Front Cover Image – Boiler Tube Failure

The cover image is of a split on a rear furnace wall tube shortly due to a combination of fireside corrosion and erosion. Corrosion is the result of the tube surface reacting with the corrosive species in the gas stream. Burning waste products to produce energy, i.e. Energy from Waste, uses a wide variety of waste products so the combusted gases usually contain many corrosive species, e.g. chlorine, sulphur etc., plus many alkali metals e.g. sodium, potassium. Contaminants like vanadium readily oxidise to form low melting point vanadates which can destroy any surface protective oxide.

Metal wastage due to corrosion and erosion leads to tube wall thinning until the internal pressure causes creep failure as shown in the cover image.
EMG newsletter lead

Packaging Energy Needs

In my capacity as a Board member of EMG representing the Packaging Society I am pleased to share the ‘energy’ needs within our Industry. First I must emphasise the importance of energy knowledge within the Climate Change context. It is irrelevant whether one agrees or not with the theory. What is important is that energy must be used as carefully as possible and not wasted. As mere consumers we are preached at regularly and of course we can help via various measures – turn lights off, lower central heating temperature, fly less, change to electric car and so on. However all industry should be examining their position also. More savings can be made by choosing the best applicable energy source - renewables, gas, oil, nuclear, biomass, etc.

The energy industry must and is exploring how we can store excess power production for that ‘rainy day’. Solar power was superb over the past summer and during the wintry days wind power comes forward. Energy storage is essential so that future increased demand for power is covered, e.g. for electric vehicles. This will create a higher need for power and batteries, where innovation is gathering speed. Another suggestion for vehicles has been ‘hydrogen’ energy. A number of years ago this was normal for taxis in Inverness. Will it return?

Changes in packaging that will occur to solve the plastics pollution problem, by using non-plastic packaging materials, may yield higher carbon emissions, which could lead to an increase in the suggested Climate Change figures. There have been UK consultations and analysis by DEFRA highlighting the need for drastic changes in direction for packaging and also waste management. If all the proposed changes were to occur then extra transportation would mean more energy needs and costs, having a negative effect on Climate Change.

Biomass has entered the equation and is used by Drax, one of the UK's largest power stations. It needs a constant supply of wood pellet mostly imported from North America. Wood as we all know is the mainstay for paper and board, widely used and not only for packaging. There are not currently enough paper mills globally to cover a much greater demand, should wood based biomass become more wide-spread. Sadly we are losing swathes of forests due to fires (Australia / USA) and reuse of land (Brazil)

Recycling is urgently being investigated, by CIWM (Chartered Institute of Waste Management), to simplify and standardise the collection and sorting of waste. Difficult to recycle plastics and indeed any waste can be sent to EfW incinerators (Energy from Waste) for disposal and/or conversion to biogas. This does help to solve the plastics problem and waste management. At present there are some 90 EfW sites in the UK with a need for more such sites. Previously many were abandoned before construction because of local environmental fears. Such infrastructures are covered by strict EU Directives which prohibits the exit of dangerous gases, achieved by optimised combustion control and/or filter systems, resulting in many new sites being built.

Food waste is another area of collection and here Anaerobic Digesters (AD) are used to convert such waste into useful compost or back as plastic feedstock. For just one collection agency renewable energy plants have saved 33,000 tonnes of CO$_2$ emissions and generated around 35GWh per year, equivalent to powering 11,000 homes.

Keith Barnes
Global Packaging Ambassador keith@keithbarnes.com
Energy Materials Information Streams

The EMG microsite is a mine of information relating to Energy Materials with links to various sources of information, including funding sources for collaborative research/development. The EMG microsite is actively managed and regularly updated; the link to the appropriate location on the microsite is given below


