The Contract Heat Treatment Association Newsletter

HOTLINE

Issue No. 142
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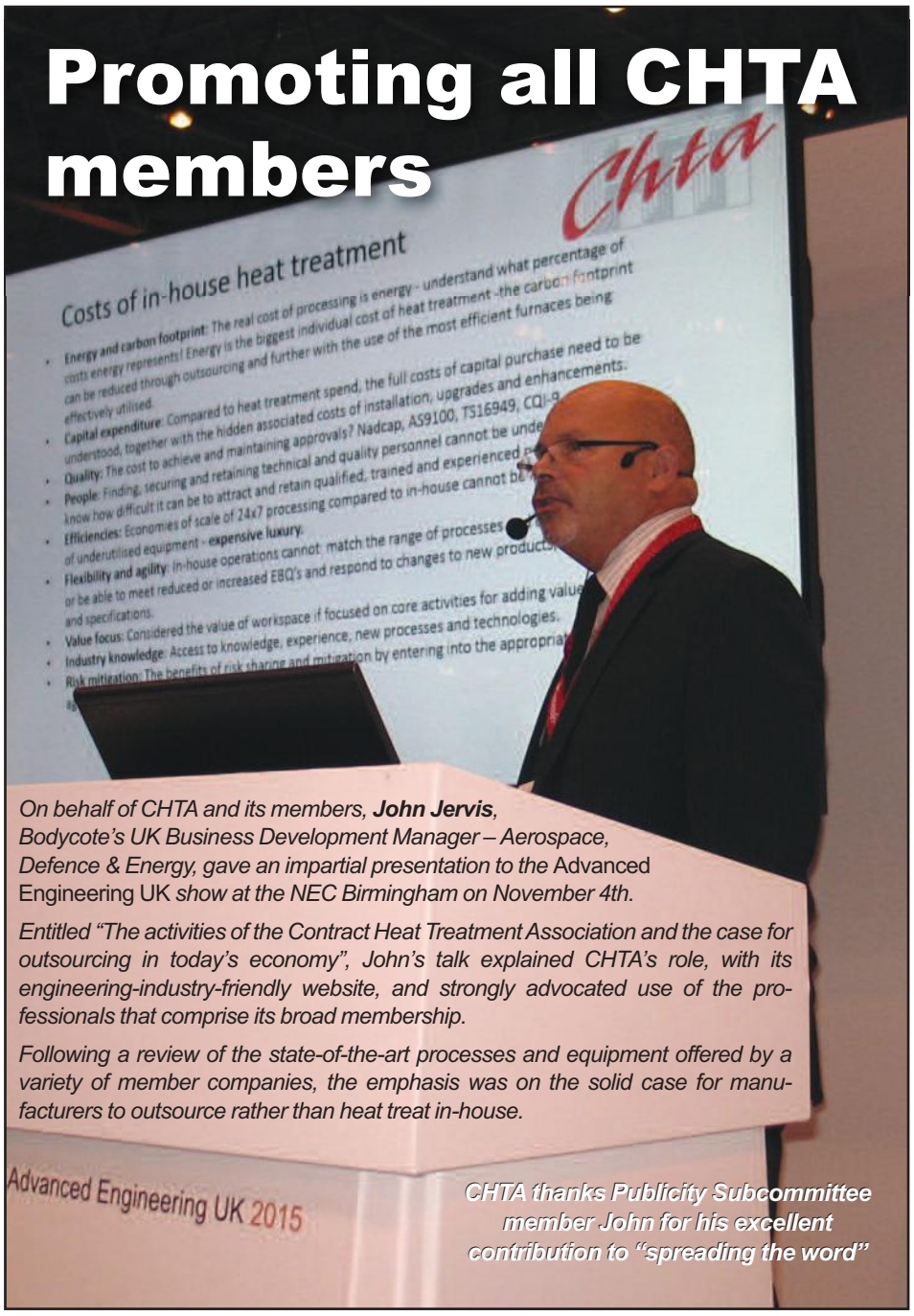
CHTA is affiliated to the Surface Engineering Association

