The Journal of The Institute of Hospital Engineering May 1985

HOSPITAL ENGINEERING

- Water treatment selection for package boilers
- The special need for adequate water treatment to remove gases from hospital steam supplies
- Preview of IHEX '85 and 41st Annual Conference

HOSPITAL ENGINEERING

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Director
David B Goad MSIAD MIOP

Editor
Jenny Campbell

Advertisement Manager
Michael Birch IMR International
14 Bath Road Swindon Wilts SN1 4AA
Telephone: (0793) 45311

All correspondence relating to the Journal should be addressed to:
HOSPITAL ENGINEERING
TGV Publications, 41 Earl Street,
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Front cover: Staincliffe Energy Centre complex will be visited by delegates to the 41st Annual Conference. The cover shows the control room panel system incorporating temperature, heat meter, oxygen trim, draught and smoke monitoring.

The Institute of Hospital Engineering
20 Landport Terrace
Southsea, Hants PO1 2RG, England
Telephone:
Portsmouth (STD 0705) 823186

Institute News

Northcroft Silver Medal Award 1984

THe Northcroft Silver Medal Award for 1984 is made to D. Harper for his Paper entitled 'Minimising the spread of Legionnaires' Disease' which appeared in the March issue of 'Hospital Engineering'.

Medical Gas Installations

A talk given by Mr N. Gaskell of Medical Gas Installations Ltd at the Post Graduate Centre, Queen Elizabeth Hospital, Birmingham on the 22 January 1985 on Site Generation of Medical Oxygen centred round the development of oxygen concentrators used as a means of supplying a medical gas pipeline system in a hospital. Basic design details were explained and with the help of slides actually showing two U.K. installations the feasibility was amply demonstrated. The talk was extended to include domiciliary concentrators and a current production model was used to indicate the various items which make up a unit. Mr Gaskell also gave a brief outline of the proposed changes to the medical gas pipeline standards to bring them in line with up-to-date information.

The Engineering Council

The Engineering Council is asking companies to subscribe to its work by becoming Industrial Affiliates and members of an industrial forum. The work of the forum will be developed, says The Engineering Council, by discussions with the Industrial Affiliates. The Engineering Council explains its work in some depth in information going to employers of engineers, under the theme "Helping to shape the future of engineering and technology".

The Watt Committee

Publication of Small-Scale Hydro-Power Report

Small-scale hydro-power, which, as defined by a working group of the Watt Committee on Energy, includes any hydro-electric scheme below the size which the public electricity generating boards have themselves considered worth developing, has the potential to provide energy equivalent to some 200,000t or 300,000t of coal per annum, says the working group in the fifteenth *Report* of the Watt Committee. The Report presents a revised and augmented version of material that was discussed at a Consultative Council meeting of the Watt Committee on 5th June 1984. Unlike its immediate predecessors, which dealt respectively with nuclear energy and acid rain, it is devoted, as Dr J. H. Chesters, Chairman of the Watt Committee, writes in a Foreword, to a renewable energy source; but like them, it is intended to clarify what at the moment could hold up development.

THE INSTITUTE OF HOSPITAL ENGINEERING ONE DAY SYMPOSIUM

'FIRE PREVENTION'

at

The Institution of Mechanical Engineers
Birdcage Walk, Westminster, SW1

Wednesday 26th June 1985

The Hospital Estate, because of its very nature, is subject to many different kinds of fire hazard. It is essential to offset these risks by incorporating fire precautions which are both economical and acceptable to medical practices. This Symposium explores the policies which have been developed and looks at developments in this field.

PROGRAMME

10.00 Coffee

10.30 OFFICIAL OPENING by Chairman for the day JOHN BOLTON ESQ, CB, LLB (Hons) Lond, CEng, FICE, FIMechE, Hon FCIBS, FInstE, FCIArb, Hon FIPHE, Hon FIHospE, FRSA
Chief Works Officer and Director General of Works
Department of Health and Social Security

10.40 PLANNING FOR FIRE PRECATIONS AT NATIONAL LEVEL
Speaker: M. F. KEMP ESQ, AADip, ARIBA
Superintending Architect responsible for Fire and Building legislation
Department of Health and Social Security

11.20 PLANNING FOR FIRE PRECAUTIONS AT REGIONAL LEVEL
Speaker: G. W. AYRES ESQ, ARICS, ACIArb
Regional Works Officer
North Western Regional Health Authority

12.00 ENGINEERING ASPECTS OF FIRE PRECAUTIONS
Speaker: D. LOMAX ESQ, CEng, MIEE
Principal Assistant Engineer
Trent Regional Health Authority

12.40 Lunch

14.00 RESEARCH IN FIRE PREVENTION
Speaker: N. PEARCE ESQ, CEng, MIMechE
Principal Professional and Technology Officer
Department of Health and Social Security

14.40 FIRE PRECATIONS IN EXISTING BUILDINGS
Speaker: T. GREENWOOD ESQ, FIFireE
H.M. Inspector of Fire Services
Home Office

15.20 PROBLEMS AT DISTRICT LEVEL
Speaker: R. L. F. COX ESQ
District Fire Officer
Preston Health Authority

16.00 OPEN FORUM

16.30 Close

TICKET APPLICATIONS

NB. Please note that tickets are available ONLY from The Institute of Hospital Engineering, (Tel: Portsmouth (0705) 823186).

To: The Secretary, The Instituate of Hospital Engineering, 20 Landport Terrace, Southsea, PO1 2RG.

Please send me.......... ticket(s) for the ONE DAY SYMPOSIUM entitled 'Fire Prevention', to be held on Wednesday 26th June 1985.

I enclose £.............. to cover the cost.

Ticket to include morning coffee, lunch and VAT.
Member: £46. Non-Member: £51.75.

No fees will be returned for cancellations (in writing please) received after midday on Thursday 20th June 1985.

VAT registration no 339 3963 20

NAME (in capitals please) ....

ADDRESSS ....

....

Position .... Non-Member (please tick) ....

Talking Point

The author is a member of Council and District Works Officer to Norwich Health Authority.

Value for money?

J A PARKER CEng FIMarE FIHospE

We hear a great deal about efficiency and value for money these days but what does it really mean? It is very much the fashion to examine closely the output from our manpower and the return for money invested, on a keen commercial, and very often, a quite doubtful statistical basis. In the National Health Service there is still quite a debate to determine the most accurate method of producing Performance Indicators to endeavour to compare aspects of the service, but how often do we hear that one method or another cannot be used because it does not compare 'like with like'.

As engineers, we are able to calculate efficiencies of many engineering processes and pieces of equipment but are not always willing to apply our abilities and our learning to the subject of managmenet. The logical mind of the engineer should be able to develop systems from first principles and apply them to whatever problem may be facing them. Many people would say that this is probably, in the main, common sense, so why is it that when we are faced with management problems common sense seems to fly out of the window.

Of course there are some problems of management which involve people and in such cases bring emotive forces into play which send people rushing off to consult the latest offerings from the academic psychologists. It is interesting to see how common sense and logical thinking can very often produce results which are exactly the same as those achieved by the application of much more erudite theories.

Generally speaking, life has become much more concerned with involved technological developments which not only concern us in our professional pursuits but have a major influence in our daily living. The rate of technological development in medicine has created many of the problems found in the National Health Service today and in order to cope with some of these pressures more technology has been harnessed in the form of computers. The idea is to be able to make decisions on the most up to date information available and thereby be able to apply the resources available, both manpower and finance, in the most effective way.

Sometimes I feel that the objectives of the service tend to become clouded by the obsession with high technology and the short-term justification on financial grounds. This has been very evident in many modern developments where saving in capital costs has been to the detriment of revenue consequences with, in many cases, a disruption of patient services. There has been a decline in engineering research spending in Britain in recent years and it is perhaps because we have not been researching sufficiently those aspects of modern engineering and construction that failures have occurred. Could more research spending be a worthwhile investment to increase our efficiency and bring about greater value for money? Research into these developments would have produced sufficient information to enable designers to narrow the failure gap and so produce long lasting facilities in which to allow other professions to practise, again to the benefit of the patient. If this is not so, where have we gone wrong in either the information that has been produced, or, in the application of that information? It is through journals such as this that the communication of this information can be directed to those people who need to consider it and apply it.

In recent years there has been an attempt at standardisation to enable hospital provision to be accelerated with a more effective value for money which, in itself, is a good theory but in practice doesn't seem to have produced the desired results; certainly not from a maintenance point of view. Again variations on this theme have brought into being Nucleus which at the moment seems to be the panacea of the National Health Service — time alone will tell if it is the answer to all our problems. Bearing this in mind, a careful analysis should be carried out of the information collected by the users so that, modern materials allowing, the next generation of health facilities will be even better value for money.

How ought we to be monitoring our efficiency? Is comparison of costs sufficient without an agreed basic standard? What should that basic standard be? These are some of the many questions that are being asked today, not only of the National Health Service but of a much wider scene.

A consultant surgeon has suggested that a team of experienced senior doctors could be set up as hospital inspectors to vet work loads of medics. Could there be a similar answer as regards the monitoring of efficiency of works officers in the service rather than by the use of dubious performance indicators? No doubt some would say that it is the job of Treasury Audit to evaluate the service, but that can only be on a financial basis. Is there need to bring in a system of professional or technical audit and might this be a spin-off of either Griffiths or the Works Review?

Whatever happens, the resources available to the National Health Service in the future will have to be used as efficiently as possible and that might mean even more standardisation. As Henry Ford said, 'you can have any colour you like, as long as it's black.'

Southern Branch Annual Dinner

This most successful social event was attended by members and their guests at the Ashburn Hotel, Fordingbridge, Hampshire.

From left to right: Mr L House (Chairman), Mrs House, Mr L Hadley (President of The Institute of Hospital Engineering), Mrs Hadley, Mrs Boyce, Mr R Boyce (Secretary).

Consulative Council Meeting

The Watt Committee on Energy announces that its Seventeenth Consultative Council meeting will be held at the Royal Society of Arts, John Adam Street, London WC2 on 11th June 1985, when the theme will be 'The Energy Industry: the Challenge of the Disposal of Solid and Liquid Wastes'. The meeting is arranged jointly by the Institution of Geologists, the Geological Society and the Watt Committee on Energy. The meeting will be open to members of the professional institutions comprising the Watt Committee on Energy and other persons with professional interests in the subject.

Enquiries may be addressed to: The Secretary, Watt Committee on Energy, Savoy Hill House, Savoy Hill, London WC2R 0BU. Tel: 01-379 6875.

continued on page 16

This paper was first presented at the Institute's symposium 'Hospital Developments' in January 1985. The author is Regional Works Officer for North East Thames RHA.

Forms of contract, tendering procedures and documentation

B W EAST CBE FRIBA

The Secretary of State in the N.H.S. Act 1977 (amended 1980) directs Regional and District Health Authorities to 'exercise his functions' in respect of building and engineering contracts; these Authorities act as principals and as these contracts concern public funds, Authorities have a general duty to secure best value for money, conform with general government policy.

