began his career with KAEA at Harwell. In 1971 he joined the EGB Scientific Services Department and was promoted head of Engineering Science in the North West Region in 1977. In 1981 he was appointed Deputy Manager of Hinkley Point 'A' Nuclear Power Station in Somerset. Dr Smitton has since been manager at Oldbury Nuclear Power Station and took up his present appointment as manager at the Hartlepool AGR Nuclear Power Station in February 1986.



Dr Smitton (left) and Mr Patterson examining one of the models at the exhibition on nuclear power held prior to the debate

Education and Training Committee

It was suggested that there should be a notice in *Energy World* about courses for the Engineering Council part 2 examinations.

Publications and Conferences Committee

The Publications and Conferences Committee chairman, N G Worley, emphasised the objective of stimulating discussion on energy topics, which was achieved, for example, by *Energy for the future*, the experimental afternoon technical meeting in which papers were discussed and the recently introduced 'Viewpoint' page in *Energy World*.

Mr Worley paid tribute to G A Payne, retiring editor of the Institute's *Reference Book and buyers' guide*, and reported that the new joint editors were A Field and G Webb.

Energy managers

Dr R E Hillyer presented a proposal for recruiting energy managers. It was agreed that the Executive Committee should consider the proposal further and that Mr Hillyer should draft an item for publication showing how membership of the Institute could benefit energy managers.

It was suggested that Institute branches should liaise closely with regional energy efficiency offices and that energy manager recruitment packs should be sent to each regional office.

Sixtieth anniversary

The president reported that the Melchett Lecture, to be delivered by Sir George

Porter PRS, marked with distinction the launch of the Institute's 60th anniversary. It was agreed that the Executive Committee should consider further ways of marking the anniversary.

International Committee

International Committee chairman, Dr E G Masdin (president-elect), outlined aspects of the committee's work and reported that Shell had sponsored the Energy Research Institute in Beijing for Collective Membership of the Institute. It was hoped that other companies might act similarly.

Engineering Council

It was mentioned that Membership Committee was planning to publish an item in *Energy World* on Engineering Council stage I registration.

Bye-laws

The president reported that the amendments to bye-laws 66 and 69 of the Institute, approved by members in the AGM on 27 May 1986, had received the formal approval of Her Majesty's Privy Council.

Advertising

The recommendation to change the Rules of Professional Conduct, in relation to advertising by members, was approved.

Correspondence on Energy for the future

It was reported that the president was still corresponding with the Secretary of State for Energy about the proposal, contained

in *Energy for the future*, that an Energy Commission should be established. It was agreed that the matter should be pursued by the president in consultation with the three joint authors of the report.

Annual luncheon

Dr A Sanyal considered that the price of tickets for the annual luncheon was rather high. The Executive Committee would therefore discuss alternative venues including, possibly, those outside London.

Obituary

Sir Humphrey Browne (a former Member), deputy chairman of the National Coal Board from 1960 to 1967, died on 20 February 1987 aged 75.

Comd C J Hereford (Fellow) died on 23 July 1986. He had been a member of the Institute since 1958.

New members Fellow

Stephen Christopher Bailey, Robert Hall & Associates, Brighton (*transfer*)
John David Hooper, Chartered Institute of Building, Ascot (*transfer*)
Peter Thomas Seaton, Fina Energy Equipment, Milton Keynes

Member

Robert Alun Brown, British Gas East Midlands, Sheffield
Yiu Ming Chan, Hong Kong Electric Company, Hong Kong
Timothy Stuart Clarke, CEGB, Rugeley Power Station, Staffs (*transfer*)

REGISTER OF ENERGY COURSES

Members are invited to make use of the Institute of Energy's national register of energy courses, through which we can supply salient details of forthcoming courses of all types. As well as the member's name and address, we need to know (a) the specific subject in which he is interested; (b) his present level of technical qualification; and (c) the preferred geographical location. Only details of suitable courses will be sent in reply.

Course No 9-356

Title: Chemical plant commissioning.
Duration: 3 days.
Location: Leeds University.
Starting: 14 July 1987.
Content: Lectures, tutorials and exercises on the commissioning and start-up of process plants both large and small, and dealing with the technical and human problems encountered.

Course No 00-355.1

Title: Drilling engineering.

