The evolution of cast iron boilers

Find out where it all began and how cast iron heat exchangers have advanced to produce high efficiency boilers today.

Water quality
Hamworthy explains the importance of adopting an effective water treatment regime for your heating system.

Refurb and retrofit
Boiling Point talks to several contractors about the challenges of heating refurbishment projects.
The Energy Act 2011 contains a provision that, when implemented, will prevent landlords of both commercial and residential properties from letting a building that falls below a specified Energy Performance Certificate (EPC) grade, unless the landlord has carried out the maximum package of measures that can be funded under the Green Deal. The exact requirements have not yet been finalised, however the scheme has to be brought into force by 1 April 2018 at the latest, so now is an ideal time to review our buildings and see what improvements can be made to ensure compliance with any future regulations.

To help the challenge of refurbishing existing commercial buildings, BRE along with partners Sustainable Development Capital Ltd, launched a new scheme to provide capital investment for non-domestic energy efficiency retrofit projects in the UK. The new Green Retrofit Investment Programme has up to £100 million available for investment in building retrofit projects and energy infrastructure projects where clear energy and carbon emissions savings will result.

Heating and hot water plant retrofit projects do present more challenges than new build, with difficulties such as access to the plant room, establishing the quality of the existing system and compatibility of new products with an old system.

This issue of Boiling Point will focus on refurbishment, looking at best practice water treatment for existing heating systems to safeguard new mechanical and electrical plant such as boilers and water heaters, and how crucial it is to select the most appropriate boiler or water heater to suit the requirements of the project.

Energy efficiency targets have driven the shift from old atmospheric boilers to modern condensing boilers as customers strive for the most efficient system possible. Our Purewell VariHeat boilers make this type of replacement simpler as they sit on the same footprint as most atmospheric boilers; can easily be connected to existing pipework and make use of existing flue runs; and are very tolerant of old heating systems due to their cast iron heat exchanger. We have also been talking to several contractors to get their views on how they approach refurbishment jobs, what is the most challenging aspect and the key drivers for change. Their thoughts can be read on page 6.

Earlier this year we were honoured to welcome Patrick Knivetson, the president of the Institution of Mechanical Engineers, to officially open our research and development centre and see our contribution to the advancement of engineering. It is imperative that we continue to manufacture products of a high quality in Britain, and this testing facility is vital to ensure our products comply with the strict efficiency guidelines set out in European Directives such as the Energy Related Products (ErP) directive.

As well as the new R&D centre we have been making improvements in our factory to operate more efficiently, fulfil shorter lead times and continue to meet our customers’ expectations. We have adopted the philosophy of Kaizen – continuous improvement, and although we are only part way through the project we are already seeing the benefits. You can read about the factory team and the changes they have been making on the back page of this issue.

Finally, I would like to take this opportunity to let you know about the commitment Hamworthy has made to give back to the local community in Poole. We have pledged to contribute one day per employee per year to support charitable causes. This year we have chosen to support a Dorset based charity that is close to the hearts of many of our employees, Forest Holme Hospice. You can see the fantastic work they do by visiting www.forestholmehospice.org.uk.

Yours sincerely,

Andy Moore
Managing Director
Water quality in existing heating systems

Boilers can count towards a significant proportion of the capital investment of a refurbishment project, and the debris and oxides found in existing heating systems can have serious adverse effects on new mechanical, electrical and plumbing equipment.

When metals meet with the oxides found in certain waters they cause a chemical reaction that can result in corrosion. The pH level of the water and the material used in the manufacture of the heat exchanger dictates the rate at which this corrosion will occur.

It is vital to assess the quality of the water within a heating system prior to installing any equipment. The results of system water analysis will enable you to adopt a regime that will maintain the correct pH levels and control the chlorides found in some heating circuits.

Maintaining efficient operation

A system that is harbouring a build up of corrosion and sludge will have to work harder to distribute the water and heat. Blockages and sludge will impact the water flow resulting in certain mechanical components having to work harder as they are fighting against the obstruction. Increased load on components such as the heating system pump will result in higher energy consumption and mean they are likely to perish at a faster rate and could need servicing or replacing sooner than expected; an unplanned maintenance cost that will have to be met.

A build-up of sludge (from corrosion) and hydrogen gases can also take place in the heating system itself, such as in the radiators which, if left to accumulate, will increase system resistance and impact the flow of water, raise the noise level of the heating system and even result in burst radiators causing damage to the building. If system debris and sludge accumulates within the boiler heat exchanger it can rapidly reduce the operating efficiency of the appliance. Just a 1mm layer over internal heat exchanger surfaces can reduce efficiency by up to 13%, resulting in higher fuel consumption and increased carbon emissions.