Promoting all CHTA members

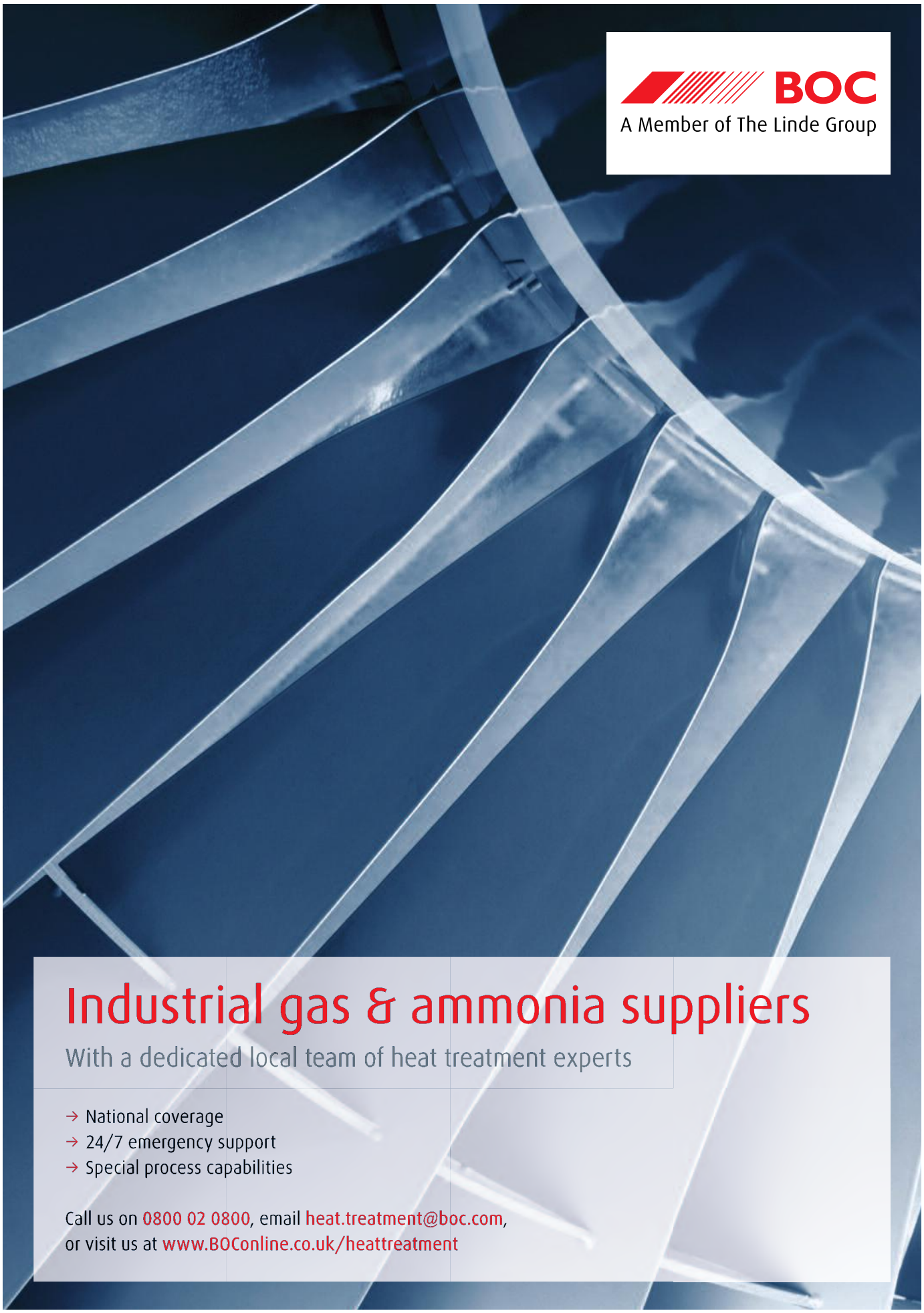


On behalf of CHTA and its members, ***John Jervis****, Bodycote's UK Business Development Manager – Aerospace, Defence & Energy, gave an impartial presentation to the* Advanced Engineering UK *show at the NEC Birmingham on November 4th.*

Entitled "The activities of the Contract Heat Treatment Association and the case for outsourcing in today's economy", John's talk explained CHTA's role, with its engineering-industry-friendly website, and strongly advocated use of the professionals that comprise its broad membership.

Following a review of the state-of-the-art processes and equipment offered by a variety of member companies, the emphasis was on the solid case for manufacturers to outsource rather than heat treat in-house.

CHTA thanks Publicity Subcommittee member John for his excellent contribution to "spreading the word"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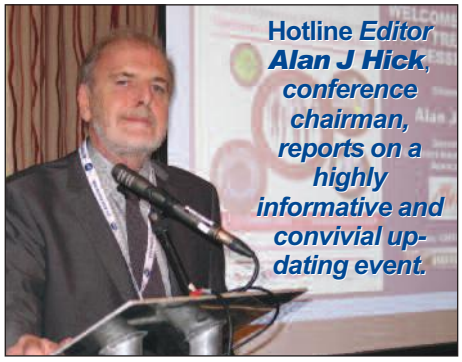
Successful first national heat treatment conference/exhibition for twelve years



Hotline *Editor Alan J Hick*, *conference chairman, reports on a highly informative and convivial up-dating event.*

Before this year, the last national heat treatment conference in England was Wolfson Heat Treatment Centre's *Advances in Heat Treatment Processing*, staged in conjunction with the final *Furnaces* exhibition, in March 2003 at Stoneleigh.

Twelve years later, the theme remained the same for the heat treatment sessions at October 16's CHTA-co-sponsored *Surface Engineering & Heat Treatment Industry Conference*, which took place alongside sessions for the metal finishers and an exhibition predominantly manned by suppliers to our industry. Some 65% of over 130 delegates were from the heat treatment community.

HEAT TREATMENT SESSIONS

The line-up of conference presentations on latest innovations in heat treatment processing offered much to those looking to reduce costs and increase productivity whilst enhancing quality, efficiency and environmental aspects.

Laser hardening

Regular readers will recall that *Hotline* 133 posed the question: "Hardening – where are the UK laser job shops?". This sparked a debate on the merits of **Industrial Laser Hardening**, well established in mainland Europe and the subject of the first conference presentation by Dr Antony Bransden of Ionbond Germany GmbH.

Tony's paper aimed to demonstrate the flexibility of the laser transformation hardening process (*Fig.1*), described along with its influences and requirements (*Fig.2*). He summarised the associated advantages:

- The rapid process speed leads to high productivity from a cost-effective treatment that facilitates fine microstructures and high strength. The narrow high-temperature gradients result in a shallow heat-affected zone.
- With a precisely-localised treatment, fine structures can be treated.
- The low heat input means low distortion.
- The process is CNC controlled, with high reproducibility and 3-D capability.