Course No 00-355.1 (continued)

Duration: 5 days.
Location: Heriot-Watt University, Edinburgh.
Starting: 10 August 1987.
Content: Drilling overview. Drilling tools/equipment. Pressure control. Drilling fluids/hydraulics. Casing/cementing operations. Directional drilling. Drilling economics. Offshore drilling. Drilling problems. Coring and testing.

Course No 00-355.2

Title: Production technology.
Duration: 5 days.
Location: Heriot-Watt University, Edinburgh.
Starting: 17 August 1987.
Content: Well completions. Subsea completions. Wellhead systems. Early production systems. Perforating. Well servicing fluids. Completion programmes. Well productivity. Vertical lift

Course No 00-355.2 (continued)

Content: performance. Well performance/tubing selection. Remedial/stimulation treatments. Well diagnosis. Acidisation. Fracturing. Artificial lift processes.

Course No 00-355.3

Title: Principles of reservoir engineering.
Duration: 5 days.
Location: Heriot-Watt University, Edinburgh.
Starting: 24 August 1987.
Content: Reservoir rock properties. Reservoir fluid properties. Fundamentals of fluid flow. Reservoir drive mechanisms. Reservoir performance prediction using the material balance equation. Immiscible displacement and water-drive.

Institute news (continued)

Nader A W Dahwa, ADACO, Abu Dhabi (*transfer*)
David Verden Evans
Dermot Charles Hogan, British Sugar, Peterborough
Ludomir Jerzy G Serafin, Wandsworth Health Authority, London (*transfer*)
Ashley Charles Smith, Air Products, Crewe, Cheshire
Peter Warm

Technician Engineer

David Stanley Milburn, Penrite Oil Company, Australia (*transfer*)
David George Titterton, East Midlands Electricity, Notts

Associate

George Edward Foster, H & V Commissioning Services, Ayrshire
Erik Thomas, University College of Swansea

Graduate

Jonathan Paul Pearson, King, Taudevin & Gregson, Sheffield
Simon Paul Dean, British Gas, ITSA Dept, Leicester

Student

Paul David Cantwell, Winchester Health Authority, Hampshire

Gary Alan Tony Carr, Exeter University
Neil Douglas Fuller, Newcastle University
David Glyn Garnett, University of Sheffield
Michael Bryan Gosling, Polytechnic of the South Bank
Richard Alan Jackson, Polytechnic of the South Bank
Peter Morris Miller, Napier College
Nicola Anne Ricci, Napier College
Peter Iain Richardson, Napier College
Neil George Simpson, Napier College
Joseph W Smyth, Polytechnic of the South Bank
Andrew Thrower, Loughborough University

Collective

Kodak Limited, Harrow Middlesex

Personal

J N Bartlam (Fellow) relinquished his directorship with Saacke, combustion equipment manufacturers of Portsmouth, on 31 March 1987 but will be retained on a consultative basis.

Sir Terence Beckett, retired director-general of the Confederation of British Industry, has been appointed a part-time member of the Central Electricity Generating Board.

R H Boissier (Associate) was appointed High Sheriff of Derbyshire for 1987/88

at a ceremony at the Crown Court, Derby, in the presence of the Chairman of the Derbyshire County Council, Mr Joyce Platts and the Mayor and Mayoress of Derby, Councillor Richard and Mrs Keene.

Mr Boissier joined the Board of Pressac Holdings, the Long Eaton based electro-mechanical engineers in 1983, having previously been with Aiton & Co of Derby. He is also a director of ABE British Gas, Broadgate Holdings, Turner & Newall, a member of the Severn-Trent Water Authority and a consultant to Allott & Lomax.

A Governor of Harrow School, where he was educated, Mr Boissier is in addition a Freeman of the City of London and at present Under Warden of the Worshipful Company of Tin Plate Workers.

J Highley (Fellow) left the Coal Research Establishment at Stoke Orchard, Cheltenham at the end of April, to take up a position on the directing staff of British Coal's Staff College, at Chalfont St Giles.

H V Keating CBE (Companion) will be retiring from his position as regional chairman of British Gas West Midlands on 26 June 1987 after 29 years in the gas industry.