This is what gives the Accounting Officer (Perm. Sec. DHSS, Sir Kenneth Stowe) the most reliable assurance that he can, if required, explain the actions of Authorities to Exchequer and Audit or, if required, the Public Accounts Committee of the House of Commons.

The Banwell Report and N.J.C.C. Code for Selective Tendering are generally adhered to in the Health Service and there is a general requirement to use contracts published by the Joint Contracts Tribunal.

This is underlined in Authorities Standing Orders. One must also comply with E.E.C. Directives (CH2) (30th December 1983) which require construction works in excess of £590,000 to be advertised in the E.E.C. Journal.

The 'Assurance of Readiness to Proceed to Tender' procedure adopted by the N.H.S. together with the avoidance of prime cost sums wherever possible ensure that the design is fully thought through before the Building Industry is invited to tender and has done much to reduce time and cost over-runs in N.H.S. contracts.

Judgement of method of procurement

CONCODE Part 1 Chapter 1. Gives guidance on the basic types of contract.

a) Lump Sum.
b) Contracts based on Measurement.
c) Contracts based on approximate Bills.
d) Contracts based on existing Priced Schedules of rates in the N.H.S. (Measured term).
e) Contracts based on reimbursement of contractors costs.
   e.1 Prime Cost.
   e.2 Management Contract.

In addition it addresses methods of procurement i.e.

Single Tenders
Negotiated Tenders
Competitive
Two Stage Tenders
Design and Construct
Consortium (Joint Venture) Tenders
Service Tenders

A contract is a serious business not to be entered into lightly and selection depends on judgement. Let us examine our information armoury.

1. The Banwell Report.
2. NJCC codes for Single Stage Selective Tendering and Two Stage Selective Tendering.
3. JCT Practice Notes relating to the various forms of contract of which PN20 (Revised 1984) entitled 'Deciding on the appropriate form of JCT Contract' is particularly helpful and the various forms of Building Contract.

Two types of contract

A. DESIGN BY THE EMPLOYERS ARCHITECT OR OTHER PROFESSIONAL CONSULTANT

1 Lump Sum Price

(Subject to Variations, Fluctuations or expenditure on P.C. or Provisional Sums).

The choice of JCT Forms for 'Lump Sum' are between:-

The Agreement for Minor Building Works (January 1980) 'MWA'.

The Intermediate Form of Building contract. (1984). 'I.F.C.'

The Standard Form of Building Contract Without Quants.

The Standard Form of Building Contract with Quants. (1980).

One of the judgements to be made clearly concerns the contract period and as suggested a rough guide:-

	Period	JCT Guidance
MWA	To 12 Months Up to £50,000 ('81 prices)	Practice Note M2 on Agreement.
I.F.C.	To 12 Months + Up to £250,000 ('84 prices)	Practice Note 20 (Rev. '84).
SF	Any period.	Practice Note 20 (Rev. '84).

A2 Indication of price

With actual price being determined as work proceeds.

If an early start is sought.

The Standard Form with approximate Quants. (Apparently used for £40-60K value work).

(The only difference between a Bill of Approximate Quants. and a BOQ is that approximate quants. are prepared from less complete design information: Both types are in accordance with the S.M.M. of Buiding Works). (JCT currently producing some drafting amendments).

Its use would be considered where the nature of the work is such that it cannot be fully described in advance; also used for early start e.g. after fire damage.

The Fixed Fee Form of Prime Cost Contract. (Mostly used on repair/alternation work). Prime Cost (actual) of labour, materials and plant and fixed fee (or percentage) addition. The Addition is to cover overheads and profit. Tendering is on the fixed fee or percentage addition. Cost Control difficult and special provision has to be made for inspecting accounts. Little incentive for contractor to be economical.

Remember that where work is Billed the Employer becomes responsible for quantity.

DESIGN OF WORKS (OR PORTION) BY CONTRACTOR

B.1 The JCT Standard Form with Contractors Design.

B.2 The JCT Standard Form with Quants. (*modified* by Contractors Designed Portion Supplement).

Design of Works (or portion) by Contractor

B.1 SF with Contractors Design	B.2 SF with Quants. (Modified by Contractors Designed portion supplement.)
Practice Note CD/1A 1B i.e. Proposals from Contractor, for design and construction.	Practice Note CD/2 i.e. Works designed by Architect with a portion to be designed by the Contractor.

Possibilities for choice

Other possibilities for choice depending on circumstances —

(a) Measured Term — Suitable for programmes of maintenance.
(b) Model Form A — IEE IMech.E. 1982 amendments.
(c) Joint Venture/Consortium — Group formed for large complex projects: With common interest — need to be jointly and severally responsible.
(d) Management — Contractor advises on, and manages work. He gets a fee plus reimbursement of cost of work which is itself let on a series of sub-contracts.

Assignment

The clients ability to assign work varies with the type of contract selected —

'MWA' No provision but form allows for description or an instruction against a Provisional Sum.

'I.F.C.' Provides for 'naming' which gives a domestic sub-contractor result.

JCT 80 + Quants. Provides for nomination Clause 35 or 'naming of 3' which gives a 'domestic' result.

Fluctuations

These can be handled in various ways —

(a) Fixed price — Nil.

(b) Limited — Limited to statutory contributions, levies and taxes.

(c) Full — Labour and material costs and statutory contributions, levies and taxes. (12 Months and over).

(d) Where Limited — Government undertaking for full pre planning and not exceeding one year; no undue delay in accepting tender, nomination etc. and avoidance of V.O's.

Contract Size and duration

3½ years maximum. (HN('81) 30 Consult DHSS!).

3 years £13-15M.

4 years £18-21M.

Tendering methods

1. SINGLE TENDER

There is no element of competition and use would be limited to:-

Public Utility Services.
Specialised Equipment (matching).
Work of great urgency.
Servicing of specialist equipment.
Jobbing works.

2. NEGOTIATED TENDERS

3. PARALLEL WORKING

Disadvantage, over-optimistic estimates.

4. SELECTIVE TENDERS

5. TWO STAGE TENDERS

Allows early contractor collaboration. First stage of tendering covers scope of works, construction methods, programming, management methods and basis of costing.

6. DESIGN AND CONSTRUCT

Brief ± sketch drawings (offices, stores, residential). Firms must be experienced in the type of work. Don't needlessly lay down requirements which restrict the design solution.

7. JOINT VENTURE TENDERS

Where the 'venturers' are jointly and severally responsible. (Yorkshire and Oxford R.H.As): Where they have the facility to discuss and agree matters of working together, integration of services, site organisation, programming *before tender bid is made*. Greater commitment of the contractors to each other. Removal of situation whereby the Building Contractor blames the services for delay and visa versa. No financial penalty to the client if one of the contractors fail.

8. MANAGEMENT CONTRACTING

5 factors in combination and to a sufficient cumulative extent.

Need to bring finished building into use as early as possible.

Need to accommodate design changes at minimum additional cost and time.

Need for flexibility of planning and execution of construction.

Need to apply construction to early planning and design.

Need to strengthen the management applied on behalf of the client.

I am conscious that this complex topic requires more time and space to do it full justice but I hope if nothing else to have lifted the lid off Pandora's Box and exhibited the scope of possibility from the contents.

Water treatment selection for package boilers – its effect upon boiler operation and energy cost

DAVID FISHER CChem MRSC

Since the oil crisis in the early seventies, users of energy have become increasingly aware of its cost and the effect these costs can have on factory gate prices.

It is natural therefore, that managers and engineers in both the public and private sectors look closely at ways and means of reducing operational and maintenance costs *to a minimum.*

This article outlines how proper consideration to water treatment requirements within the boiler house can make a significant contribution to reducing these costs and obtain the maximum in terms of operational efficiency and trouble-free operation of the boiler plant.

The prime consideration of any water treatment programme will be to prevent scale deposition and corrosion within the boiler and feed lines. However, before discussing in some detail modern methods of approach to boiler water treatment, it is worthwhile reviewing the effect that scale deposits and corrosion can have on operation and energy costs.

Scale

Scale deposits within the boiler, will have the effect of reducing heat transfer with its consequent effect upon fuel consumption and safe operation of the boiler.

Generally speaking, scale formation will tend to be greatest where the heat flux is greatest. Modern package boilers transfer heat over a much smaller surface area and much higher peak heat fluxes tend to take place. *This makes these units far more* sensitive to scale deposits than the earlier types.

The effect of any scale deposit on the heat transfer surface will be to thermally insulate the waterside of heating surface, retarding the flow of heat from the metal to the water. The only way that heat can get through this insulating barrier of scale, is to raise the metal temperature. In this way the heat is forced through to the water, which, as a consequence increases the temperature of the gases leaving the boiler. This has a twofold effect:

1. It increases the metal temperature, which may endanger the boiler structure.
2. Higher exit gas temperatures will effect and reduce boiler efficiency.

Let us first examine the effect on the boiler structure, by reference to Fig 1, which shows the effect of a 1/32" scale on the metal shell of a boiler subjected to a typical heat flux of 120,000 Btus/ft^2/hr.

With no scale deposit, one can see that the gas side metal temperature reaches 700°F. In contrast to this, the effect of 1/32" scale is to increase the metal temperature up to 940°F for the same heat transferred. *This latter temperature is well beyond* 870°F, the temperature at which creep begins to dominate the elastic properties of the metal. In addition the higher furnace temperature creates a greater expansion, and hence – thrust on the end plates.

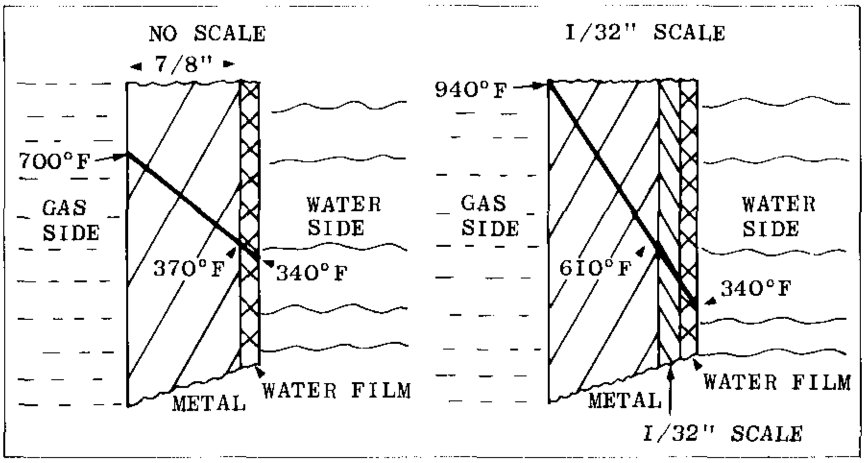


Figure 1

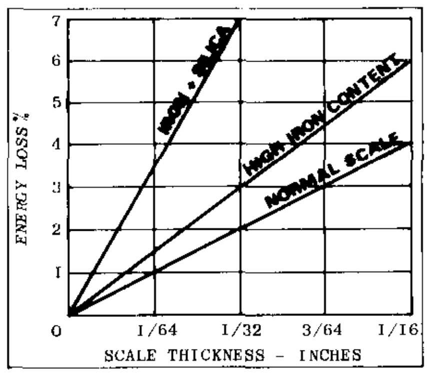


Figure 2

For the fireside tubes particularly in the second and more so the third pass tubes, the effect of scale on creep properties is not so critical since the gas temperatures are not so high. In this respect the effect of scale on the tubes is more important in terms of fuel efficiency.