A wide range of laser hardening applications carried out under industrial conditions were shown (including small parts, such as lock components, collet chucks and cutting and forming tools - see *Hotline* 133, page 3), together with a case

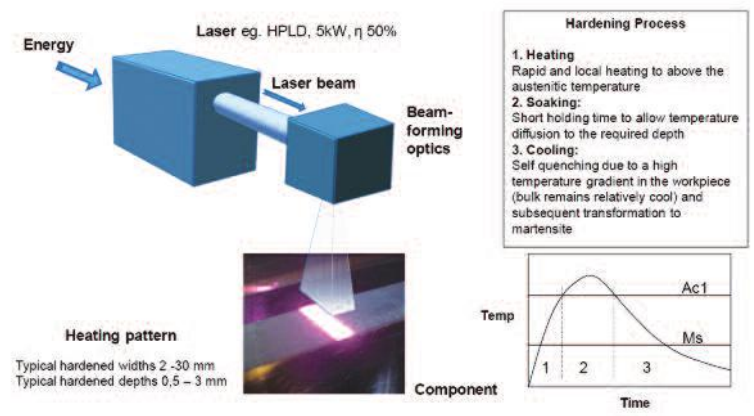


Fig.1: Principles of laser hardening.

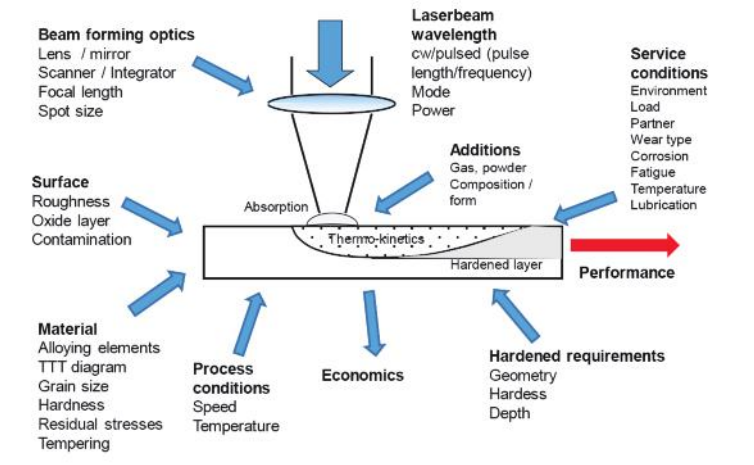


Fig.2: Laser hardening process influences

study on the laser hardening of plastic injection moulds.

Temperature profiling

In the second presentation, **Challenges and Benefits of Temperature Profiling in the Heat Treatment Industry**, David Plester of PhoenixTM, UK, described the use of 'hot-box' temperature-profiling systems, an advantageous option compared with the limited "trailing thermocouples" approach, in a variety of applications. He looked at how this type of system has evolved over the last 20 years as temperature uniformity surveying (TUS) has become an ever-increasing requirement of aerospace and auto manufacturing industries, and how development is underway to broaden their use for system accuracy tests (SAT).

In hot-box temperature-profiling systems a multi-channel datalogger, protected by an insulated thermal barrier, travels through furnace together with the products being heat treated, thermocouples feeding temperature data back to the logger. At the end of the process, data are examined using purpose-built software. Further developments allow data to be sent out of the furnace via RF so that the process can be seen in real time (essential for surveying).

Fig.3: In order to overcome the hostile-environment challenges, with quench and wash added to high temperature and furnace atmosphere, the PhoenixTM TS 12 system hot box for oil quench uses a thermal barrier with two-part insulation. The outer sacrificial insulation, surrounding a substantial sealed inner barrier, is replaced after every run.

David reviewed the specific hostile-environment challenges and engineering solutions for hot-box temperature surveying in a pusher carburising furnace, in a walking-beam furnace heat treating aluminium logs and in a sealed-quench carburising furnace.

In the latter case, the first hot box capable of also passing through the oil quench was described (see *Fig.3* and a video at *https://goo.gl/ewsCvm*). This offers the possibility of monitoring temperature distribution, and its effect on component distortion, during the quenching phase. However, here the question arises: what influence on results does the rather bulky hot box have in terms of normal-operation quench-oil flow, cooling rate, etc?

Conference chairman Alan J Hick with fellow speakers Bernd Edenhofer (Ipsen), James Cross (Super Systems Europe), Dave Plester (PhoenixTM) and Tony Bransden (Ionbond Germany).

Software

Without doubt, the biggest single innovation in my 50 years in heat treatment has been the ever-widening spread of computerisation. Some latest developments were considered in a presentation that focused on collecting and analysing data with new software features. These identify the weakest/poorest areas of a heat treatment department in terms of utilisation/downtime, cost, productivity and process times.

In introducing his talk, **Using Heat Treatment Software to Increase Productivity**, James Cross of Super Systems Europe observed that the UK and other developed heat treatment markets are suffering from knowledge loss, partly attributable to the increasing spread of automation that has eliminated the need for process specialists. "Automated systems yield high uptime when working as designed but are problematic when they cease to function exactly as intended, simply because there is less experience".