He joined the East Midlands Gas Board in 1958, where after a succession of managerial appointments he became

(continued on p 2)

SPECIAL ANNOUNCEMENTS

South Wales and West of England: Lunchtime lecture

The South Wales and West of England branch have organised an annual lunchtime lecture at the NCB Coal Research Establishment, Stoke Orchard, Cheltenham, Glos for 12 noon on Thursday 18 June 1986. Dr R J Cohen of Jodrell Bank, University of Manchester, will speak on *Quasars: the most powerful energy sources known to man*. Tickets and further information from A A Randell, NCB, Gloucester, Glos (tel 024 267 3361).

European oil and gas market round table: Paris, 1-3 June 1987

CEA's forthcoming European oil and gas market round table will be held at the Cercle de l'Union Interalliée in Paris on 1, 2 and 3 June 1987. There will be an off-the-record discussion of world oil and natural gas markets among a high level group of CERA clients and invited guests. A limited number of places are available to non-clients at a fee of US\$50.

The round table will focus on *Towards 1990: oil and gas strategies and risks*. Topics will include the short- and medium-term oil market outlook; OPEC strategy; security of supply from the Arabian Gulf; the national security debate in the United States; European and international natural gas markets; and the question of the impact of Chernobyl on future energy supply.

Further information from Cambridge Energy Research Associates, Representative Office for France, 2 rue Duphot, 75001 Paris, France (tel 42 96 12 38; tlx 213649 F).

Imperial College: Aerodynamic combustion research colloquium

Thursday 2 June. Prof J Peeters (University of Leuven, Belgium). *New insights into the C₂H₂/O reaction mechanism*. Colloquium to be held at 1545 h (tea available from 1530 h).

Visitors welcome without fee or formality. Further information from Prof F J Weinberg FRS, Department of Chemical Engineering and Chemical Technology, Prince Consort Road, London SW7 2BY (tel 01-589 5111 ext 4360).

Energy transportation in pipelines: Symposium, London, 18 June 1987

This symposium will discuss the main measurement problems in selected key areas, highlight advances in instrument technologies indicating current limitations and outline future trends. The symposium should therefore be useful to design and development instrumentation and control engineers, energy engineers, plant managers and research personnel in industry and education. The programme deals with separate energy transport problems with a common theme of metering of difficult fluids as well as discussing the measurement of the energy content of the material or fluid. *The Institute of Energy is a co-sponsor of this symposium*. Further information from the Institute of Measurement and Control (tel 01-387 4949).

Programme

- 1000 Coffee and registration
- 1030 Difficulties of flow measurement in pipelines, by Dr A T J Hayward (Moore Barrett & Redwood).
- 1045 Metering of process gas energy, by W Jones (British Steel Corporation).
- 1130 Lunch

- 1345 Metering of pulverised and granular coal, by Dr M J Corbett (British Steel Corporation) and Dr J Coulthard (Teesside Polytechnic).
- 1430 Metering of steam, by F Napier (Slough Power Station)
- 1515 Metering of refrigerants, by A J Giegel (Food Research Institute).
- 1600 Tea
Close.

Combustion fundamentals: Course, Imperial College, 28 Sept-2 Oct 1987

This introductory course of 19 post-experience lectures, arranged by Prof F J Weinberg FRS, will be held in the Department of Chemical Engineering and Chemical Technology, Imperial College from 28 September to 2 October 1987.

The course is intended to provide an introduction to the subject for students about to embark on research in combustion and for any others who may require general outline knowledge. The main aspects covered comprise: fuels; the chemistry of slow combustion reactions and spontaneous ignition; conditions for flame propagation in gas mixtures, their ignition, explosion and detonation; the thermodynamics, structure and radiation of flames; diffusion flames, fires and the burning of droplets; flame propagation; flames on burners, their stability and shape; high-intensity combustion; practical combustion devices, their characteristics and applications; explosions, including those through gases, mist and dust suspensions; pollution.

Further information from Prof F J Weinberg FRS (see address above).

Environmental acoustics

Details of a day-release MSc in *Environmental acoustics* may be obtained from Dr Max Vuillermoz, South Bank Polytechnic, Borough Road, London SE1 0AA (tel 01-928 8989 ext 2109).

Petroleum economics: June/July courses, Oxford

The College of Petroleum Studies, Oxford have arranged the following courses for June and July 1987.