Materials at High Temperatures, Volume 36, Issues 5 & 6, 2019

- Effect of creep lifetime on geometric optimization of boiler tubes for thermal power plants
- Analysis of creep deformation and damage behaviour of 304HCu austenitic stainless steel
- Mechanical behaviour of conventional, Pt- and Pt/Ir-modified NiAl diffusion coatings after thermocyclic exposure at 1100°C
- Effects of creep properties of materials on unified creep constraint parameter $A_c$ for cracked pipes
- Mechanism of intergranular reheating crack in butt-welded joint of 12Cr1MoV tube served for 40,000 hours
- Simulated fireside corrosion of T91 in oxy-combustion systems with an emphasis on coal/biomass environments
- Procedures for handling computationally heavy cyclic load cases with application to a disc alloy material
- Quantitative study of microstructure evolution and the effect on mechanical properties of Super304H during aging
- Elevated temperature fatigue behaviour of structural materials for advanced ultra supercritical application
- Dynamic strain-rate effect on uniaxial tension deformation of Ti5Al2.5Sn α-titanium alloy at various temperatures
- Study on microstructure and properties of centrifugal casting 35Cr45NiNb+MA furnace tubes during service
- Al depletion and elemental redistribution in PtAl coated CMSX-4 and IN738LC after high-temperature exposure
- Use of the Wilshire equation to correlate and extrapolate creep rupture data of Incoloy 800 and 304H stainless steel
- Analysis of the power boiler superheater strain-and-stress state under creep conditions
- Microstructural and phase characterisation of pyrolytic graphite coating by CVD using propane and methane as precursor
- Creep rupture behaviour of modified 9Cr-1Mo heat-resistant steel strengthened with different mechanisms
- Fatigue and creep-fatigue crack growth in alloy 709 at elevated temperatures
Organisation Profile

Association of Renewable Energy Research Centres

The Association of Renewable Energy Research Centres, EUREC, is the voice of renewable energy research in Europe, representing European Research Centres active in renewable energy. The purpose of the association is to promote and support the development of innovative technologies and human resources to enable a prompt transition to a sustainable energy system.

EUREC was founded in 1991 as European Economic Interest Grouping (E.E.I.G.) with the goal of improving the quality and scope of European research and development in renewable energy technologies. Members are prominent research and development (R&D) groups spread across Europe, operating in all renewable energy technologies (wind, biomass, small hydro, marine, geothermal, photovoltaics, solar thermal electricity, and solar thermal heating and cooling). Members also conduct research into supporting technologies such as energy efficiency, storage, distribution and integration, and undertake studies to evaluate the social and economic aspects surrounding renewable energy.

EUREC brings together 38 research centres from 16 European countries, renowned for their expertise in the field of renewable energy, representing the majority of EU Member States. EUREC has gained extensive experience in the management of European co-funded projects, as well as in communication, dissemination and training activities. Examples of current projects are listed below:

- **TRACER** – Transition in Coal Intensive Regions in order to facilitate their transition towards a sustainable energy system. (South Wales being 1 of the 9 regions supported)
- **PV IMPACT** - Support to the execution of the Implementation Plan for Photovoltaics of the SET Plan and monitoring the Implementation Plan's delivery
- **HYDROPOWER-EUROPE** – development of a technology roadmap for the hydropower sector.
- **SMARTSPEND** - foster efficiency in allocation of public & private funding, and to better inform stakeholders through the preparation and dissemination of reports.
- **SHIP2FAIR** (Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables) - aims to foster the integration of solar heat in industrial processes of the agro-food industry
- **PV WIND Maps** - provide the most relevant information about existent PV and Wind projects funded by European programmes, via an interactive site.
- **CryoHub** - develop and investigate the potential of large scale cryogenic energy storage at refrigerated warehouses and food factories
- **CAPTure** (Competitive Solar Power Towers) - increase plant efficiencies and reduce levelised cost of electricity (LCOE) by developing innovative plant configuration.
- **RHC** (European Technology and Innovation Platform on Renewable Heating and Cooling) - define a strategy for increasing the use of renewable energy technologies for heating and cooling
- **ETIP PV** (The European Technology and Innovation Platform for Photovoltaic) - improving the competitiveness of the European PV industry

For more information on the activities of EUREC please visit [https://eurec.be](https://eurec.be)
**Editor's Titbits Section**

**Zero carbon homes policy**

The government must reinstate the zero carbon homes policy to help consumers save money on their energy bills. The Energy and Climate Change Committee is also calling on the government to reinvigorate the “able-to-pay” market as it believes there is no support to help households who wish to install energy efficiency measures but cannot meet the upfront costs. It suggests BEIS to consider using the “pay-as-you-save” mechanism as well as the infrastructure behind the Green Deal Finance Company. Its new report published today stresses the need to drive demand by pressing ahead with developing incentives such as the introduction of stamp duty and council tax reductions for efficient homes.