On the basis that many UK furnaces could be more productive by increasing their efficiency and reducing maintenance downtime, James examined how software built around operators, maintenance engineers and managers can help enhance productivity by improving the way in which live data are made available and historical data are utilised. Examples of the application of supervisory control and data acquisition (SCADA) included:

- Reducing downtime by predictive intelligent maintenance: early/immediate identification of a cracked radiant tube / predictive maintenance of an endothermic gas generator / trend analysis / additional hardware requirements / predictive maintenance using vibration monitors (re fan or quench agitator) / oxygen-probe monitoring.
- Increasing furnace efficiency by periodic comparison of key trends: trending heat-up times.
- Increasing process efficiency by integrating gas analysis with control to reduce cycle times: accuracy of control.
- Improving operator performance by making the most relevant data more available more quickly / comparing shift performance.
- Reducing the burden of standard adherence by incorporating Nadcap and CQI-9 compliance.
- Providing analytics – comprehensive and comparative cost reporting per furnace per hour/day/week/load – from data gathered electronically plus manual input. This also allows comparison of furnaces in terms of time in production, maintenance and non-load *(Fig.4)*

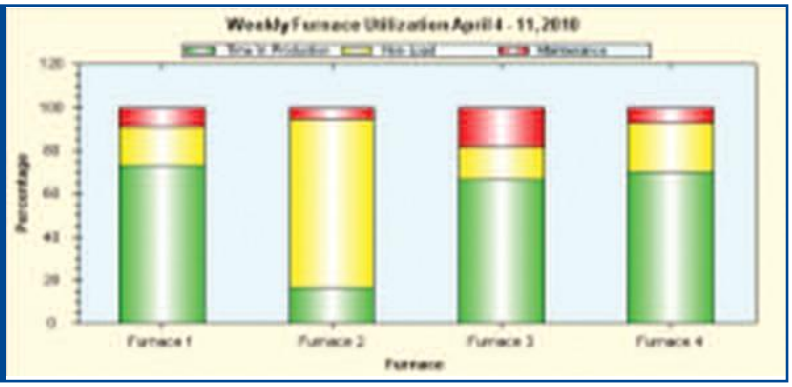


Fig.4: Sample screen view from Super Systems' furnace utilisation reporting.

Carburising

The subsequent four conference presentations outlined options to traditional gas-carburising procedures.

In ***HybridCarb* - Method to Reduce Operating Costs in Gas Carburising Processes**, Dr Bernd Edenhofer (Ipsen, Germany) described a proven revolutionary innovation, soon to be operated by at least two CHTA members, that recycles the furnace atmosphere, rather than burning it off, whilst dispensing with the endothermic gas generator. As indicated in the full presentation, published on pages 11-14 of this edition of *Hotline*, in well-sealed furnaces, atmosphere gas savings approaching 90% are claimed.

A system that offers an alternative to both conventional endothermic-type atmospheres and low-pressure (vacuum) carburising was the subject of **Gas Carburising without Internal Oxidation (Activated Carburising)** by Maximus Akuh and Mike Wilkinson (Air Products, Germany/UK). This method, involving a non-thermal electric discharge activating low-percentage hydrocarbon (between 0.1 and 5vol%) in nitrogen during furnace injection, produces an oxygen-free carburising atmosphere that eliminates the intergranular oxidation that occurs in endo-carburised steel parts. Cost benefits are also claimed; "the carburising cycle can be reduced by about 15% when aiming for 0.5mm carburising depth".

The plasma discharge is said to act as a catalyst for the reaction between the gases and the steel being treated, increasing the surface carburising speed compared with traditional atmosphere processes.

The amount of gas and hydrocarbon (methane or propane) introduced is controlled by an in-situ carbon-flux sensor and intelligent carbon diffusion modelling software. This process control method, developed jointly by Air Products and Process-Electronic GmbH, predicts the surface carbon profile from the mass of the carbon entering the metal and not by the commonly-used measurements of the carburising gas concentration in the furnace atmosphere. The accuracy of this predictive method is said to be high because it is not affected by the unreacted gases, typically present in carburising.

Elimination of internal/intergranular oxidation is one of the virtues of low-pressure carburising, as reiterated in our assessment in *Hotline* 128. An update on the technology and equipment developments was provided in **Low-pressure Carburising and High-pressure Gas Quenching** by Matthias Rink of Ipsen, Germany.

With reference to Ipsen's *AvaC*® low-pressure carburising (LPC) technique *(Fig.5)* using low-flow acetylene (C_2H_2), he listed the other advantages including:

- the ability to treat complex geometries and dense loads;
- higher carbon transfer and the use of higher processing temperatures lead to faster carburising and shorter cycle duration;
- optimum and repeatable case uniformity;
- lower gas consumption and costs;
- no thermal radiation / flames;
- environmentally friendly;
- no conditioning of the furnace.

The downside is higher equipment investment expense, compensated by the elimination of oil quenching and washing, and care has to be taken with regard to the possibility of formation of soot and tar in the furnace, too-high carbon content in edges and tips of components, and effusion of hardenability-enhancing manganese, chromium and silicon from the steel surface.