- 1-5 June A five-day course in Oxford. *Structure and development of the international petroleum and petrochemical industries*. Course code OV1.
- 8-12 June A five-day course in Oxford. *Major capital projects in oil and gas — evaluation, management and finance*. Course code PL1.
- 15-19 June A five-day course in Oxford. *Natural gas — economics, demand and politics in a competitive environment*. Course code SP2.
- 22-26 June A five-day course in Oxford. *Crude oil supply, transportation, refining and trading*. Course code SP1.
- 6-10 July A five-day course in Oxford. *The use of microcomputer in supply planning and refinery operations*. Course code RF2.
- 13-17 July A five-day course in Oxford. *Planning and economics of refinery up-grading*. Course code RF1.
- 20-24 July A five-day course in Oxford. *Refinery non-fuel streams — the market potential*. Course code RF3.

27-29 July A three-day course in Oxford. *Energy forecasting techniques and practices*. Course code PL2.

30-31 July A two-day course in Oxford. *A practical approach to forecasting world oil demand, supply, trade and prices*. Course code PL3.

Further information from College of Petroleum Studies, Administrative Offices, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD (tel Oxford (0865) 250521; tx 838950 COLPET-G or 83147 VIAOR Ref COLPET).

ACHEMA 88: Call for papers

The international meeting on *Chemical engineering and biotechnology*, the 22nd exhibition-congress, will take place in Frankfurt am Main, FDR from 5-11 June 1988.

Lecture programme

The lecture programme of *ACHEMA 88* will comprise about 450 informational papers on subjects originating from research, development and industrial practice.

Subjects should be selected in accordance with the subject groups listed below. The notification of a lecture is subject to the condition that the paper in question is an unpublished original contribution. Notifications must be received not later than 15 June 1987. The duration of a lecture is 20 minutes; projection size: 5 x 5 cm.

List of lectures

1. *Advances and developments in process engineering.*
2. *Packaging, storage and transport.*
3. *Developments in the design of equipment, machines and plants.*
4. *Computers in chemical engineering and biotechnology: process simulation, engineering, design, manufacturing.*
5. *New processes in chemical engineering.*
6. *Contributions of chemistry and biology to energy technology: recovery, conversion, storage, transport.*
7. *Offshore process engineering and sea water desalination.*
8. *Food technology: equipment, plants, processes.*
9. *Pharmaceutical engineering.*
10. *Biotechnology: bioreactors and plants, processing and purification of bioproducts, new processes, genetic engineering.*
11. *Measurement and control systems, on-line control and modelling of biotechnological processes.*
12. *Measurement and control instrumentation, process control systems.*
13. *Materials for chemical engineering: manufacturing, processing, application; behaviour under mechanical, thermal, chemical stress.*
14. *Materials and components testing.*
15. *Analytical methods for laboratories, plants and the environment.*
16. *Advances in laboratory engineering, automation, use of robots.*
17. *Waste gases, waste water, wastes and soil, recycling, noise.*
18. *Safety engineering in the chemical industry.*
19. *Information systems and data banks: state of the art, developments, trends.*
20. *Expert systems.*
21. *Methods and teaching aids for vocational training and continuing education.*

Institute news (continued)

director of supplies in 1971. He was appointed deputy chairman of Southern Gas in 1973 and came to the West Midlands Region in 1975 as deputy chairman before becoming chairman in 1977.

Mr Keating, in addition, served as a part-time Member of the Board of British Gas for three years from March 1981.

K H Tanner (Fellow) has established a practice to provide consultancy services for mechanical and electrical engineering works in the fields of HVAC building services, steam, power, and process and energy conservation engineering. The services his practice can provide cover all aspects of consultancy from initial conception to final hand-over.

Mr Tanner has been engaged in

consulting engineering for 19 years. His practice is trading as Kenneth H Tanner Associates and is located in Irvine, Ayrshire, Scotland.

Ironsides Lubricants have appointed **MD Ward** (Member) to the newly created position of executive director, responsible for running a new division of the company, Shield Lubricants. Mr Ward, who took up his new post on 1 February, 1987, had been with Total Oil of Great Britain for 17 years — where he was responsible for the sale of base oils, greases and wholesale lubricants. He will initiate Ironside's diversification into new markets.