Water treatment should be carried out as standard at any initial system set up and must be tailored to the; type of boiler; materials used to construct the system (pipework, storage tanks etc); age of the system and supply/make-up of the water. For example, chemically cleaning older systems can often expose problems such as leaks that have been previously concealed by sludge and scale. With this type of installation it is prudent to only clean-water flush the system and it may be advantageous to totally separate the boilers from the secondary circuits by using a plate heat exchanger.

This method of connection prevents system debris/contaminates entering the boiler. This is not a replacement for water treatment but it does help to safeguard the boiler plant from the effects of debris and harmful compounds found in existing systems.

Despite taking the correct measures to clean and protect a system with an inhibitor you cannot guarantee that all detrimental dirt accumulations are removed. This is where the addition of an air and dirt separator can offer added assurance. Providing a dual function they collect and remove dissolved gases from system water through an automatic air vent at the same time as trapping dirt particles that can be removed periodically through a flushing valve.

Matching the right boiler to the system

We often hear the myth that ‘stainless steel boilers do not require water treatment as the metal is more resistant to corrosion’. This is not the case. Stainless steel corrodes - just at a different rate and pH level to other materials. Plus, chlorides are extremely detrimental to stainless steel in particular.

These issues are not evident in every system and the degree of their effect on the plant in the system varies; some constituents in the water can even be beneficial.

Consideration should always be given to the age and condition of the system and it is important that the appropriate boiler and heat exchanger material and construction is matched to the system. For very old systems a cast iron heat exchanger with larger waterways would be more tolerant to the conditions present in the heating circuit. However, low water content boilers that have small waterways would be preferable for a new build project.
The evolution of cast iron boilers

Where it all began

Cast iron has long been the choice of material for the manufacture of boilers, dating back to the late 19th century where the first coal fired cast iron boilers were produced. In the UK at this time there were many foundries that could cheaply and easily make the large components required. Cast iron was also chosen for its tolerance to sulphurous flue gases – a by-product released as a result of burning coal which has high sulphur content.

In 1956, when the clean air act was introduced, we saw the move from solid fuel to town gas and oils and with that the arrival of steel as a viable material for boiler heat exchangers.

Once natural gas became readily available this opened the door to all types of metals and more refined manufacturing processes. Today we see boilers manufactured in a range of metals from steel, stainless steel and aluminium, to copper and cast iron.
How has it evolved?

Cast iron is a proven material that has stood the test of time, demonstrating its reliability over many years. Of course over the years cast iron heat exchangers have been continuously improved and refined, pushing the boundaries of the casting process whilst still benefitting from the properties of a robust, rugged metal that does not readily corrode.

Improved heat exchangers

Historically cast iron heat exchangers have been constructed using sectional designs that remain in use today. Early designs used sections that stood vertically, like a sliced loaf of bread, with the system return entering at the bottom of the rear section. Flow throughout the sectional assemblies was not always even and some boilers relied on the use of flow distribution tubes to help direct flow to the front sections of the heat exchanger.

In the late 1960’s Hamworthy introduced a heat exchanger design using horizontal sections stacked one above the other. System return water entered the bottom section and flowed towards the front where it would rise into the section above and flow towards the back, again rising into the next section above. Using this series flow arrangement resulted in a naturally balanced flow path throughout the boiler. Hamworthy have continued to refine this design through the evolution of boiler models such as UR and Purewell Classic and now the Purewell VariHeat boiler range – our most efficient cast iron boiler.

The design also allows for simple replacement of a single section, if required. If access to the plant room is restricted, the boiler and heat exchanger can be quickly dismantled into manageable sections and reassembled in situ.

The high outputs of Purewell VariHeat from a relatively small heat exchanger is the result of investment in casting technology allowing high density well defined fins to maximise heat transfer to the water.

The waterways in a cast iron heat exchanger are larger than typical lightweight wall-mounted boilers making it more tolerant of demanding system conditions often found in existing heating systems.

Increased efficiencies and load matching

Some regard cast iron boilers as inefficient and old fashioned technology. However this is in part due to the basic controls (on/off or high/low) available in old cast iron atmospheric boilers out in the field today.

The modern cast iron boilers from Hamworthy have pre-mix burners and are fully modulating to enable output to be closely matched to the load profile of the building. Plus, the efficiency of the Purewell VariHeat boiler is further increased on the condensing models through the use of a secondary heat exchanger that ensures the maximum amount of residual heat from the process of combustion is extracted.

This efficiency improvement is even more evident in multiple boiler systems as shown in the diagram above. Older On/Off and High/Low multiple boiler systems had poor turndown ratios, less accurate load matching and low seasonal efficiencies. Compare that with the modern Purewell VariHeat boilers that have excellent turndown ratios, superb load matching capability, and high seasonal efficiencies both individually, and under sequential Merley control which equates to long term fuel savings and reduced carbon emissions. Plus, with higher outputs now possible from a single boiler there is the opportunity to reduce the number of installed boilers with a resulting reduction in installation and maintenance costs.