The MPs said the energy efficiency supply chain has also been affected by “inconsistent and unpredictable policy signals” as regulations have been chopped or changed. The Chair of the Energy and Climate Change Committee said: “We need to ensure all new houses are super insulated and fit for the future by reintroducing a zero carbon homes policy, especially as many building companies are prepared to deliver it but it is the improvements we make to Britain’s existing housing stock that will make the most difference. Because many of our homes were built before the Second World War, Britain has some of the most inefficient and heat-leaking housing in the world.”

**Battery prices plummet 87% between 2010 and 2019**

Battery prices, which were above $1,100 (£846.4) per kilowatt-hour in 2010, have fallen 87% in real terms to $156/kWh (£120) in 2019. By 2023, average prices will be close to $100/kWh (£76.95), at which point EVs will start to reach price parity with internal combustion engine vehicles, according to the latest forecast from research company Bloomberg New Energy Finance (BNEF).

The firm credits reductions in 2019 to increasing order size, growth in battery electric vehicle sales and the continued penetration of high energy density cathodes. The introduction of new pack designs and falling manufacturing costs are expected to drive prices down further in the near future.

**Can the UK reach net zero with technologies already widely available**

The UK can reduce its energy demand by 60% and reach net zero using existing technologies, without relying on carbon capture and storage (CCS). That’s the suggestion from the Centre for Alternative Technology (CAT), which says significant changes to energy, buildings, transport, industry, diets and land use are needed to decarbonise and create “natural carbon capture” through the restoration of forests and peatland.

It suggests to reach a carbon-neutral economy by the planned deadline of 2050, it is necessary to ‘power down’ energy use through increased efficiency and behaviour change, while ‘powering up’ clean renewable energy supplies and transforming land use. ‘Powering down’ energy would require high ‘Passivhaus’ standards to be implemented for new buildings, as well as wide-scale retrofits and temperature controls being installed – the report notes this could reduce energy demand for heating by around 50%.
It calls for increased use of public transport, more walking and cycling, more switching to electric vehicles and flying to be reduced by two-thirds, in order to reduce energy demand for transport by 78%. Project Coordinator Paul Allen said: “Relying on speculative future technology to get to net zero risks overshooting the remaining carbon budget, resulting in the very real possibility of global temperature rises of 2°C or more.

**Road transport emissions ‘remains a significant challenge’**

Cutting road transport emissions remains a significant challenge. That’s the verdict from the Office for National Statistics (ONS), which highlights how in 2017, greenhouse gas emissions from the sector made up around a fifth of the UK’s total emissions. It notes that although the UK’s total greenhouse gas emissions fell by 32% between 1990 and 2017, emissions from road transport increased by 6% in the same period. Slightly more than three-quarters of the road traffic in 2018 was generated by cars and taxis.

A new report published by the ONS shows at the end of 2018, only 0.5% of all UK vehicles were categorised as ultra-low emission – these emit less than 75 grams of carbon dioxide for every kilometre travelled and are generally battery electric, plug-in hybrid electric and fuel cell electric vehicles. In 2018, 64,000 ULEVs were registered in the UK, an increase of a fifth on the number registered in 2017 and making up 2.1% of all new vehicle registrations.

The ONS notes that despite road traffic in the UK having increased by 29% from 255 billion miles travelled in 1990 to 328 billion miles in 2018, related emissions have gone up more slowly, increasing by 6% between 1990 and 2017, suggesting that the vehicles used now are significantly cleaner. The report highlights the total amount of fuel used for road transport in the UK remained relatively stable from 1990 to 2017 as the fuel efficiency of newer vehicles has improved – however, which fuel is used has changed significantly, with petrol use in the UK falling from 27 million tonnes of oil equivalent (Mtoe) in 1990 to 13 Mtoe in 2017, while the use of diesel has increased from 11 Mtoe in 1990 to 27 Mtoe in 2017.