Mr Ward is also a Fellow of the Institute of Petroleum and was for some years a director of Dobeta, a company

Further information from DECHEMA, Deutsche Gesellschaft für Chemisches Apparateswesen, Chemische Technik und Biotechnologie eV, Theodor-Heuss-Allee 2, D-6000 Frankfurt am Main 97, FRG (tel (069) 75 64-0; tx 4 490 dch d).

EIA trade mission to Australia and New Zealand

The Engineering Industries Association with British Overseas Trade Board support are organising a trade mission to Australia and New Zealand for two weeks from 18 September to 4 October 1987. The mission will be based in Sydney for the first ten days, but delegates will be free to visit other centres in Australia. The mission will then visit Auckland for three days, although delegates may remain on in New Zealand if they wish.

The travel and hotel cost will be £2070. The BOTB travel grants are £915 for companies on their first, second or third visits to both markets on a BOTB supported mission and £400 for a fourth visit. The closing date for applications is 12 July 1987.

Further information from Anna Small, export director, EIA, 16 Dartmouth Street, Westminster, London SW1H 9JF (tel 01-222 2367).

NCSR distributes data system

Taking advantage of the new generation of microcomputers, the National Centre of Systems Reliability are now able to offer Associate Members of the Centre's Systems Reliability Service their own reliability database. Instead of direct requests for data to NCSR's central databank, members will in future receive a database system and a library of component reliability data on 'floppy' disks.

The system is designed for an industry standard microcomputer (IBM PCAT or equivalent) and Associate Members will be able to have access to over 10 000 data sets on the reliability of engineering components. The data will be updated and added to on a regular basis.

The NCSR Distributed Data System is provided free of charge to SRS Associate Members. To receive the data base, companies will only have to sign a licensing agreement, although the continuing use of the system and data will be dependent on their remaining members of SRS.

Further information from National Centre of Systems Reliability, United Kingdom Atomic Energy Authority, Wigshaw Lane, Culcheth, Warrington WA3 4NE (Tel (0925) 31244; tx 629301).

formed by the oil industry to provide certificates of approval for oil-firing central heating systems and equipment. He was for many years on the council of the Combustion Engineering Association, and is at present a member of the Midlands branch committee of the Institute of Petroleum.

Sir Frederick Warner (Melchett Medallist), a former president of the Institution of Chemical Engineers, has been appointed chairman of the Council of Science and Technology Institute. This organisation represents 14 bodies that cover a wide range of scientific and technical areas. The objective of the Council is to further the common interests of members and promote good inter-disciplinary professional relations.

CONFERENCES

The following conferences, courses and meetings are organised by bodies other than the Institute of Energy. For Institute conferences please see IFC

June 1987

Liquid catalyst cracking
Eight annual symposium, Budapest (Hungary), 1-4 June 1987.
Details from Nancy Waxter, Katalistiks International Inc, 1501 Sulgrave Avenue, Baltimore, MD 21209 USA (tel (301) 777-1000).

Nuclear power at the crossroads
Conference, Geneva (Noga Hilton Hotel), 3 and 4 June 1987.
Details from European Study Conferences, Douglas House, Queens Square, Corby, Northants NN17 1PL.

Coal in the heat market
International conference, Berlin (FRG), 22 and 23 June 1987.
Details from J K Wilkinson, Commission of the European Communities, DG VII/B/3, 200 rue de la Loi, B-1049 Brussels, Belgium (tel (02) 235 55 76).

Power supply 87
International trade fair for electronic power supply systems, Frankfurt (FRG), 22-27 June 1987.
Details from Messe Frankfurt GmbH, Objekt 10, Postfach 970126, D-6000 Frankfurt 1 (tel (069) 7575-385).

June/July 1987

Energy decision making for uncertain times
Executive seminar, Stanford University (USA), 21 June-3 July 1987.
Details from Susan Van Every Sweeney, Seminar coordinator, Energy Modelling Group, Terman Engineering Centre, Stanford University, Stanford, CA 94305, USA (tel (415) 326-6670/(415) 325-1876; tlx 348-402 STANFRD TNU).

Safety aspects of ageing and maintenance of nuclear power plants
International symposium, Vienna, 29 June-3 July 1987.
Details from Department of Energy, Atomic Energy Division, Thames House South, Millbank, London SW1P 4QJ (tel (01) 211 6850).