Fig 2 illustrates the effect of varying thickness of scale on the efficiency of the boiler.

Thus a normal scale deposit which is 1/16" in thickness will reduce the operating efficiency of a boiler plant by 4%. If the scale contains high levels of iron oxide and silica then the effect is even more dramatic eg 1/32" deposit reduces efficiency by 7%

Table 1 illustrates what this loss of efficiency means in terms of additional or wasted fuel costs based upon a normal scale ie Calcium/Magnesium carbonates.

The problems outlined to date are those *directly attributed to scale deposits in the* boiler and demonstrate the effect these deposits can have on the safe operation of the boiler and fuel costs.

Corrosion

The effect of corrosion on the boiler system is probably more dramatic than scale formation. This is due principally to the fact *that when corrosion takes place metal loss* occurs. This is metal that cannot be replaced and if the corrosion process is allowed to go unchecked then perforation of the metal will occur leading to a costly and invariably an inconvenient shut-down for repair.

Thus it is apparent that, in designing suitable water treatment programmes for a boiler plant, the two main problem areas that are of concern are scale deposit and corrosion.

The approach adopted significantly affects the energy and maintenance costs of the boiler house. The next section of this

Table 1
Effect of scale on boiler fuel costs £/annum for varying steaming rates (oil costs 50p/gall)

Lbs/Hr Steam	Scale Thickness 1/64"	1/32"	1/16"	1/8"
5,000	2,300	4,700	9,400	18,000
10,000	4,700	9,400	18,700	37,000
15,000	7,000	14,000	28,000	56,000
20,000	9,400	18,700	37,400	75,000
25,000	11,700	24,400	47,000	94,000
30,000	14,000	28,000	56,200	112,000

Thus for a boiler plant steaming at a rate of 10,000 lbs/hr and having a 1/32" scale, the fuel losses are equivalent to £10,000 per annum compared to the same plant operating with no scale deposit paper concerns itself with the means by which these problems can be minimised and eliminated. However, before progressing to this, it is as well to quote from BS 2486: 1978 "The Treatment of Water for Land based Boilers". The following are extracts taken from the Recommended Characteristics for Shell Boilers:

1. Feed water hardness

'Boilers with high output, relative to water content and/or employing high heat flux density usually require feed water of low hardness, not only to avoid scale formation on heat transfer surfaces but also to minimise on suspended solids, or sludge in the boilers. Consequently water with a residual hardness of 2 mg/litre (2 ppm) or less should be used.'

2. Oxygen

'Dissolved oxygen in the feed water should be reduced to the lowest practicable level before addition of an oxygen scavenger.'

Scale and methods of prevention

Let us first examine this problem of scale and how it arises. All natural waters contain dissolved impurities and the dissolved impurities that are of concern in causing deposition problems are the salts of calcium and magnesium. Under normal conditions the bicarbonates of these metal ions are soluble. However, under the influence of heat these break down to give off carbon dioxide and insoluble carbonates or hydroxide. These insoluable salts precipitate in the feed tank and feed lines or they form a sludge in the boiler itself which may deposit on the heat transfer surfaces. Other deposits that cause scale are calcium sulphate, silicates and iron oxides which tend to deposit directly on to the boiler metal and do not form a sludge. For the purpose of this paper, the discussion is confined to the deposits arising from calcium and magnesium salts.

Methods of Prevention

There are two commonly used methods of scale prevention. These are:

1. Internal Softening
2. External Softening

Internal Softening

This should not be confused with internal conditioning which is described later. The term internal softening describes the form of treatment in which the water is rendered non-scale forming by reactions that occur within the boiler itself.

In simple terms the boiler is used as a reaction vessel. Scale formation is limited by converting the hardness salts of Ca + Mg into a free flowing sludge which is removed via normal blowdown. However, if the amount of sludge produced cannot be effectively or economically removed from the boiler by blowdown, consideration must be given to the installation of appropriate pre-treatment plant to remove or reduce the hardness of the feed water to acceptable levels.

The two generally accepted means of internal softening are either by carbonate or phosphate conditioning with the addition of a natural or synthesised organic molecule to promote sludge conditioning.

Internal softening programmes on today's modern package boilers needs strict control if the problems outlined earlier are to be avoided. As a consequence the use of a softener or some other pre-treatment plant is usually used.

External Softening

From what has been discussed previously, it is evident that the easiest solution to preventing scale deposition is to remove the offending solids prior to entry to the boiler. This can be achieved by a variety of methods, the most common of which are:

1. Lime/Soda Softening.
2. Ion exchange.
3. Reverse Osmosis.
4. Evaporation.
5. Any combination of these.

1. Lime/Soda Softening

This is a process whereby the hardness salts of Ca + Mg are precipitated by the addition of, as the name suggests, lime and soda ash to the raw water in a large reaction vessel. Hardness levels of less than 5 ppm can be achieved. However, due to the size, inefficiency and cost of the plant involved, this process is no longer popular.

2. Ion Exchange

The ion exchange process is one that makes use of materials capable of exchanging ions and there are a number of variations by which the desired end result can be achieved. It is possible to utilise ion exchange resins that are specific to particular ions and in this way one can be selective about which ions are removed from the water.

By far the simplest and most popular in use on shell and package boilers is the base exchange, whereby the troublesome scale forming Ca + Mg ions are replaced by the innocuous sodium ion. This produces a softened water with a hardness of less than 2 ppm. There are variations on this principle notably Dealkalisation and Demineralisation which are outlined in detail later.

Reverse Osmosis and Evaporators are less common in this country and are only generally used where power is relatively cheap.

Ion Exchange

The three most popular ion exchange processes currently in use in the UK are:

1. Base Exchange
2. Dealkalisation/Base Exchange
3. Demineralisation or Deionisation

The choice of process will be governed by many factors such as:

(i) % Condensate Return
(ii) Alkalinity and Hardness levels of the make-up water
(iii) Blowdown and heat recovery considerations
(iv) Water source and its cost
(v) Boiler type and its pressure/heat output.

1. Base exchange

The base exchange process involves the use of a strongly acidic cation exchange resin in the sodium form. Hard water containing the objectionable calcium and magnesium ions is passed over the resin which is usually in the form of small beads. These calcium and magnesium ions replace sodium ions on the resin matrix, according to the following simple chemical reaction:

$$2R\text{-}Na + \begin{pmatrix} Ca^{2+} \\ Mg^{2+} \end{pmatrix} \rightarrow R_2 \begin{pmatrix} Ca \\ Mg \end{pmatrix} + 2\,Na^+$$

No other reaction occurs and any other dissolved solids in the water pass through unchanged. Thus the total dissolved solids level of the water remains virtually the same.

There is quite obviously a limitation as to just how much exchange capacity is available and a time will come when all the available exchange sites are saturated with Ca + Mg. In this state the resin bed is exhausted, and it is regenerated to the Na form using a solution of common salt. Using such a plant a water with a hardness of <2 ppm is produced. Figs 3a and 3b show a typical plant and layout.

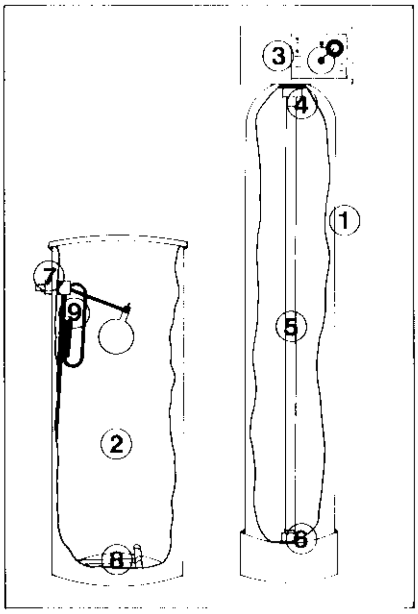


Figure 3a Typical water softening plant used on a package boiler. 1 Resin shell; 2 Brine tank; 3 Main control valve; 4 Upper distributor; 5 Riser tube 6 Bottom filter; 7 Refill water valve; 8 Refill distributor; 9 Brine draw assembly.

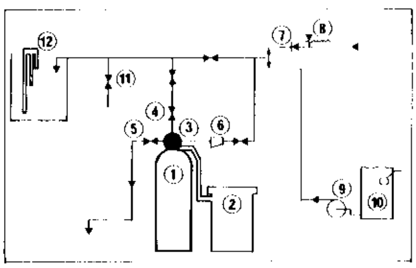


Figure 3b Layout of typical plant. Components: 1 Resin shell; 2 Brine tank; 3 Main control valve; 4 Service solenoid valve; 5 Motorised drain valve; 6 Strainer; 7 Non-return valve; 8 Vacuum break valve; 9 Booster pump; 10 Break tank; 11 Sample cock; 12 Level probes.

2. Dealkalisation/base exchange

As mentioned earlier, by a judicial selection of ion exchange resin materials and the form these are in ie hydrogen, sodium, hydroxide etc, one can be very selective about which ions are removed from the water.

Natural waters contain two types of hardness temporary or permanent.

The so called temporary hardness derives from the presence of either calcium or magnesium bicarbonates in the water. (This is normally equivalent to the alkalinity of the water.)

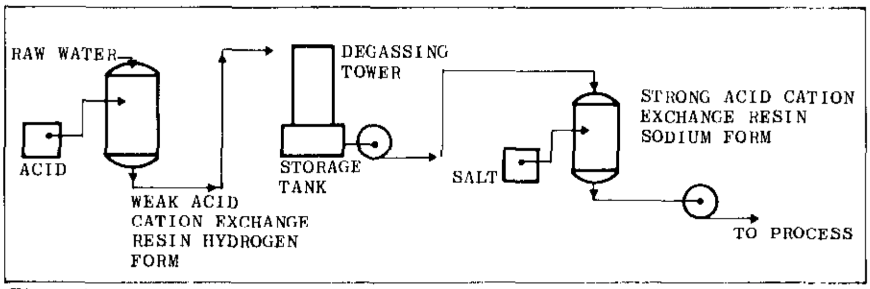


Figure 4

The permanent hardness on the other hand is the calcium and magnesium associated with other salts in the water such as sulphate and chloride.

Fig 4 shows a typical plant layout of a Dealkalisation/Base Exchange unit.