**Drax ‘to become carbon negative by 2030’**

Drax is to announce plans to become carbon negative by 2030. The energy producer says this will rely on “an effective negative emissions policy and investment framework for new technologies like bioenergy with carbon capture and storage (BECCS)”. It is already trialling BECCS at its power station and claims it is managing to capture a tonne of carbon dioxide every day. Combining BECCS equipment with “sustainable biomass” generation at its power plant in North Yorkshire means it could capture more than 16 million tonnes of carbon dioxide a year.

Drax produces 12% of the UK’s renewable electricity. With the right negative emissions policy, Drax could remove millions of tonnes of emissions from the atmosphere each year. The volume of greenhouse gases produced by the firm are likely to fall with or without BECCS in the next five years, as it plans to close its two remaining coal-generating units by 2025.

**Iceland bans heavy fuel oil in shipping sector**

Iceland has banned the use of heavy fuel oil in its shipping sector to curb emissions from the environmentally-intensive industry. The nation’s Minister for the Environment and Natural Resources, Gúðmundur Ingi Guðbrandsson, has implemented a new rule to restrict exhaust emissions containing high levels of sulphur from being burned by ships in Iceland’s territorial waters. The government claims the move to reduce the sulphur emissions cap from its current
level of 3.5% mass-by-mass (m/m) to 0.1% m/m means Iceland will have one of the strictest heavy-fuel regulations in the world.

**China’s first 100MW molten salt solar plant**

China’s first 100MW molten salt solar thermal power plant has successfully hit its maximum power levels. Built by Beijing Shouhang IHW Resources Saving Technology, the three billion yuan (£345m) project in Dunhuang uses 12,000 mirrors to concentrate sunlight onto a receiver, which is then used to heat the molten salt.

It is capable of generating 390 million kWh of clean power each year, enough to reduce carbon dioxide emissions by 350,000 metric tonnes. Unlike the intermittency associated with traditional solar energy systems, the molten salt allows energy to be stored and later used to generate power on demand.

**Renewables and SF6 - the most potent greenhouse gas in existence**

Emissions of what is thought to be the most potent greenhouse gas in existence are rising rapidly – and it could be due to renewables. Sulphur hexafluoride (SF6) gas is commonly used as an insulating material to prevent short circuits, fires and electrical accidents across the sector – however, SF6 leaks across the UK and the rest of the EU in 2017 could cause additional warming equivalent to that produced by 1.3 million cars. The drive to add more distributed and renewable infrastructure to the grid has increased the number of electrical switches and circuit breakers needed, the majority of which use SF6 gas as part of their safety mechanisms.

The gas is said to have the highest global warming potential of any known substance – scientists say it is 23,500 times more potent than carbon dioxide and can last in the atmosphere for up to 1,000 years. The UK’s network of power lines and substations now contains around one million kilograms of the gas, with the amount used increasing by up to 40 tonnes per year across all transmission and distribution networks,

**Camel cull in Australia to alleviate drought and protect Aboriginal communities**

A camel cull in Australia aims to alleviate drought, protect Aboriginal communities and help tackle methane emissions. Around 10,000 camels were shot and killed following complaints that they were drinking too much water – the cull last approximately five days, over which period riflemen in helicopters shoot the animals – there are estimated to be a total of one million wild camels in the country.

Aboriginal officials in the Anangu Pitjantjatjara Yankunytjatjara (APY) province said the camels are endangering communities struggling to find enough water during prolonged dry periods and has contributed to the wildfires sweeping the nation. An official statement said: “With the current ongoing dry conditions the large camel congregations threatening the APY communities and infrastructure, camel control is needed.”