Today Hamworthy’s cast iron boilers can more than compete on efficiencies with any product on the market. In fact, the Purewell VariHeat condensing boiler is the only ErP ready commercial condensing cast iron boiler range in the UK.

*ErP draft requirement is for a part load efficiency of 104.3%, Purewell VariHeat actually delivers a part load efficiency of 107%)

### Improved turndown and efficiency in multiple boiler plant

<table>
<thead>
<tr>
<th>4 x 70kW On/Off atmospheric boilers (UR)</th>
<th>High Fire or Off</th>
<th>Max. plant output</th>
<th>Min. plant output</th>
<th>Seasonal efficiency</th>
<th>Turndown ratio</th>
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<td>70kW Off</td>
<td>280kW</td>
<td>70kW</td>
<td>78%</td>
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<tr>
<td>4 x 70kW High/Low atmospheric boilers (Purewell Classic)</td>
<td>High Fire or Low Fire</td>
<td>Max. plant output</td>
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<td>Seasonal efficiency</td>
<td>Turndown ratio</td>
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<tr>
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<td>280kW</td>
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<td>High Fire or Low Fire</td>
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### Purewell VariHeat

- 5 condensing models, 70kW to 180kW
- 4 non-condensing, high efficiency models, 65kW to 125kW
- Exceptional efficiency up to 108.8%
- Fully modulating pre-mix gas fired burner
- Robust cast iron heat exchanger
- 10 years’ warranty (primary and secondary heat exchanger only, terms and conditions apply)
- Natural replacement for atmospheric boilers
- Tolerant of existing heating systems
- The UK’s highest efficiency condensing cast iron boiler

For more information scan this QR code with your tablet or smartphone:
With heating and hot water plant refurbishment projects we are seeing a shift from traditional atmospheric boilers and water heaters to modern condensing models. When embarking on this type of project it is vital to assess the current system and review all the options available to gain the maximum benefit from the new products and, where practicable to do so, make use of existing services including pipework and flue runs.

We understand that each project is unique and will have different requirements, depending on the customer, site and condition of existing system. Boiling Point spoke to several contractors about how they approach retrofit installations to share with us some of the methodology used and challenges that need to be overcome.

Tom O’Donovan, contracts manager at GS Mechanical Ltd, said, “We look at a number of criteria when embarking on a boiler refurbishment project and the deciding factor is nearly always the flue. This will invariably determine whether we will choose to upgrade to a condensing boiler and replace the flue or if we choose a high efficiency boiler that can potentially make use of the existing flue, even if it just acts as a liner, saving costs on installation but still meeting all the requirements of the Building Regulations Part L.”

Danny Bulch, director at Cedar Green commented, “We pride ourselves on giving customers continuity of their heating and hot water systems throughout refurbishment projects. It is vital for commercial premises such as hotels and hospitals to have no system downtime due to the services being critical to their business.”

Modern boilers with low water content are less tolerant to fluctuating flow conditions in the heating circuit, so a low loss header is recommended to safeguard the condensing boilers from low flow conditions in the secondary circuit which may be caused by a pump modulating or a motorised mixing valve changing position.

Tom O’Donovan added, “We will always look for areas which can be improved on a system, such as the pipework, pumps and pressurisation unit equipment and strongly recommend the addition of a low loss header.”

The provision of a low loss header ensures that a steady flow of water is maintained through the boilers protecting them from potential damage as a result of firing when there is insufficient or no water flow. Ultimately a heating and hot water plant refurbishment project should always be viewed in the wider context; not just the boilers and water heaters in isolation. This approach will ensure that a best practice solution is achieved and the customer gets best value for money, high efficiency compliant products with full system integration.

Dave Gregory, director at R&L Paul Ltd concluded, “It is vital that customers understand they need the right boiler for the project. This may not always be a condensing boiler, for example if the system operates 24 hours a day you will not get the sizeable efficiency gains from a condensing boiler due to the higher return temperatures, so a high efficiency boiler would be favourable where no flue changes will be required.

We also encourage building operators to implement a service regime. We can’t simply fit and forget a boiler; regular servicing ensures the system is operating to the maximum efficiency possible and highlights any issues before they become a problem.”
CASE STUDY

Hamworthy heats up hotel on south coast

Hamworthy’s Purewell VariHeat boilers were the natural choice to enable a seamless heating upgrade at the Menzies Carlton Hotel, a four star hotel on the east cliff of Bournemouth.