Matthias described the boost/diffuse cyclic nature of the process, conducted at temperatures of 850-1100°C and pulsed pressures of 4-10mbar, and control via simulation with *Vacu-Prof* software. Applications examined included dense loads of the inevitable diesel injection nozzles and the high-temperature carburising (1050°C) of a full load of 14NiCrMo13-4 (832M13/En36C) components to an effective case depth (CHD) of 2.0-2.3 mm in a cycle time

Conference speakers Steve Plumb (TTI Group), Pat Torok (United Process Controls), Derek Close representing event co-sponsoring Wolfson Heat Treatment Centre, Matthias Rink (Ipsen), Mike Wilkinson and Maximus Akuh (both Air Products).

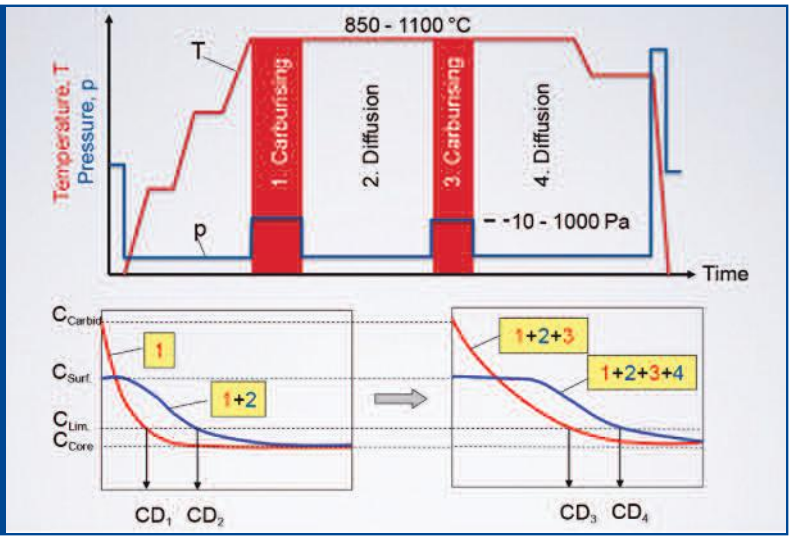


Fig.5: AvaC® process procedure and carbon profile development.

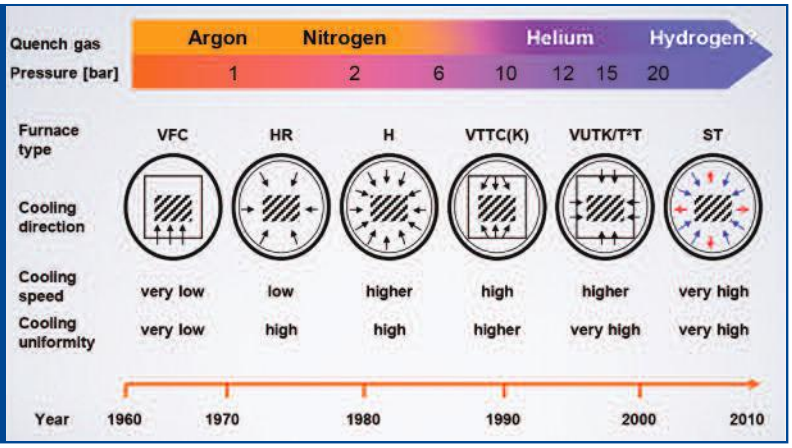


Fig.6: The evolution of high-pressure gas quenching.

of 10.5 hours.

With regard to high-pressure gas quenching after LPC (eliminating post-cleaning), Matthias reviewed the chronological evolution of equipment (single- and multi-chamber) and techniques to yield increasingly higher cooling speed and uniformity (*Fig.6*).

The prospect of shortening carburising cycles through the use of higher LPC temperatures has also been looked at by other furnace manufacturers. A technique that counters reservations about high-temperature grain growth, and facilitates dramatic increases in productivity via this route, was addressed in the paper by Michał Sut (Seco/Warwick, Poland), **Faster Carburising with *PreNitLPC*®**, presented in Michał's absence, due to illness, by Alan J Hick.

Through ammonia dosing of the nitrogen carrier during the controlled heat-up ramp to promote nitriding (*Fig.7*), the LPC furnace can run at higher temperatures (1000°C and above), while maintaining a fine grain structure within the case. *PreNitLPC*® technology at 1000°C results in a smaller grain size of the case in comparison with straight LPC processing at 920°C.

The high temperature of the process increases the carbon diffusion coefficient, leading to a significant reduction of the carburising time. The boost/diffuse time for carburising a gross load weight of 400kg to an effective case depth of 0.6mm has been demonstrated to be reduced from 2hours 47minutes in endothermic atmosphere at 920°C to 54minutes by *PreNitLPC*® processing at 1000°C.

Table 1 shows the impact on overall cycle time, compared with traditional endothermic gas processing at 930°C. Taking account of the times to heat up to carburising temperature and cool down to quenching temperature, the reduction in overall cycle duration for higher carburising temperatures becomes more dramatic with deeper case depths.