**Energy industry needs 400,000 more employees to reach 2050 net zero goal**

More than 400,000 workers will be needed in the energy industry to help deliver the government's ambition for net zero carbon by 2050. That's according to new research published by National Grid, which sets out how the energy sector can build a net zero energy workforce able to transform the UK’s energy system over the next 30 years, bringing
opportunities for skilled tradespeople, engineers and other specialists across every region of the country.

Out of the job opportunities available, 260,000 will be in new roles, while 140,000 will be replacing those who have left the workforce. However, the report suggests there are challenges which include loss of existing talent due to a baby boomer retirement crunch and competition for skilled workers from other sectors, such as finance and technology.

It found in this decade alone, the industry must increase low carbon power generation by around 50%, install low carbon heating systems in 2.8 million homes, develop carbon capture, usage and storage (CCUS) technology and hydrogen networks as well as install 60,000 charging points to power 11 million electric vehicles (EVs).

**Rolls-Royce plans operational mini-nuclear reactors by 2029**

Rolls-Royce plans to install and operate factory-built mini nuclear power stations in the UK by 2029. The deployment of small modular reactors (SMRs) could make build costs more predictable and affordable, lowering the price of electricity for consumers.

It reportedly said the technology could result in electricity being sold below £60 per MWh, putting SMRs in competition with some renewables. It has announced it is leading a consortium to develop the devices, which it says will be built in a factory and delivered in separate sections by trucks – once complete, they take up a much smaller area of land than a traditional nuclear power plant.

Rolls-Royce reportedly hopes to build between 10 and 15 of the power stations across the country, which it says will be installed in former nuclear sites for security reasons. The firm believes the innovative form of power generation will play a key role in delivering net zero emissions by 2050.

Editor’s Note: Unless mentioned the source of many of these titbits is *Energy Live News.*
Mini Feature

HyDeploy demonstration

https://hydeploy.co.uk/

As the first ever live demonstration of hydrogen in homes, HyDeploy aims to prove that blending up to 20% volume of hydrogen with natural gas is a safe and greener alternative to the gas we use now. It is providing evidence on how customers don’t have to change their cooking or heating appliances to take the blend, which means less disruption and cost for them. It is also confirming initial findings that customers don’t notice any difference when using the hydrogen blend.

HyDeploy @ Keele is the first stage of this three stage programme. In November 2019, the UK Health & Safety Executive gave permission to run a live test of blended hydrogen and natural gas on part of the private gas network at Keele University campus in Staffordshire. Once the Keele stage has been completed, HyDeploy will move to a larger demonstration on a public network in the North East. After that, HyDeploy will have another large demonstration in the North West. These are designed to test the blend across a range of networks and customers so that the evidence is representative of the UK as a whole. With HSE approval, and success at Keele, these phases will go ahead in the early 2020s.

The first stage, which went live during the summer of 2019, is a 10 month live demonstration across parts of the Keele University campus, as shown in the graphic below. The demonstration covers 101 residential houses, 8 student halls, 17 office blocks and labs and 7 recreational and service facilities. The campus population and associated office, labs and facilities involved in the demonstration are similar to that of a small town.

The hydrogen is generated on site via a 0.5MW electrolyser and mixed with incoming natural gas in a grid entry unit prior to injection into the Keele privately owned gas network. Natural gas isn’t a unique composition and is source dependent and is a mixture of methane, CH4, 70-90% with the balance comprising ethane, C2H6, butane, C4H10, and propane, C3H8. 13 different gas mixes were used including Grade G20, pure methane, with 28.4 mol% H2.

Monitoring of boiler flue gas emissions showed a reduction in CO2 with the introduction of H2. One balancing act that needs to be controlled is flame out. The velocity of the flue gas/air mixture was slower than the fuel/H2 mixture which can cause flame out due to light back. Tests have shown that this only becomes an issue with H2 concentrations of 80 mol%, way beyond the 20 mol% used in the trial.