In this process the Dealkalisation unit contains a weakly acidic cation resin in the hydrogen form. As the raw water passes over this resin only those Ca + Mg ions associated with the bicarbonates are removed and exchanged for hydrogen ions, according to the following reaction

$2RH + (Ca)(HCO_3)_2 \rightarrow R-(Ca)\ R + 2H_2CO_3$
(Mg) (Mg)

The bicarbonate is converted to carbonic acid (CO_2 dissolved in water) and is easily removed by passing over a degassing tower. On exhaustion, the resin is regenerated using HC1 or H_2SO_4.

The remaining non-alkaline or permanent hardness is then removed by a simple sodium base exchange unit (as described earlier). Again a water with a *hardness of <2 ppm can be achieved.*

What then is the advantage of this dealk/Base Exchange over a simple Base Exchange plant. The answer lies in an alkalinity and TDS reduction. In the Dealkalisation plant virtually all the dissolved solids associated with the alkalinity or temporary hardness are removed. In the Base Exchange plant no such reduction occurs.

This is quite an important consideration when designing a plant.

3. Demineralisation

The last plant under consideration is demineralisation or deionisation. This plant will consist of a cation and anion exchange resins for the complete removal of all salts *to produce a very pure water.*

The plant usually comprises of three distinct sections and in this arrangement complete solids removal is achieved. The water is first passed through a strong cation exchange resin which is in the hydrogen form and converts all the dissolved salts into their corresponding acids. This is represented by the following simple reaction:

$$\begin{array}{ll} R-H + Ca(HCO_3)_2 & R_2Ca + H_2CO_3 \\ CaSO_4 \longrightarrow & H_2SO_4 \\ CaCl_2 & HCl \end{array}$$

On exhaustion this resin is regenerated using either dilute hydrochloric or sulphuric acid.

As with the dealkalisation unit, the carbonic acid formed is easily removed by passing the water through a degassing tower which is the next unit in the process.

The third and last unit in the process contains a strongly anion exchange resin in the hydroxide (OH) form. This has the effect of removing and neutralising the acid radicals formed in the cation exchange unit.

This proceeds by the following reaction:

$$\begin{array}{lll} R\text{-}OH + HCl & \rightarrow R\text{-}Cl & + H_2O \\ + H_2SO_4 & R_2\text{-}SO_4 & \end{array}$$

On exhaustion, this resin is regenerated using a dilute solution of sodium hydroxide solution.

The whole process is represented schematically in Fig 5.

The demineralisation or de-ionisation process produces water of a very high quality containing zero solids.

Tables 2 and 3 summarise the effect on the various dissolved salts in raw water which has been passed through the pretreatment plants described earlier. Also included is the approximate treatment cost.

Selection of plant

What then are the factors governing selection of a suitable pretreatment plant.

British Standards 2486 is of great use in this respect, but other considerations are important, particularly the quality of the raw water to be treated, percentage condensate return and blowdown *requirements.*

As a general rule of thumb, it is not considered necessary to install a Demineralisation Plant for Shell boilers in the UK and it is far more likely that a simple Base Exchange or Dealk/Base Exchange plant will suffice. The selection will depend upon raw water analysis and blowdown requirements.

For high pressure and water tube boilers it is generally accepted that demineralisation plants are required.

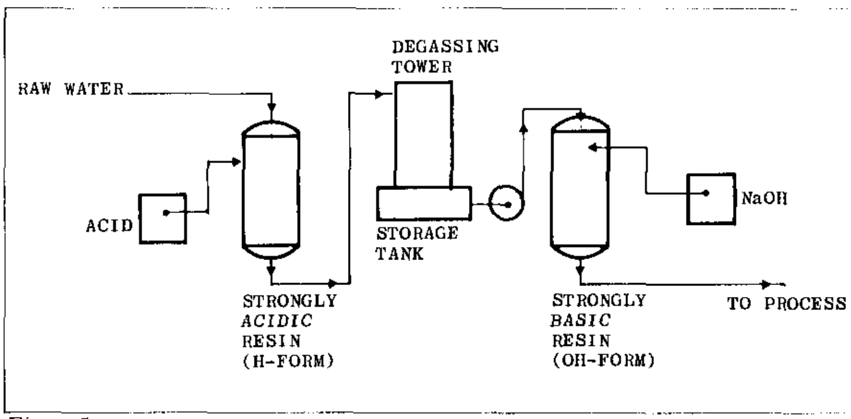


Figure 5

	Raw Water	BX	Dealk/BX	Demin
TH	250	Nil	Nil	Nil
Alk	200	200	20	Nil
DS	320	320	90	Nil

Table 2 Effect of treating water with various plants

	Raw Water	BX	Dealk/BX	Demin
TH	60	Nil	Nil	Nil
Alk	50	50	10	Nil
TDS	75	75	35	Nil
Cost of treatment per/1000 gallons	—	5p	15p	90p

Table 3

Water Treatment Plant Plant	20% MU	50% MU	80% MU	100% MU
Raw Water	16.6%	NA	NA	NA
Base Exchange	4%	10%	NA	NA
Dealk/BE	1.8%	2.5%	3.2%	3.8%
Demin	<1%	<1%	<1%	<1%

Raw Water Analysis
TH 250
Alk 200
TDS 320

Table 4

Water Treatment Plant	20% MU	50% MU	80% MU	100% MU
Raw Water	6%	15%	NA	NA
Base Exchange	1.5%	2.5%	4%	5%
Dealk/BE	<1%	<1%	<1%	<1%
Demin	<1%	<1%	<1%	<1%

Water Analysis
TH 60
Alk 50
TDS 75

Table 5

It is most probable that for the majority of boiler plants encountered in the package boiler market a simple base exchanged water will be sufficient provided its analysis is similar to that outlined in Table 3. On the other hand it is most probable that if the available water has an analysis similar to that in Table 2, then a Dealkalisation/Base Exchange plant would be required. However, this is by no means certain, since condensate return and blowdown considerations will have an important bearing on the selection of plant.

This is best illustrated by referring to Tables 4 and 5 which indicate what the blowdown requirements would be for plants operating with various make-up water quality based on chemical composition and condensate return. These tables have been drawn up to conform to BS 2486 with regard to boiler water quality for a typical package boiler operating at 100 psig.

These tables illustrate that in the selection of a suitable pretreatment plant, blowdown requirement is a very important consideration. Using the 'thinner' of the two waters illustrated above, it would be economically possible to run a boiler plant using 100% make-up provided heat recovery was installed. As a rough guide to the relative capital costs for a 1000 gp hr plant these are:

Base Exchange	£1500
Dealkalisation/BE	£10,000
Demineralisation	£15,000

It can be seen from the foregoing discussion that plant selection is not simple and straightforward and many factors have to be taken into consideration. Simply selecting a plant based upon flow rate considerations is not satisfactory and it is advisable to engage the assistance of water treatment consultants.

Feed Water Conditioning

The discussion so far has been primarily related to the type of pre-treatment plant required in order to provide a water of suitable quality in terms of hardness and other dissolved solids levels. Unfortunately it is only part way to achieving a boiler feed water suitable in terms of preventing scale and corrosion in the system.

The next important part of the boiler water treatment programme is feed water conditioning as distinct from feed water softening. With feed water conditioning we are concerned with conditioning the feed water so as to render it completely scale and corrosion free before entry into the boiler.

We have seen how with the use of suitable pre-treatment plant we can reduce the hardness level to 2 ppm. At this level of hardness it now becomes economically acceptable to remove this small residual hardness chemically so that the optimum in terms of boiler cleanliness can be achieved.

In fact with the correct selection and application of chemical treatment it is possible to attain a boiler surface absolutely free of any deposits enabling the maximum heat transfer efficiency to be obtained.

The most common means of achieving this is by the use of phosphate or chelant for scale conditioning. Both are acceptable but with very differing mechanisms and results.

Phosphate Conditioning

With phosphate conditioning the treatment involves the addition of small amounts of phosphate to the feed water to form insoluble calcium phosphate, calcium phosphate is preferred to calcium carbonate because it forms a less 'sticky' deposit and gives a mobile sludge which can be easily removed from the boiler via the blowdown.

Boilers on such a programme are generally very clean, however, it should be noted that such programmes are still precipitating programmes and over a period of time tube deposits will result, albeit on a much reduced scale than for an internal softening programme. Nevertheless, the effect on heat transfer and energy costs can be significant. Thus the movement from an internal softening programme to one with external softening plus internal conditioning with phosphate will give a significant improvement in boiler cleanliness.

Frequency of descaling and cleaning of the boiler can be reduced from once per 1-2 years to once per 5-10 years.

Chelant Conditioning

Chelant conditioning differs from phosphate conditioning in as much as the residual hardness reacts with the added chelant to form a soluble complex. With this approach it is possible to attain a boiler water condition with no insoluble impurities and hence the potential for deposit build-up is completely eliminated. There are some minor modifications that may be required to look after silica and iron oxide but in general these treatments have been extremely successful particularly on high pressure water tube boilers and in the last 5 years this success has also been transferred to low pressure and package boiler units.

Chelant programmes can have one major drawback, in that with inadequate control resulting from over feed of chelant, it is possible to have chelant attack on the metal surface causing corrosion. This has been noted in high pressure water tube boilers but rarely in package boilers.

This problem has been overcome, however, with the introduction of chelant /polymer programmes which allow the chelant to be fed substoichiometrically ensuring that no free residual or excess chelant is present in the boiler. This approach requires no free chelant and has all the benefits of a chelant programme in terms of boiler cleanliness, but without the risk of chelant corrosion. Boilers treated with such programmes give internal conditions far cleaner than with phosphate, and with proper control chemical cleaning of the boilers becomes a rarity.

Polymers

The final conditioning programmes to discuss come under the heading of polymers. Inevitably as we have progressed in the elimination of the more common deposit forming impurities in the treatment of boiler feed water, we have highlighted other deposit forming impurities. These have always been present, but formed only a very small part of the original deposit. As the major deposition problems have been eliminated, then the so called minor component becomes a major component. An example of this is iron oxide, brought forward in the feed water. Iron oxide deposition has become a major problem in very high pressure water tube boilers.

Neither phosphate nor chelants will deal with this and so supplementary polymer feed is required. This acts by dispersing the iron oxide into very fine particles which are easily removed with blowdown.

In the past 12 months a new concept in boiler water treatment has been introduced based upon the exclusive use of a polymer. This approach is a single polymer application and contains neither phosphate nor chelant, thus reducing precipitation reactions and eliminating the potential for chelant corrosion.

The programme is a solubilising one for any hardness present in the feed water and any other impurities such as iron oxide, silica or phosphate (occurring naturally in the raw water) are dispersed in a manner similar to a conventional polymer and removed via the blowdown. Boilers on such a treatment programme have given extremely good results with 100% transportation of all the feed water impurities through the boiler resulting in as new boiler internal conditions.

Whichever treatment philosophy is selected for internal conditioning for prevention of deposits, it is essential to have a proper pre-treatment plant. The internal conditions spoken of here could only be achieved in the past by the use of a Demin plant. Such a unit would be uneconomic on a small package boiler. However with the advancements made in water treatment technology, the same internal boiler conditions can be achieved with the use of a simple base exchange plant, or depending on raw water supply – a Dealk/BE plant, plus the proper selection of internal conditioning chemicals.