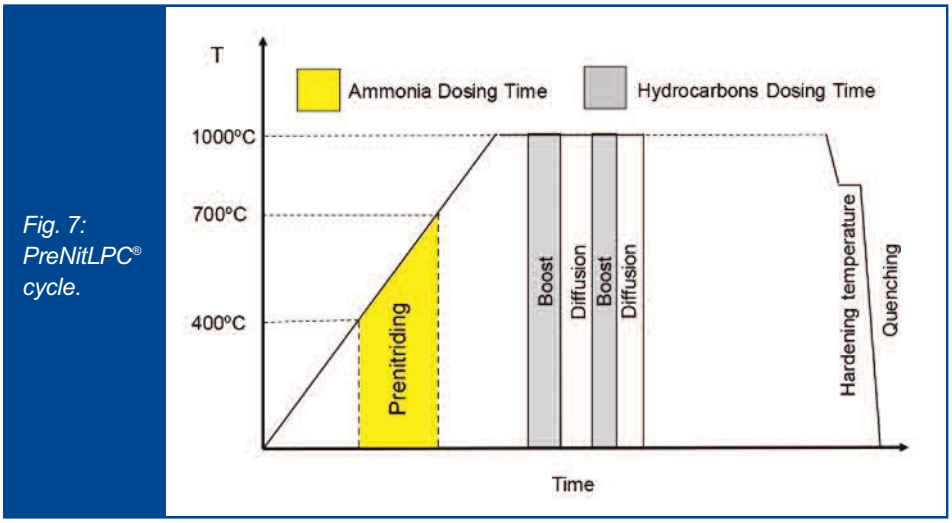


Fig. 7: PreNitLPC® cycle.

Table 1: Total cycle times for* PreNitLPC® *compared with conventional endothermic gas carburising.

Effective case depth		Endo		*PreNitLPC*®	
		930°C		980°C	1030°C
mm	inch	h	%	%	%
0.40	0.016	3.6	100	89	97
0.60	0.024	4.7	100	79	81
0.90	0.035	6.8	100	72	65
1.20	0.047	9.7	100	68	55
2.00	0.079	20	100	65	44
3.00	0.12	39	100	68	41
5.00	0.20	102	100	68	38

The mechanical properties (hardness, fatigue strength, pitting resistance and impact strength) obtained with *PreNitLPC*® technology are comparable with the properties obtained in standard carburising processes at lower temperatures (in some cases, better).

This technology saves process costs by reducing the carburising cycle time and the consumption of process gases (C_2H_2, C_2H_4, H_2, NH_3) as measured in litres and not, as in the case of conventional technologies, in m³/h.

Nitriding/Nitrocarburising

Upgrades that enable compliance with today's strict specifications, by the application of new control and sensor technology, were addressed by Pat Torok (United Process Controls, USA) in **Solution-oriented Approach to Nitriding/ Nitrocarburising Controls.**

Pat noted that industry's first attempt at nitriding specification, 1987's AMS 2759/6, based on traditional control by burette ammonia dissociation measurement, was followed in 1999 by AMS 2759/10, a refinement enabling diluted atmospheres and "Automated Gaseous Nitriding Controlled by Nitriding Potential". Filling the gap for ferritic nitrocarburising came AMS 2759/12, "Gaseous Nitrocarburizing, Automatically Controlled by Nitriding and Carburizing Potentials".

He went on to explain nitriding and carbon

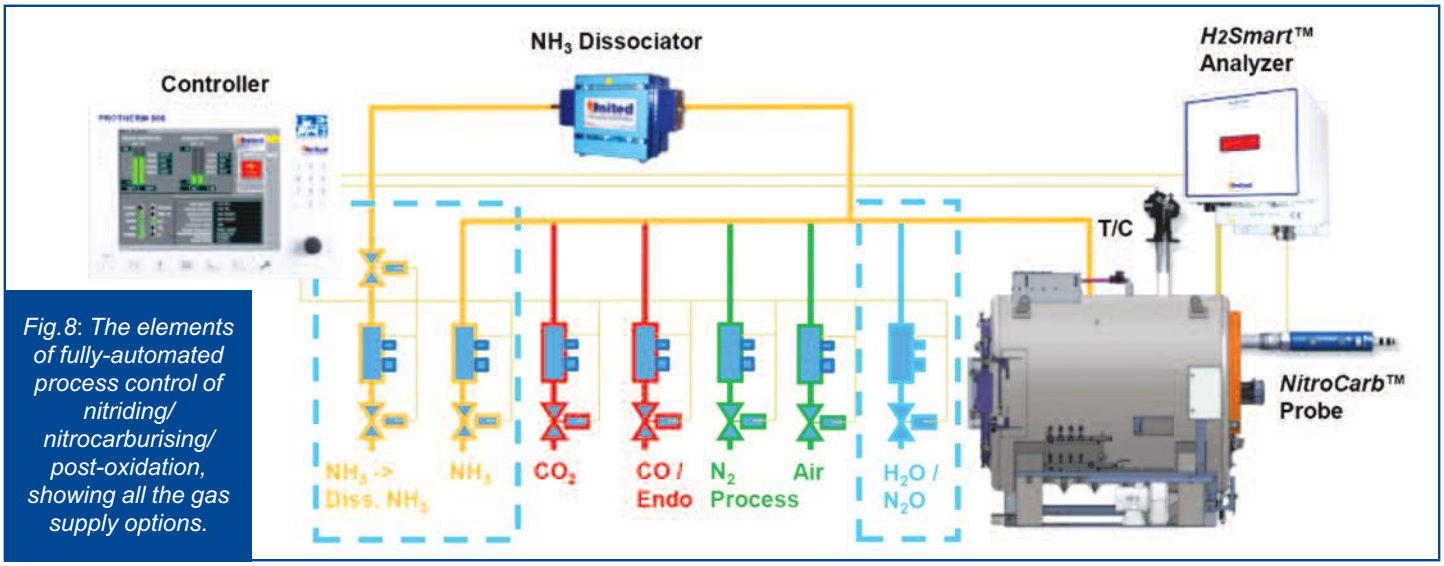


Fig.8: The elements of fully-automated process control of nitriding/ nitrocarburising/ post-oxidation, showing all the gas supply options.