July 1987

Fluidised bed combustion technology
Seminar, Vancouver (Canada), 7 and 8 July 1987.
Details from DELTA-H Institute, PO Box 1053, Springfield, NJ 07081, USA (tel (201) 654-9633; tlx 238667 ATT DELTA).

Energy forum
International congress-fair, Hamburg (FRG), 7-12 July 1987.

July 1987 (continued)

Details from Hamburg Messe und Congress GmbH, Postfach 30 24 80, D-2000 Hamburg 36, FRG (tel (040) 35 69-21 70; tlx 2 12 609 messed).

Microscopy in the energy industry
Session at *Industrial and biomedical micro* 87 exhibition and conferences, London (London West Hotel), 9 July 1987.
Details from the administrator, Royal Microscopical Society, 37/38 St Clements, Oxford OX4 1AJ (tel (0865) 248768/721081).

IFAC world congress
Tenth congress, Munich (FRG), 27-31 July 1987.
Details from United Kingdom Automatic Control Council (UKACC), at Institute of Measurement and Control, 87 Gower Street, London WC1E 6AA (tel 01-387 4949).

August/September 1987

New trends in coal science
Meeting, Mugla (Turkey), 23 August-4 September 1987.
Details from Prof Dr Y Yurum, Director — NATO ASI, Hacettepe University, Department of Chemistry, Beytepe, Ankara 06532, Turkey.

September 1987

Industrial energy and technology
Conference and exhibition, Houston (TX, USA), 15-18 September 1987.
Details from Dr Mario Colaluca, conference director, Mechanical Engineering Department, Texas A & M University, College Station, Texas 77843, USA (tel 409-845-1251).

Asia — Pacific petroleum conference
Raffles City Convention Centre, Singapore, 21-23 September 1987.
Details from conference manager, Times Conferences Pte Ltd, 19 Tanglin Road, No 12-02, Tanglin Shopping Centre, Singapore 1024 (tel 7349385/2355222; tlx RS 40113 ATT).

Energy statistics
Conference, London, 29 September 1987.
Details from Jean Etherton, Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR (tel 01-636 1004).

Furnaces workshop 87
Conference, Birmingham, 30 September 1987.
Details from Ken Stanford (conference manager), Fuel and Metallurgical Journals, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS (tel 0737 68611 ext 3244; tlx 948669 TOPJNL G).

September/October 1987

Fuelling the 21st century
International scientific forum, Moscow (USSR), 29 September-6 October 1987.
Details from IVTAN, Izhorskaya 13/19, Moscow 127412, USSR (tel 485 95 72; tlx 411959 IVTAN SU).

October 1987

Joint power generation
Conference, Miami (FL, USA), 4-8 October 1987.
Details from American Society of Mechanical Engineers, 345 E 47th St, New York, NY 10017, USA (tel (212) 705-7795).

Hazardous waste
World congress, Budapest (Hungary), 5 October 1987.
Details from Iambe, Unep, Unido, World Bank, ISWA Secretariat, Paris 553.45.04, France.

Energy engineering
Tenth world congress, Atlanta (GA, USA), 6-8 October 1987.
Details from Assn of Energy Engineers, ste 340, 4025 Pleasantdale Rd, Atlanta, GA 30340, USA (tel (404) 447-5083).

Electric energy: electric machines and drives
International conference, Adelaide (Australia), 6-9 October 1987.
Details from Conference Dept, Institution of Engineers, Australia, 11 National Circuit Barton, ACT 3600, Australia.

Safety in the environment
Conference, Glasgow, 28 and 29 October 1987.
Details from Institution of Chemical Engineers 165-171 Railway Terrace, Rugby CV21 3HQ (tel (0788) 78214; tlx 311780).

November 1987

Energy management
Exhibition and conference, London (Olympia), 4-6 November 1987.
Details from June Hurlock, Trenton Group, Trenton House, Imperial Way, Croydon CR0 4RR (tel 01-680 7525; tlx 9419608).

Mine safety and health
Congress, Johannesburg (RSA), 19 and 20 November 1987.
Details from congress manager, *Mine safety and health* congress, Chamber of Mines of South Africa, PO Box 809, Johannesburg 2000, RSA.

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