Corrosion

In the section on Internal Conditioning, we have looked only at treatment philosophies used to keep the heat transfer surfaces free of deposits. Such efforts to achieve clean deposit free surfaces will be to no avail if there is no metal to keep clean. By this statement we are, of course, referring to corrosion.

The form which corrosion takes place in a boiler itself is by pitting and the cause is the presence of oxygen. A lot of energy is expended in converting iron oxide into a form of iron suitable for use in industry. It takes but a little time and money to prevent the reversion of this iron into its natural state.

For complete protection against corrosion it is essential to add an oxygen scavenger such as sodium sulphite or hydrazine. Because there is a finite time that is required for those chemicals to react with any O_2 present, these are usually supplied with an added catalyst which increases the reaction time by some 500 times making it more or less instantaneous.

Hydrazine or similar such compounds eg hydroxylomine, are not generally employed unless there is a deaerator in use and only then on very high pressure units. However, deaerators are not normally used on package boilers due to their high cost £30,000 plus and, therefore, chemical means are normally employed for oxygen scavenging, unless the steam load is high enough to justify installation of such equipment.

Fig 6 is a graph of the dissolved oxygen content of water at various temperatures. As can be seen, there is an inverse relationship between these and the higher the temperature, the lower the residual oxygen.

Thus by increasing the feed water temperature this inverse relationship can be used to advantage in one of two ways:

Table 6

Feed Water Temperature	90°F	180°F
Feed Water Alkalinity	30	30
Feed Water TDS	60	60
Total Feed Water TDS	130	80
Maximum concentration factor	23	35
Blowdown required	4.3%	3%

Thus for a boiler with a steam load of 10,000 lbs/hr, increasing the feed water temperature to 180°F would result in a fuel savings of £1,300 due to reduced blowdown and a further saving of £2,000 pa in oxygen scavenging costs.

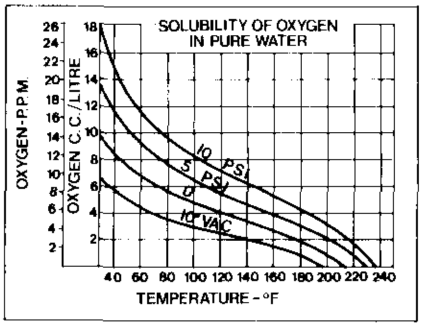


Figure 6 Solubility of oxygen in pure water

1. Chemical Scavenger requirements and hence costs are reduced.
2. The dissolved solids level of the feed water is reduced due to reduced scavenger requirements and hence blowdown and fuel costs can be reduced.

This graph shows that at 90°F water contains 7 ppm of dissolved O_2 but at the 180°F this drops to 2 ppm. Thus a feedwater at a temperature of 90°F will require 3½ times as much O_2 scavenger than if the water were at 180°F. Hence it is advantageous to get the feed water temperature as high as is practicably possible.

From an energy requirement point of view, the difference in the fuel required to heat the water in the feed tank as opposed to the boiler will be marginal.

Table 6 illustrates the points discussed above and quantifies in monetary terms the approximate savings to be accrued in raising the feed water temperature from 90° to 180°F.

Thus for a boiler with a steam load of 10,000 lbs/hr, increasing the feed water temperature to 180°F would result in fuel savings of £1,300 due to reduced blowdown and a further saving of £2,000 pa in oxygen scavenging costs.

Condensate Protection

The last remaining area to be covered is the protection of steam and condensate lines against corrosion. This is generally caused by CO_2 from the boiler and ingress of O_2 in the condensate system.

The most effective means of protection is by the use of:

1. O_2 removal in the boiler feed.
2. Neutralising amines which neutralise the CO_2 and raise pH.
3. Filming amines which put down a protective monmolecular film.
4. A mixture of neutralising and filming amine.

The choice of programme will depend upon the type and relative amount of make-up water used and the complexity of the condensate system. In the hospital service there is a complete ban on the use of all amines other than octadecyclamine which is a filmer. It is, however, fair to say that most Hospital Engineers prefer not to use any condensate treatment at all, though why is not fully understood, since the cost of condensate pipework replacement can be very expensive.

Summary

This paper has demonstrated the effect that scale deposits on heat transfer surfaces and corrosion in the boiler system can have on the safe operation of the boiler and the energy costs of the plant.

With the selection of proper pre-treatment plant – based upon ion exchange processes – and a chemical treatment programme designed to eliminate deposition and corrosion problems, it should be possible to run the plant for a period well in excess of the previously accepted life of the boiler and at optimum efficiency.

Mr Cripps is Principal Assistant Engineer with West Midlands RHA, and Dr Ellis is Business Development Manager with Dearborn Chemicals Ltd, Widnes, Cheshire.

The special need for adequate water treatment to remove gases from hospital steam supplies

N F CRIPPS CEng MIMechE FIHospE
D M ELLIS BSc PhD MIWSoc MInstE

The great majority of the energy used in industry and in public services is directed at the production of steam in boilers. The need for water treatment is widely accepted in the prevention of such problems as corrosion, scaling and carryover. It is not always appreciated however, that a water treatment programme capable of protecting all parts of the boiler system should be used. This applies not only to the boiler itself but to all other ancilliaries including the feed system and the condensate system. Water treatment costs can frequently be cut by the use of a partial treatment programme but the total operating cost may well be considerably increased by such measures. Corrosion or scale both lead to increased maintenance costs and downtime as well as reducing heat transfer and therefore boiler efficiency.

Protection of condensate systems

Corrosion of condensate lines is a special problem within the health service and will be discussed in detail later. Where such corrosion occurs, the costs can be great. A single pin-hole can necessitate the replacement of a 20 foot length of pipework and corrosion products returning to the boiler with the condensate, will cause the formation of highly insulating iron oxide deposits. Condensate leaks can also cause considerable loss of efficiency.

Modern boiler water treatment techniques can now successfully combat all of these problems, but consideration must always be given to the use for which the steam is intended and the limitations which this may impose on the type of treatment chemicals which can be used. Where steam may come into contact with food it is obvious that great care must be taken to prevent contamination which could have harmful effects. This is the case in hospitals and for this reason the type of treatment which can be used to prevent condensate corrosion is restricted. Such treatment chemicals must be steam volatile and will always be present in the steam. Hospital Technical Memorandum No.6 considers that only one compound, octadecylamine (a filming amine) can be used and only then with certain restrictions. These restrictions are as follows:-

1. Cooking and food processing — concentration of octadecylamine in steam not to exceed 3 ppm.
2. In sterilisers octadecylamine not to exceed 2.4 ppm.

3. In milk kitchens octadecylamine must *NOT* be used.
4. Humidifiers — 3 ppm maximum.
5. Distilled water — where produced from steam the water should *not* contain octadecylamine.

Because of the above restrictions it is unusual to find condensate line treatment in use within the health service and for this reason, corrosion is a widespread problem. Under such circumstances it is vital that the rest of the water treatment programme used is adequate. The careful application of the correct chemicals in conjunction with adequate pretreatment can bring condensate corrosion problems under control even when specific condensate treatment cannot be applied. To understand how this can be achieved it is first necessary to identify the main cause of corrosion in steam boiler systems. This is due to two principal gases, carbon dioxide and oxygen.

Carbon dioxide in boiler feed water

Carbon dioxide may be present in the feedwater, but is generally produced in steam boilers by decomposition of the bicarbonates and carbonates which are commonly found in raw water.

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

$$Na_2CO_3 + H_2O \rightarrow 2\ NaOH + CO_2$$

Carbon dioxide so formed in the boiler will flash off with the steam and redissolve in the condensate where it forms an aggressive solution of carbonic acid which gives rise to typical grooving of pipework.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

If such problems are to be avoided then the amoutn of both carbon dioxide and oxygen in the steam must be reduced to an absolute minimum by careful control of feedwater quality.

Boiler feed water treatment

In order to ensure that carbon dioxide is not formed, the concentration of carbonate and bicarbonate in the boiler feedwater must be reduced to a minimum. Scale control programmes based on carbonate as a precipitant will clearly be unsatisfactory. Appropriate pretreatment of the feedwater will be necessary and one of three techniques may be used — Dealkalisation, chloride anion exchange or demineralisation. The widely used practice of base exchange softening is not effective in reducing carbonate and bicarbonate as it merely reduces the hardness ions calcium and magnesium. Even when feedwater alkalinity is relatively low, it is advantageous to reduce this still further, as only 1 ppm of carbon dioxide can reduce the condensate pH from 6.5 to 5.5.

All the processes mentioned for reduction of carbonates and bicarbonates are based on the use of ion exchange resins. These materials are capable of exchanging ions on their surface for ions in the feedwater and can be of two types — Cationic resins will remove cations such as calcium and magnesium while anionic resins will remove ions such as carbonate, sulphate and bicarbonate.

Dealkalisation is probably the best approach to use on medium sized plant and it can also be justified on small plant.

Here, a weakly acidic cation exchanger is used in the hydrogen form to remove calcium, magnesium and sodium ions associated with alkalinity. This converts these salts to carbonic acid which is then removed in a degasification unit. Non-alkaline hardness is finally removed by softening with a base exchange unit. The process reduces feedwater dissolved solids and hence blowdown. The payback for weak acid dealkalisation over base exchange softening can be as little as 8 months.

In chloride anion dealkalisation the feedwater is first passed through a cationic resin to remove calcium and magnesium and then through an anionic resin to remove carbonate, bicarbonate etc. The resins are both regenerated with brine and the resulting feedwater will contain principally NaCl.

The running costs for a chloride anion dealkalisation unit are similar to the weak acid dealkalisation process mentioned previously. Unfortunately the chloride anion process does not reduce the dissolved solids in the boiler feed water. Boiler blowdown is not reduced and consequently, the overall cost of operating a chloride anion plant is higher than a weak acid dealkalisation plant. In this respect chloride anion exchange is inferior.

Demineralisation is generally used only on high pressure plant where a feedwater of very high quality is required. The process is essentially the same as the chloride anion dealkalisation process except that acid and caustic soda are used to regenerate the cationic and anionic exchange resins respectively. The nett result is that all cations are converted to H^+ and the anions to OH^-. These then produce water, effectively providing a feedwater with no mineral content. Demineralisation is useful for processes outside the boilerhouse, and may be required in laboratories and pharmacies.

The application of the above techniques will reduce the feedwater alkalinity to a low level but a small amount will still be present and give rise to a little carbon dioxide. This means that condensate treatment should still be used if possible and the application of filming amines will be discussed later. Neutralising amines are widely used in industry to increase condensate pH but unfortunately these cannot be used in hospitals (see HTM 6).

Oxygen in boiler feedwater

Oxygen removal from condensate is in many ways even more important than carbon dioxide removal because of the localised nature of the attack.