Of most importance to us is the interaction of hydrogen with materials is in the system. These materials range from ceramics through to polymers, with the most safety critical being the main delivery pipe, i.e. polyethylene. Testing in gas atmospheres to 100% H2 showed no significant deterioration of any material after soaking in these atmospheres at 1.5 bar for 6
weeks at 75°C. These same materials will again be tested after the 10 month trial. Further tests are planned on corroded surfaces, similar to those expected after many years operation using natural gas. When the next phase is rolled out, i.e. to a wider spectrum of the general populace, older installed boiler and appliances will have corroded surfaces. The uptake of H₂ is expected to be more significant in such circumstances compared to the tightly controlled Keel environment.

The next step is to replicate HyDeploy on a larger public network. HyDeploy² is the connecting step between trial-scale deployment and commercialization—further building the necessary evidence to demonstrate hydrogen blending. HyDeploy² will consist of the same project development team as HyDeploy, with Cadent and NGN as the network sponsors, Progressive Energy as the project developer and with the scientific programme lead by HSL. HyDeploy² will be the largest gas project ever funded through the Ofgem Network Innovation Competition, with confirmation of funding received in November 2018. The strategic objective of HyDeploy² is to bring hydrogen injection to the same level of regulatory approval as biomethane injection. This would create the regulatory framework for commercial-scale production to be developed and injected into the gas grid without undertaking network checks or further evidence gathering.

HyDeploy² is to carry out two further trials over the course of 4 years, starting in 2019—in total supplying ~1500 households with blended gas. Currently testing/servicing of appliances in the target area is under way, a pre-requisite to going live. From December 2020, and following approval from the HSE, a second pilot will take place on the gas network in Winlaton, Gateshead. Around 670 homes and businesses will receive the blended gas for 10 months.

HyNet is the commercial realization of hydrogen blending into the natural-gas network and is being developed in collaboration between Cadent and Progressive Energy in the north-west of England.

HyNet will be the first project on a national scale to develop hydrogen production for the purposes of decarbonizing both industrial clusters and domestic heat. Using Auto Thermal Reformer Technology (ATR) generating 800 MW(th) of hydrogen in conjunction with a Carbon Capture and Storage infrastructure will result in carbon savings of over 1 MTCO₂/yr.

Operation of the hydrogen-production facility is scheduled for the mid-2020s, which will allow carbon savings to be realized in line with the 2018 Committee on Climate Change report on the UK decarbonisation progress. The project scope is a purpose-built hydrogen network feeding directly into industrial clusters and injecting into the Local Transmission System (LTS) at four strategic locations to allow a blend to be provided to 2 million homes.

For more details on HyDeploy please see https://hydeploy.co.uk/
NEXT COMMITTEE MEETINGS

11:00 5th Feb 2020, IOM3, 297 Euston Rd, London

11:00 July 2020, location TBA

EMG SPONSORED WORKSHOPS/CONFERENCES

PVSAT - 16, 15–17 Apr, 2020, Salford, UK


ECCC2020, 14–16 Sept, 2020, Edinburgh, UK

OTHER WORKSHOPS/CONFERENCES/COURSES OF INTEREST

Int. Conference on Energy, Materials and Sustainability, 13 – 14 Feb, 2020, Dubai, UE

International Conference on Energy, Materials and Systems, 23 – 24 Mar, 2020, Tokyo, JP

Battery Tech Expo UK, 26 Mar, 2020, Silverstone, UK


Tackling Low Temperature Superalloy Degradation, Spring, 2020, Rotherham, UK

Structural Integrity Developments for a Competitive UK Nuclear Industry, 30 April, 2020, Cambridge, UK

ICEMR 2020 International Conference on Energy Materials and Research, 04 – 05 May, 2020, Rome, Italy

NANO4EV’S - ENERGY STORAGE, 5 May, 2020, London, UK


36th World Congress on Materials Science and Nanotechnology, 13-14 May, 2020, Tokyo, JP

International Conference and Exhibition on Advanced Energy Materials, 21 – 22 May, 2020, Athens, GR


ALTA 2021 Nickel-Cobalt-Copper, Uranium-REE, Gold-PM, in Situ Recovery, Lithium & Battery Technology Conference & Exhibition, 22 - 30 May, 2021, Perth, AU