Cedar Green Commercial Heating and Building Solutions installed 7 Purewell VariHeat 180kW condensing boilers in place of the existing 16 Purewell Classic 70kW atmospheric boilers. The new boilers plus 5 remaining calorifiers provide the space heating and hot water for the entire 76 bedroom hotel and adjoining timeshare apartments, including a leisure club with indoor and outdoor pool and spa.

Danny Bulch, Director at Cedar Green commented, “With higher outputs available from a single boiler we were able to reduce the boilers from two rows to just one. This meant we could keep a row of old boilers running whilst the new equipment was installed alongside.”

The Purewell VariHeat boilers are commonly used in refurbishment projects as they fit on the same footprint as old atmospheric boilers, and can easily be connected to existing pipework to speed up installation.

Danny went on to say, “I only ever install Hamworthy boilers; they are easy to fit and reliable. The Carlton Hotel has seen their system upgraded from the early Hamworthy UR cast iron boilers through to the Purewell VariHeat cast iron boilers of today. The upgrades have been straightforward and the newer models provide benefits to the hotel of better efficiencies and lower service and maintenance costs, since the number of boilers have more than halved.”

IMechE president officially opens new R&D centre

As part of a commitment to new product development and innovation Hamworthy has invested £500,000 in a new research and development centre.

The president of the Institution of Mechanical Engineers, Patrick Kniveton, officially opened the 150 square metre facility at the factory site in Poole, Dorset, as part of his first visit as the newly elected president.

Thanking Hamworthy for the invitation, Patrick Kniveton said: “It is a real pleasure to take part in the opening of this centre. From my tour of the factory, it is evident that the work Hamworthy is doing here is pretty impressive and very promising for the future of British manufacturing.”

After cutting the ribbon, the president was taken on a tour of the new purpose built facilities which provide a controlled environment for the development and approvals testing of boilers, in accordance with the European Standards on product safety and performance.

The purpose built centre has the ability to fire up to 3 boilers with a combined capacity of 1MW, consuming 50m³/hr of cooling water, with the availability of specialist gases for performance and accelerated life testing. State of the art equipment is used to determine thermal and emissions performance of the products.

Literature updates

We have added or amended the following literature in our technical library:

- NEW Guide to Commercial hot water
- NEW Dorchester DR-SA/SE water heaters
- NEW Dorchester DR-SA/SE water heaters
- UPDATED Ensby LT boilers
- UPDATED Purewell VariHeat boilers

To view these and other technical brochures please scan the QR code.
Meet the Team – Production

Located at Hamworthy Heating’s head office in Poole, the 4,300 square metre factory has been manufacturing leading commercial boilers for over 45 years. With 24 employees across the various sections including assembly line, end of line testing, quality control and goods in/out, the factory operates with a lean workforce.

Over the years, we have seen many changes to the way our factory operates. Now, more than ever, it needs to be agile and flexible to respond to the continual shift in priorities faced by the production team.

Shorter lead times
The team in the factory have to be able to adapt on a daily basis to meet with demand, invariably operating double shifts and switching production lines to ensure customer expectations are met.

As with any manufacturing company, sales forecasts are made to aid planning in production but there are often unpredicted spikes in demand. To ensure orders are fulfilled on time the team have been making improvements in the factory to reduce component stock levels, eliminate wastage and ultimately become more efficient.

Continuous improvement
The first phase has adopted the Japanese practice of Kaizen that focuses on continuous improvement of processes in manufacturing, engineering, and business management plus the tried and tested methods used by our parent company, Groupe Atlantic, in their factories across Europe.

Each boiler production line is assessed in turn to see where improvements can be made. The project began with reorganisation of the Fleet boiler production cell and has seen the area reduced in size by 80%, saving 155m².

Modular flexible racking has been introduced on the station with a two bin method to easily show re-supply signals. When the components in one bin run out this is turned around so that it can be seen clearly from the walkways for restocking. This has reduced stock levels in production cells from 3-4 months to 2-4 days.

Rob Prince, continuous improvement manager, said “Not all changes have to be major and it’s amazing how small improvements can have a big impact. For example, if we reduce the size of our walkways and introduce flexible fork lifts we can achieve additional storage capacity of an extra 850 pallets in our factory.”

Responding to demand
Rob continued, “We are making all of our production cells fully mobile. Whereas, previously we had fixed cranes which determined the production cell layout and workflow, we have now invested in mobile cranes that can be moved and relocated in a matter of minutes with no disruption to work, thereby providing greater flexibility to the workflow within the factory.”

After the success of the Fleet cell improvements, work has begun on the Purewell VariHeat boiler production line, and once all the production lines have been assessed the focus will be on re-organising the racking space in the factory.

Rob concluded, “Ultimately these changes will have huge benefits for our customers; we can meet shorter lead times, respond quicker to changes in the product mix and free up space in the factory to keep additional stock of finished products for those distress purchases when boilers are needed in a matter of hours.”