About 9 ppm of dissolved oxygen will always be found in water at room temperature, and gives rise to rapid pitting corrosion which can perforate pipe in a very short time. When both carbon dioxide and oxygen are present together attack can be extremely rapid.

There are a number of ways in which oxygen can find its way into the condensate and these include:-

1. Ineffective oxygen removal from the feedwater.
2. Oxygen ingress into the condensate system.

   Oxygen ingress into the condensate system will occur at regions of low or zero pressure such as condensate receivers and through any leaks in the system.

Oxygen can enter the condensate system if it is turned off overnight for energy conservation reasons. As the system cools down and the steam condenses, a partial vacuum is created which will cause air to be drawn in. The oxygen ingressing, in conjunction with any carbonic acid already present will provide corrosive conditions. To minimise corrosion, it is important that the condensate system is properly designed with adequate gradient of the pipe work and positioning of steam traps at the lowest points to give effective draining.

As the temperature of water is increased the dissolved oxygen content falls until at boiling point very little is left. It is obviously of interest therefore to increase the temperature of the boiler feedwater to a maximum. This implies heating hotwells and maximising condensate recovery the latter also increasing boiler efficiency. Where cost effective, heat recovery from blowdown will also increase feed temperatures. Feed preheaters, vacuum and thermal deaerators may also be used. Oxygen will be reduced in this way, but the corrosion rate in the feed system may be increased. This is because there are two opposing factors at play. First, corrosion increases with temperature in a closed system where the oxygen cannot escape. As the temperature increases however, the oxygen content will fall and less oxygen will be available to cause corrosion. The nett result in an open system is a curve which has a maximum at about 85°C — a typical feedwater temperature. If corrosion in the feed system and boiler are to be prevented we must therefore eliminate oxygen from the feed as rapidly as possible. Any oxygen remaining in the feed when it enters the boiler will tend to flash off and will enter the steam. An effective chemical agent capable of removing the remaining oxygen must therefore be used.

Oxygen scavengers

To be effective the oxygen scavenger must be a powerful reducing agent, must be capable of reacting with oxygen at a reasonably fast rate and should have no adverse affect on the boiler metal or other chemical treatment compounds. Materials which have been commonly used include:-

1. Tannin
2. Sodium Sulphite
3. Hydrazine

Tannin is a naturally occurring substance which can react with oxygen but only slowly. It can be effective at reducing corrosion in feed systems and in the boiler by formation of an iron tannate film but because it is a poor oxygen scavenger, the feedwater entering the boiler will still contain some oxygen and this will flash off as described previously. Existing tannin-based products must therefore be considered as inadequate for use in hospitals except where low feedwater temperatures make sulphite uneconomical.

Sodium sulphite is generally the oxygen scavenger of choice for use in hospital boilers. This substance reacts rapidly with oxygen to form sodium sulphate.

$$2\,Na_2SO_3 + O_2 \longrightarrow 2\,Na_2SO_4$$

The rate of reaction can be increased by as much as twenty times by the addition of a small amount of transition metal catalyst. In this way practically oxygen-free feedwater can be produced.

Hydrazine is generally used only on higher pressure plant. This is because of its higher costs which can only be justified where the feedwater oxygen content has previously been reduced to a very low level by deaeration. It has the advantage that unlike sulphite it does not contribute to boiler dissolved solids as the reaction with oxygen produces only nitrogen and water.

$$N_2H_4 + O_2 \longrightarrow N_2 + 2H_2O$$

Hydrazine cannot be used however because of its high toxicity. It has also been implicated as a carcinogen.

Another approach which can be used is that of the volatile oxygen scavenger. This approach is unique in that it will not only remove oxygen from the feedwater but can pass over with the steam so that it is then available for scavenging oxygen in the condensate. This is clearly an enormous advantage as no other scavenger can remove the oxygen entering the condensate system itself. A typical example of such a treatment is diethylhydroxylamine (DEHA). This substance is a highly effective oxygen scavenger especially when catalysed. It has good steam volatility and it also promotes magnetite formation. Unlike hydrazine it has a very low level of toxicity. Unfortunately this material does not yet have FDA (Food and Drug Administration) approval and should not therefore be used in the majority of hospitals because of the limitations described earlier.

Hotwell design

A further aspect which is often neglected is that of hotwell feedtank design. It is important that these be designed in such a way as to give the best possible mixing of condensate and make-up so that a feed of uniform temperature is produced. In this way the correct dose of oxygen scavenger can be provided. When temperature varies, insufficient scavenger may be present at times while at others there will be a large excess.

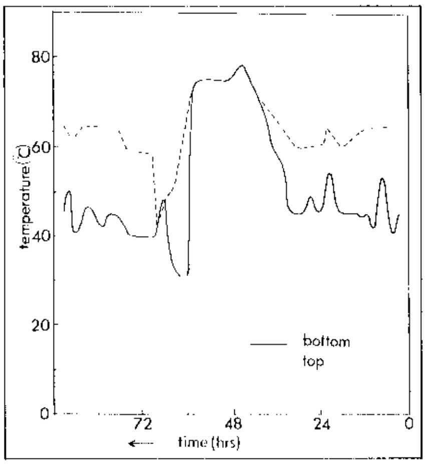


Figure 1. Variation in hotwell temperature (case study)

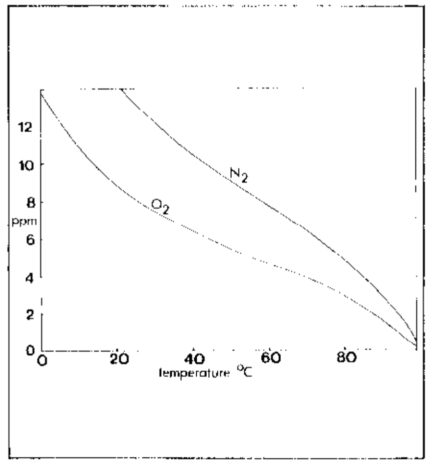


Figure 3. Solubility of oxygen & nitrogen in water

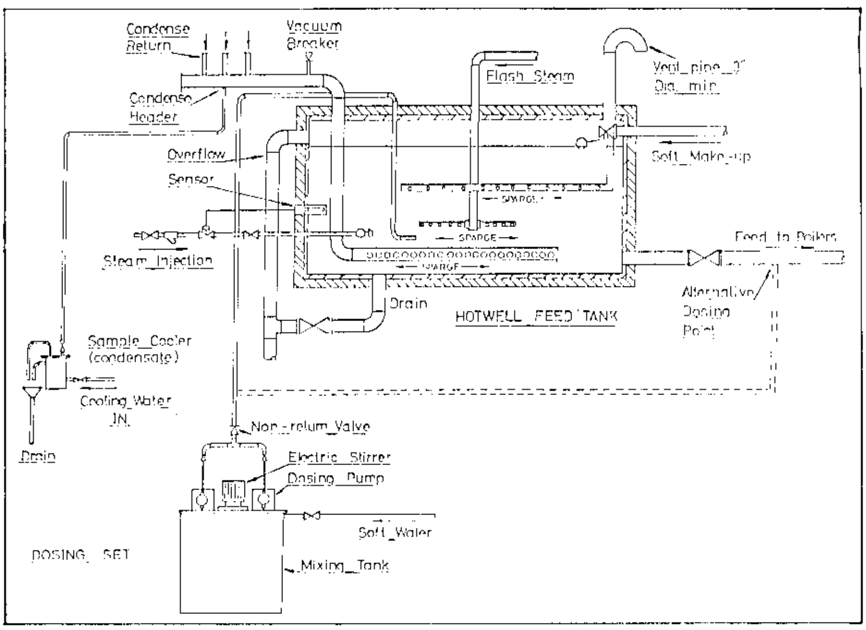


Figure 2. Hot well design

When a large department is turned on first thing in the morning it is likely that the steam demand will be high. At first a little or no condensate will be returned resulting in a high proportion of cold make-up to the boiler. Then, cold condensate will be returned and this will gradually warm-up until equilibrium is achieved. The lower feed water temperature which will result means that the level of dissolved oxygen will be higher than normal and there will be insufficient oxygen scavenger to cope. This will reduce or even destroy the chemical reserve in the boiler. A practical solution to this problem is to shot dose oxygen scavenger on start up in addition to thermostatic control of feedwater temperature with steam injection as described below.

It is also important to ensure that gases are not dissolved in the water due to cascading as it enters the feedtank. This is frequently the case in poorly designed systems where the condensate return is substantially aerated by entering above the water level. The adjacent location of the make-up water inlet and boiler feed take-off will give a high probability of cold make up water passing directly to the boiler.

Figure 1 shows a specific case in a hospital where poor mixing is indicated by the temperature gradient across the tank.

The classic solution to this problem is to use sparge pipes below the water level for the condensate return and make-up water. Unfortunately this is not always adequate.

The ideal hotwell should have sparge pipes below the water level and thermostatically controlled live steam injection to cause turbulence and maintain a constant water temperature. Figure 2 shows a well designed system which will give excellent mixing and good temperature control.

Materials for condensate systems

Means of reducing carbon dioxide and oxygen have been discussed and when carried out with careful supervision will reduce problems to a minimum. Some corrosion however is certain to occur and two approaches have been used in hospitals — use of copper condensate pipework and the application of filming amines. The use of copper in condensate systems however should be AVOIDED. Traditionally copper systems have been used because this metal is less prone to attack than steel. Some corrosion still occurs however, and the dissolved copper produced, if returned to the boiler, may give rise to severe galvanic corrosion of the boiler metal. This is because copper will plate out on the metal surface and the iron then behaves as a anode. Extremely severe pitting can occur under these conditions. In one specific case within the Health Service a boiler had to be completely retubed because of this problem. With a correctly designed condensate system and a correct, well managed water treatment programme, the additional cost of copper cannot be justified. Steel should be used.

Filming amines

The use of filming amines offers a viable approach for controlling condensate corrosion. These materials prevent both attack by carbon dioxide and oxygen by the formation of a water repellent barrier on the metal surface. Effective protection can be achieved with as little as 0.5 to 1 ppm of amine in the steam. The most commonly used amine is octadecylamine, and it can be seen that the working concentration is well below the limits specified in HTM6. Care should be taken to test regularly for amine to ensure that the correct dose level is maintained but not exceeded. Filming amines should be dosed initially at a lower level and this then increased slowly over a period of several months. This is due to the detergent properties of octadecylamine which may dislodge large quantities of corrosion products if over-dosed initially. This can give rise to the formation of gunk balls and the blocking of steam traps.

The presence of gases in the steam supply can give rise to considerable corrosion as already discussed but may also give rise to other special problems in hospitals. The most important example is in the correct operation of porous load sterilisers.