Industry sponsors...

Seen at the exhibition...

Exhibitors...

● Ajax Tocco International ● Alloy Heat Treatment ● BMI Fours Industriels ● Bodycote ● Browndog Design ● Citation ● Clayton Thermal Processes ● Codere ● Cronite Castings ● Eurotherm ● Harter Environmental ● Keighley Laboratories ● PhoenixTM ● SAFECHEM ● Schunk UK ● STOWURC ● Super Systems Europe ● TTI Group ● Valuechain.com ● Vacuum and Atmosphere Services / Ipsen ● WS Burners ● Zwick/Roell

potentials for these low-temperature processes and methods for controlling them. In nitriding, where hydrogen measurement comes into play to assess potential, the ability to dilute ammonia with cracked ammonia or nitrogen enables low nitriding potentials while maintaining a constant furnace pressure.

AMS 2759/12 recommends ranges of nitriding potential depending on the depth of white layer permitted. Similarly, for nitrocarburising it defines limits on nitrogen and carbon potential relative to the allowed depth of porosity in the epsilon compound layer. These potentials are interrelated and must be controlled simultaneously by furnace additions of, variously, carbon dioxide, endothermic gas, and carbon monoxide plus carbon dioxide, with certain advantages and disadvantages. UPC's controller is able to react to varying process conditions so that the two potentials are kept constant.

Pat also demonstrated that the level of hydrogen partial pressure in diluted atmosphere has a dramatic effect on the speed of nitrogen transfer. Here the *H2Smart*™ hydrogen analyser has an additional important role in potential plus speed control.

An oxygen-probe-controlled post-oxidation stage, with H_2O/N_2O introduced into the furnace atmosphere, enables the development of optimum corrosion resistance on nitrided/nitrocarburised components.

Pat then concluded by describing the equipment for fully-automated process control, based on the foregoing (*Fig.8*).

Fig.9: An example of high-strength transmission components subjected to LPC by TTI. Only the tracks of these S156 selector barrels, with very low grinding allowance, are to be carburised. LPC results in low distortion and reduced dimensional changes. In developing the process, the influence of masking compounds has been studied by TTI.

Trends

Overviewing recent developments in carburising, nitriding, nitrocarburising (*Nitrotec*) and PVD coatings in the closing presentation, **Thermochemical Heat Treatments: the Changing UK Scene**, Steve Plumb (TTI Group, UK) highlighted the advantages in component properties and applications, seen by the end-users in the new markets that are now part of the engineering picture of the UK.

One of three CHTA members offering low-pressure carburising (see *Hotline* 128, pages 4-6), TTI installed its first LPC furnace (Ipsen) in 2007. The intervening years have seen process development (including 1050°C carburising and optimisation of stop-off procedures – see *Fig.9*) and increasing client interest, particularly from those involved in Formula 1 and wider motorsport, close co-operation with steel suppliers re optimum process response, and a growing list of customer approvals.

In order to meet the demand for more capacity, a Seco/Warwick 6bar-nitrogen-quench low-pressure carbonitriding furnace, also facilitating *PreNitLPC*®, nitriding at 400-800°C, hydrogen cleaning and step quenching, was installed and commissioned in 2014.

PLENARY SESSIONS

Designed to be of mutual interest to all conference attendees, plenary sessions included **R&D tax relief on the day-to-day activities of heat treaters and metal finishers** by Dominic Bartholdi of Leyton UK (see *Hotline* 137; a CHTA member has benefitted substantially). Other contributions were **Growing your business through digital**, by Alexis Bradbury (Browndog Design), and **Reshoring production to the UK** by Alison Phillips of the Manufacturing Advisory Service (MAS).

EXHIBITION

The well-attended exhibition saw suppliers to the heat treatment sector dominate the list of table-top exhibitors.

CHTA takes this opportunity to thank industry sponsors and exhibitors whose much-valued support contributed hugely to the success of the event.

CONFERENCE DINNER

In the build-up to the event, *Hotline* noted that opportunities for the heat treatment community to get together over a few drinks are rare these days. Accordingly urged, many CHTA members attended the post-conference evening drinks reception (kindly sponsored by Wallwork Heat Treatment) and dinner to make a great night of it.

Like the conference and exhibition, the evening events were superbly organised and administered by SEA, to whom our sincere thanks.

Convivial? I'll say! One of the best days of my heat treatment life ended in a close encounter with a flower bed!

...so good that a repeat of the event is planned for 2017. Watch this space!

Surface Engineering and Heat Treatment Industry Conference
16 October 2015
Stratford-upon-Avon, UK
Co-sponsored by...

What did you think?

Hotline **has been gathering opinions from delegates, speakers, sponsors and exhibitors after October's event…**

Debbie Mellor, Managing Director, Keighley Laboratories Ltd:
An incredibly well-organised event with industry-relevant speakers - looking forward to the next one! Really good to be able to catch up with other heat treatment professionals in a relaxed environment.

Andy Borg, Managing Director, TTI Group Ltd:
TTI Group were delighted to be able to support this industry conference. The sponsorship deal was good value for money and provided a rare opportunity to bring along a wider company contingent than would normally be possible.
I thought that the day itself was really well attended by competitors and suppliers, and was extremely well organised.