Porous load sterilisers

Following the publication of HTM 10 (1980) problems were encountered in practice in achieving porous load steriliser chamber temperatures within the 5°C tolerance. Various causes have been identified, but one of the most frequent is the presence of non-condensible gases in the steam. These gases may also cause the steriliser air detector to abort cycles. The gases responsible for these problems are oxygen, nitrogen and carbon dioxide. The concentrations of oxygen and nitrogen found in water at different concentrations of oxygen and nitrogen found in water at different temperatures are shown in Figure 3. It can be seen that in both cases solubility decreases with increasing temperature. The concentration of carbon dioxide is usually quite low in boiler feedwater, the principal source in the steam being the decomposition of bicarbonates and carbonates as discussed earlier. Non-condensible gases can therefore be reduced to a very low level by two actions:

1. Ensuring maximum feedwater temperature to the boiler.
2. Dealkalisation of boiler feedwater.

While maximising feedwater temperature is good practice and involves minimum cost, dealkalisation requires considerable capital investment and for this reason it is worth establishing if the problem is a water treatment one before embarking on extensive modifications. Chamber temperatures in excess of the 5°C tolerance is a classic problem which has been solved in many cases by small changes in operating practice such as reducing the rate of entry of the steam into the evacuated steriliser chamber or by modifying the cycle to elminate vacuum — pressure reversals immediately before the constant temperature period.

Conclusions

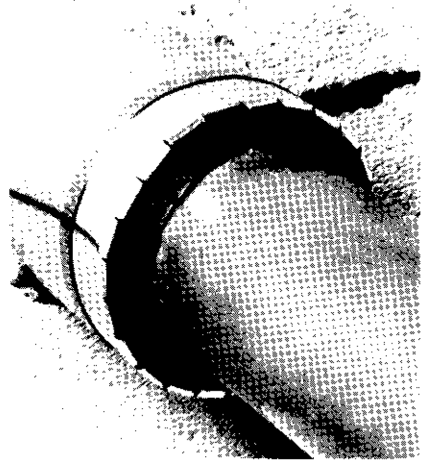
Water treatment within the health service has special implications which should not be overlooked. Reducing costs by installing inappropriate pretreatment plant or by using cheap chemical treatment programmes may at first sight appear attractive, but will almost certainly lead the user into substantially increased maintenance and running costs as well as putting at risk the correct operation of important equipment. While scale prevention has not been considered in this article it is worth remembering that only one thirty second of an inch can cost the operator several times the cost of an effective water treatment programme because of the resulting loss in efficiency.

Product News

Fire Barrier protection

Fire Barrier, the highly successful 3M system for preventing the spread of fire through service ducts in walls and floors, has been extended to include a kit for use with PVC soil pipes. Like other Fire Barrier products the new kit can be installed without any special skills or equipment, eliminating the need to employ outside contractors.

The 3M kit is suitable for the protection of pipes up to 4 inches in diameter and has passed the requirements of BS 476, Part 8, for a fire rating of over 3½ hours.



Further details from: Electrical Products Group, 3M United Kingdom PLC, 3M House, PO Box 1, Bracknell, Berkshire RG12 1JU. Tel: (0344) 58755.

Prefabricated Insulation

'Sealsulation' is a new concept in prefabricated insulation to be used when installing or re-lagging water tanks and oil tanks or insulating hot or cold rooms in laboratories. Overlapping 'planks' of a hollow plastics extrusion are filled with mineral woold or granules and sealed at each end. Wood has been used in this way for well over a century and the adapting of new materials to an old principle has extended its use to many areas for which wood is quite unsuitable. The system is naturally limited in application to flat or cylindrical surfaces but the possibility of extending the idea toi conical surfaces is under consideration. 'Sealsulation' is available in two thicknesses, 32mm and 55mm and in a range of colours. Alternatively it can be clad with foil, either 0.2mm Aluminium 1200 alloy grade or 0.11mm Stainless steel grade 316.

Further details from: Sealsulation, 9 Walkwood End, Beaconsfield, Bucks. HP9 1PR. Tel: 04946 4828.

Crane Valves

Ivco Process Valves Limited, the nationwide distributor, stockist and manufacturer of valves, actuators and associated equipment, announces that it has been appointed UK Mainland distributor for Crane cast and forged steel valves. Ivco Process Valves will stock the full range of Crane's forged and cast steel gate, globe and check valves. As with all their valve products, Ivco Process Valves will offer Crane valves with a full actuation and packaging service, utilising proprietory electric and pneumatic actuators, including Worcester, Norbro and Kinetrol, and a wide range of control options. Based at Southall in London, Ivco Process Valves have eight regional distribution centres situated throughout the UK, including one at Aberdeen.

Further details from: Ivco Process Valves Ltd, Bulls Bridge Industrial Estate, Hayes Road, Southall, Middlesex UB2 5NB. Tel: 01-561 4000.

Continued on page 16

The Conference goes to Harrogate

41st Annual Conference of The Institute of Hospital Engineering
Hotel Majestic, Harrogate
Opening Wednesday 22 May — 10.30am
Closing Friday 24 May — 12.00pm

The ancient market town of Knaresborough has historic charm. (Photographs by courtesy of Harrogate Resort Services Publicity Department.)

IHEX '85

Hotel Majestic, Harrogate
Wednesday 22 May — 9.00am to 5.30pm
Thursday 23 May — 8.30am to 3.30pm
Admission free

This year the International Hospital Engineering Exhibition is double the size of IHEX '84. The spacious Conference Hall of the Hotel Majestic also allows space for more extensive displays, and larger exhibits and working machinery. Once again it will cover the latest developments in all aspects of hospital engineering, including building and construction, hospital equipment technology, communications, computers and manufacturers' supplies.

Conference delegates will be joined by exhibitors for lunch on both days of the exhibition. On Wednesday at 5.30pm there will be a cheese and wine party within the Exhibition for delegates and IHEX '85 visitors.

Welcome to the Conference

'COME TO HARROGATE!, England's Floral Town', evolved as a famous Spa Centre following the discovery of the first medicinal waters by William Slingsby in 1571. Over the years, altogether 100 Springs were found, all with distinct unique properties and the Town grew accordingly, successfully catering for the needs of Visitors 'taking the waters'. Still today it continues to attract many people, both in its function as a popular Tourist Centre and as a Conference Venue.

This year the Institute has selected Harrogate for its Annual Conference and our Organising Committee have worked hard to prepare an interesting Programme of Technical Sessions and Visits. There is to be a Civic Reception at the Royal Baths Assembly Rooms and there is to be another exhibition, IHEX '85, organised by T. Jarvis Exhibitions. Those who attended the Bristol Conference last year will recall the success of the exhibition held then. This year promises to be as good as if not better. The Ladies Programme will include visits to Ripley and the Wharfdale & Historic Herriot Country.

Do please support the Institute's efforts to provide a Conference that is different. My wife Doris and I look forward to welcoming you all.

L G HADLEY CEng FIMechE FInstE FCIBS MConsE FIHospE
President of The Institute of Hospital Engineering

EXHIBITORS AT IHEX 85

Afos Ltd.
Compressors driers and filters

Altro Floors
Safety flooring and whiterock wall cladding

Amersham International PLC
Enclosures cabinets etc

N. G. Bailey & Co.
Medical gas pipeline equipment

Balston Filter Products
Filters for sterilizers

Calomax (Engineers) Ltd.
Water boilers for hospital ward kitchens

Cass Electronics Ltd.
Paging nurse call and telephone systems

Cross-Guard Ltd.
Miracle multi-purpose protective coating

Dearborn Chemicals Ltd.
Products and services for water treatment

Dex-O-Tex International Ltd.
Trowelled seamless floors membranes

Dowson & Mason Ltd.
Incineration equipment

Evans Universal Limited Incinerators

Feedwater Treatment Services Ltd.
Products and services for water treatment

Frenger Troughton Ltd.
Radiant heating equipment

Stuart Forbes Ltd. Fire stops

Future Laundry Systems Ltd.
Energy recovery/materials handling

GD Engineering (Ilford) Ltd.
Bedhead trunking and nurse call systems

Hamworthy Engineering Ltd.
Burners boilers heaters and combustion control equipment

Hospital Engineering (Harlow) Ltd.

Hoval Farrar Limited Incinerators

Howorth Air Engineering Limited
Specialised environmental and microbiological air engineering products

HPC Engineering Ltd.
Fittings for pathology, post mortem and aseptic pharmacy areas

Luwa (UK) Ltd
Ultra clean operating theatres

Marley Extrusions Ltd.
UPVC above and below ground draining systems

Medical Gas Installations Ltd.
Piped medical gases and electrical services

Mediplan Engineering Ltd.
Hospital communications/nurse call systems/hospital lighting

M.I.M. Ltd.
Medical gas equipment and alarms

National Coal Board

NEI International Combustion Ltd.
Boilers and stokers

Neil and Spencer Ltd.
Laundry equipment

N.I.F.E.S. Energy conservation

Ohmeda Integrated patient services

Orwak Linley Ltd.
Waste compactors

Scott-Western Ltd.
Bedpan washers and disinfectors

J. G. Shelton & Co. Ltd.
Incinerators

W & G Sissons Ltd.
Sanitory assemblies

C.A.W. Stanbridge Ltd.
Bedpan washing machines

Static Systems Group Ltd.
Nurse call and fire alarm equipment

Surgical Equipment Supplies Ltd.
Portable and free-standing sterilizers

Tweedy of Burnley Ltd.
Clinimatic macerator

Twin Industries Agencies Ltd.
Steam boilers and heat reclaimers

Walker Crosweller & Co. Ltd.
Shower equipment and thermostatic mixing valves

Wardray Products (Clerkenwell) Ltd
X-ray protection and X ray accessories

Tour of the Staincliffe Energy Centre Complex

Delegates will be taken on a tour of the Staincliffe Energy Centre Complex as part of the Conference programme. The visit will emphasise the management, financial and technical responsibilities involved in maintaining and operating such a large and important complex. It is hoped to have technical representatives from all the equipment manufacturers on site to be able to answer in full any questions from delegates. The District Works Department, Dewsbury, extend an invitation to Institute Members who are unable to join delegates on this particular tour to visit the Energy Centre.

It is the turn of Yorkshire to play host to the Annual Conference of the Institute, and what better location could there be than the historic and gracious spa town of Harrogate, with its lovely parks, gardens and open spaces. In fact it is a return visit and this time we chose the Hotel Majestic, famous to so many conferences over the years.

Whilst the menfolk consider a wide range of technical subjects, the ladies will visit York, taking lunch there in the Merchant Venturers Hall, and visiting the Viking Centre. Also they will tour Herriot country and visit Fountains Abbey.

The Mayor of Harrogate will be kind enough to give a reception for approaching 200 delegates and their ladies during the stay. The Annual General Meeting of the Institute will be held on the final morning of the Conference.

Harrogate

Situated in an area of outstanding natural beauty, Harrogate is renowned for its beautiful parks and gardens. In particular, the magnificent Valley Gardens, as well as containing acres of floral displays, rhododendrons and pine woods, offer entertainment, sport and playgrounds.

Those interested in history will not want to miss a visit to the Royal Pump Room Museum, which contains displays of Harrogate's heritage and period costumes.

Following the discovery of its first medicinal spring in 1571, Harrogate became one of the most fashionable spas in Europe. The grandeur and elegance with which its Victorian forefathers endowed the city can still be experienced among the imposing buildings, broad tree-lined streets and impressive shopping centre.

The surrounding countryside, too, is well worth a visit. Of particular note are: Ripon, a historic cathedral city which now boasts a popular race course; Knaresborough, an ancient market town still steeped in olde worlde charm; and Boroughbridge, a Norman town which became Knaresborough's port and whose streets still contain fine Regency, Georgian and Victorian buildings.

41st ANNUAL CONFERENCE
HOTEL MAJESTIC
HARROGATE, MAY 22nd—24th 1985

CONFERENCE PROGRAMME

Wednesday 22nd May

9.00am IHEX '85 Exhibition opens
Coffee available with exhibitors

10.30am OFFICIAL OPENING of 41st Annual Conference and IHEX '85 by BRYAN ASKEW ESQ.
Chairman, Yorkshire Regional Health Authority
Introduced by L. G. HADLEY ESQ CEng, FIMechE, FInstE, FCIBS MConsE, FIHospE, President, The Institute of Hospital Engineering

10.40am ELECTRICAL SERVICES IN HOSPITALS
'15th EDITION — ITS APPLICATION'
Speaker: D. K. MORRELL ESQ CEng, MIEE, MCIBS
North Western Regional Health Authority
'INTEGRATION OF ELECTRICAL SERVICES'
Co-ordination of Electrical Services
Speaker: A. V. WHETHAM ESQ, William Steward & Co Ltd
Approach from the Designer
Speaker: R. M. CUTCLIFFE ESQ CEng, FIMechE, FCIBS, FIHospE. Regional Engineer, West Midlands Regional Health Authority
Chairman: M. N. LOWSLEY ESQ CEng, MIMechE, MCIBS, FIHospE. Regional Engineer, Yorkshire Regional Health Authority

12.45pm Lunch

2.00pm DEVELOPMENTS IN LINEN SERVICES
'MODERN LAUNDRY DESIGN CONSIDERATIONS'
Speaker: W. G. FUELL ESQ CEng, MIMechE. Laundry Engineering Advisor, Department of Health & Social Security
'CONCEPTUAL DESIGN OF INTEGRATED HEAT AND WATER RECOVERY SYSTEMS'
Speaker: R. M. NEALE ESQ BSc, PhD, CEng, MIChemE
Director of Research, Fabric Care Research Association Ltd
'TUNNEL WASHING SYSTEMS'
Speaker: E. A. JACKSON ESQ Head of Applied Technology. Fabric Care Research Association Ltd
Chairman: K. H. DALE ESQ OBE, CEng, MIEE, FIHospE lately Regional Engineer, Yorkshire Regional Health Authority

5.00pm Visit to Exhibition IHEX '85 to include Cheese and Wine Party

7.00pm CIVIC RECEPTION —Royal Baths Assembly Rooms

Thursday 23rd May

8.30am IHEX '85 Exhibition opens
Coffee available with exhibitors

10.00am HSDU, PINDERFIELDS
'PLANNING AND THEORY'
Speaker: W. R. HYSLOP ESQ BArch (Hons), RIBA, ARIAS
Principal Architect, Department of Health and Social Security
'OPERATIONAL MANAGEMENT'
Speaker: J. G. HARDMAN ESQ CEng, MIMechE, FIHospE
District Works Officer, Huddersfield Health Authority
Chairman: D.A. HEARH ESQ RIBA. Assistant Regional Architect, Yorkshire Regional Health Authority

12.00noon IHEX '85 Exhibition
Coffee available with exhibitors

12.30pm Lunch

1.00pm VISIT TO THE ENERGY CENTRE,
STAINCLIFFE GENERAL HOSPITAL, DEWBURY

4.30pm Leave Dewsbury and return to Hotel Majestic arriving 5.30pm

7.40pm CONFERENCE DINNER DANCE

Friday 24th May

10.30am THE FUTURE FOR THE ENGINEERING PROFESSION
Speaker: PROFESSOR J. C. LEVY OBE, PhD, CEng
Director — Engineering Profession Engineering Council
Chairman: J. G. CLARKE ESQ, Dip. Arch, RIBA
Regional Works Officer, Yorkshire Regional Health Authority

12.00pm CONFERENCE CLOSURE by The President The Institute Of Hospital Engineering

Branch Officers for 1985/86

Southern Branch: *Chairman:* S. Whiteley
Secretary/Treasurer: A. J. Styles, 11 Rufford Close, Boyatt Wood, Eastleigh, Hants. SO9 4RU. TN: Southampton (0703) 777222.

West Midlands Branch: *Chairman:* D. L. Hall *Treasurer:* G. Pike
Secretary: J. M. Hinckes, 10 Rowley Grove, Tile Cross, Birmingham B33 0AS. TN: Birmingham (021) 705 6741.

East Midlands: *Chairman:* John Hemes
Hon Secretary: E. A. Hall Esq. FIHospE Messrs. E. G. Phillips Son and Partners, 26 Annesley Grove, Nottingham NG1 4GW. TN: Nottingham (0602) 475783.

Wales: *Chairman:* R. G. Kensett *Hon Treasurer:* P. Jackson
Hon Secretary: M. J. Back Esq. MIHospE, 10 Nant-y-Felin, Efail Isaf, Nr. Pontypridd CF38 1YY. TN: Cardiff (0222) 755944 ext 2562.

North West: *Chairman:* J. Sunderland
Hon Secretary: B. Duncan Esq. FIHospE, North Western Regional Health Authority, Gateway House, Piccadilly South, Manchester M60 7LP. TN: Manchester (061) 236 9456 ext 284.

FORTHCOMING BRANCH MEETINGS

Southern Branch: *Hon Sec: A. J. Styles, 11 Rufford Close, Boyatt Wood, Eastleigh, Hants. SO9 4RU. TN: Southampton (0703) 777222.*

8th May — Water Authority Bye Laws by John Barlett, Board Road, Royal Hampshire County Hospital, Winchester.

10th July — Wessex Body Scanner, Deans Suite, Southampton General Hospital.

Welsh Branch: *Hon Sec: M. J. Back, 10 Nant-y-Felin, Efail Isaf, Nr Pontypridd CF38 1YY. TN: Cardiff (0222) 755944 ext 2562*

17th May — Study visit to Amersham International.

Oxford Spring Lecture

5th June — John Radcliffe Hospital, Oxford.

Should you wish to attend any of the above meetings, kindly notify the Honorary Branch Secretary by filling in the below slip:

ATTENDANCE AT BRANCH MEETINGS

Members who intend attending any particular branch meetings are urged to complete this return slip and send it in to the relevant Branch Honorary Secretary so that anticipated numbers for each meeting are known in advance.

To: The Hon. Secretary,______________________________Branch

I would like to attend the meeting on ______________________

Name: ______________________________

Tel. No: ______________________________

Continued from page 13

Kitchen drainage — a new hygiene service

A leaflet issued by AMK Pipe Technology Ltd outlines a consultancy, inspection, repair and maintenance service for drainage systems of kitchens and food preparation areas. AMK points out that the number of notified cases of salmonella in England and Wales has grown from 6,000 in 1974 to 17,000 in 1983. In some cases, says the leaflet, the cause of the infection has been traced to the drainage systems of kitchens where build-up of fats and other food debris creates an ideal breeding ground for many types of pathogen responsible for food poisoning. AMK offers a service to hospitals, institutions, hotels and restaurants.

Further details from: AMK Pipe Technology Ltd, 18 Chester Road, Castle, Northwich, Cheshire, CW8 1JB. Tel: (0606) 77234.

British Standards Institution

METRIC SPECIFICATIONS FOR PLAIN BEARINGS

The latest Part of BS 4480, one of a series of standards of interest to the engineering industry, to be published by the British Standard Institution, is BS 4480 *Plain bearings: metric series* Part 8 *Specification for dimensions, tolerances and methods of checking the thin-walled flanged half bearings.* It is identical with ISO 6864 published by the International Organisation for Standardisation (ISO) and lays down the main dimensions and tolerances for such bearings used in reciprocating machinery. These are fixed for a series of thin-walled flanged half bearings suitable for housings having inside diameters from 40 to 250mm. The standard also lays down dimensions and tolerances for characteristic features whose incorporation into a particular design is a user-decision based on knowledge of the intended application. Parts 1 to 7 of the standard are already available. Copies of BS 4480: Part 8 may be obtained from the Sales Department, British Standards Institution, Linford Wood, Milton Keynes MK14 6LE. Price: £12.20 (£6.10 to BSI subscribing members).

HYDRAULIC STAPLE TYPE CONNECTORS

Of interest to hydraulic fluid power, mining and other heavy industries BS 6537 *Specification for staple type connectors for hydraulic fluid power applications* relates to a series of connectors secured by staples to enable hydraulic engineers to connect rigid and flexible tubing to fluid power system components. Copies of BS 6537 may be obtained from the Sales Department, British Standards Institution, Linford Wood, Milton Keynes MK14 6LE. Price: £12.20 (£6.10 to BSI subscribing members).

CLASSIFIED ADVERTISEMENTS
Appointments and situations vacant

THE INSTITUTE OF HOSPITAL ENGINEERING

Applications are invited for the post of

SECRETARY

which will become vacant on the retirement of the present Secretary, John E Furness, MBE, VRD.*

The Institute, formed over forty years ago, is a Learned Society which serves the Health Service, associated professions and industry.

The Secretary who is the chief salaried officer of the Institute has responsibility for the general administration of the Institute's affairs, for servicing Council and Council Committees and organising Conferences, Seminars and Symposia. The Secretary is responsible to Council for the efficient and effective organisation of a small office located in Southsea, Portsmouth, Hampshire, which deals inter alia with qualifications, member and branch relations, finance and administration. The post has appropriate administrative/secretarial support.

Applicants should be suitably qualified and have proven administrative and organisational experience.

The commencing salary will be by agreement but will not be less than £11,000.00 per annum. A non-contributory pension scheme is in operation and assistance with re-location expenses will be considered.

Applications, which must be received not later than 14th June 1985 giving full c.v. and the names and addresses of three referees, should be sent to:

The President, The Institute of Hospital Engineering, 20 Landport Terrace, Southsea, Hampshire PO1 2RG.

marked 'Confidential – Application for post of Secretary' in the top left hand corner of the envelope.

Short listed applicants will be interviewed in London.

SAUDI ARABIA

MEDICAL EQUIPMENT SPECIALIST

Urgently required for established Saudi architectural and engineering practice for various prestigious projects.

Applicants should have a Diploma in Equipment Technology/Certified Technicians, preferably BSc (Bio-Medical).

This position offers 2 years renewable contract with excellent benefits.

Please send a detailed CV to:

S.N.H. Razyi
Zuhair Fayez and Associates,
79/83 Great Portland Street, London
W1N 5RA
Telephone: 637-3181