Simon Blantern, VP Sales Europe / AD&E, Bodycote Heat Treatments Ltd:
I personally enjoyed the CHTA-co-sponsored *Surface Engineering & Heat Treatment Industry Conference/Exhibition* in Stratford; it was a good opportunity to discuss general business with competitors in the UK heat treatment industry.
The presentations on all existing and new technologies were interesting and well delivered. The table-top exhibition from suppliers (some co-sponsors) was also beneficial and well located close to the refreshments. The attendance from the UK heat treatment industry well exceeded my expectations
I think we should consider a similar event, probably every two years, and inviting people from other heat treatment trade associations, in both Europe and North America, to share their experiences, for example.
Finally I would like to say a big thank you to SEA's Diana Blair and Alan J Hick, Secretary of CHTA, for the effort they put in pulling together an event that ran seamlessly. Thanks!!

Peter Carpenter, CEO, Wallwork Heat Treatment Ltd:
I was very pleased to see that a heat treatment conference had been organised in the UK this year.
I thought that the structure of the conference, particularly combining some sessions with the surface engineering, worked well. The lecture topics where diverse and interesting although, had the changeover times of lectures in both sessions been identical, it would have made it easier to swap between heat treatment and surface engineering sessions.
The exhibition was a good focal point although slightly cramped during lunchtime.
The venue was excellent, reasonably central and accessible, with good parking at a reasonable price. Having the event on a Friday also worked well, with good attendance at the dinner which was a great opportunity to have a more relaxed chat with other people in the industry.
Thank you very much to everyone who contributed to the organisation of the event. I shall look forward to hopefully having similar events in the future.

Conference collaborators: Alan J. Hick, heat treatment sessions organiser and publicist, with SEA's Diana Blair, event administrator.

Yvette Lawlor, TTI Group Ltd:
It was a very worthwhile day, with lots of relevant content and plenty of chances to network with our colleagues/competitors and suppliers in an informal environment.

Bernd Edenhofer, Ipsen International GmbH:
Thank you for staging the *Surface Engineering & Heat Treatment Conference, Exhibition and Dinner 2015*. I extremely enjoyed being part of it.
Topics and speakers chosen represented a good mixture of novelties in our field. I was especially impressed by Tony Bransden's presentation on industrial laser hardening, which showed progress in this technology that surprised me.
The Stratford Manor Hotel, the exhibition and the conference dinner all presented a perfect framework for this occasion. They reminded me of many wonderful conferences that I was lucky to attend in England in the 70s, 80s and 90s and also in the early 2000s. I hope that this old tradition can be continued in the future.

Kevin Robinson, Eurotherm by Schneider Electric:
Well done on a great event; you must be very pleased.
I would say that the CHTA conference was the material processing event of the year in the UK. Although the last 12 years have not seen many process breakthroughs, in that time the knowledge and experience of the audience has certainly changed.
The event provided a concise update on the state of our art. The table-top exhibition was well received and gave everyone an opportunity to catch up, both personally and professionally.
It seemed a well organised and attended event and Eurotherm by Schneider Electric were proud to be a part of it!

Mike Long, Managing Director, Vacuum & Atmosphere Services Ltd:
I thought the day and evening were very good. Whilst there weren't many customers, those that attended were interested. No time wasters. We would do it again.

Tony Alderton, TTI Group Ltd:
It was a very good day with the ability to meet existing and, in particular, potential new suppliers. The papers presented were very interesting and informative for someone who is new(ish) to heat treatment. I'm hoping this will become a regular event.

Richard Starkey, Regional Sales Manager, SAFECHEM Europe GmbH:
We thought that the event was extremely well attended, and were a little surprised that it had been 12 years since the last heat treatment event.
The organisation was excellent and SAFECHEM appreciated the opportunity to address the industry as a whole, with many customers already within the sector. I hope it doesn't take 12 years for the next one!

Joseph Cadwallader, TTI Group Ltd:
This was my first time attending a CHTA event. The day was very well organised at a first-class venue. The opportunity to question some of the industry's most influential people was a rare and valuable one.

Linda Evans OBE, Deputy Chairman, Surface Engineering Association:
I cannot say how much I enjoyed the day. Speaking to many of the delegates, they really enjoyed it too and, more importantly, would like to do it again.
If you could not attend this event, then you missed a treat. I feel we should do other joint projects; after all, we need each other to operate and have the same common interest.
Well done! To the SEA team, Dave Elliott, Diana Blair and Michaella Mais, Wolfson Heat Treatment Centre's Derek Close and CHTA's Alan J Hick. The success was due to all your hard work.

HybridCarb® - method to reduce operating costs in gas carburising processes

Bernd Edenhofer, Dirk Joritz, Matthias Rink and **Markus Reinhold**
Ipsen International GmbH, Kleve/Germany, Global R&D

Heat treatment furnaces, especially those for carburising and hardening, utilise a continuous process gas flow. Despite the fact that the consumption of atmosphere gas is considerable, and represents a certain cost factor in heat treatment, the flue gas of heat treatment processes has hitherto been burnt off uselessly.
A new technology uses the catalytic regeneration of the atmosphere gas, brings it back to its original state and returns it into the heat treatment furnace. This reduces the process gas consumption of carburising and hardening furnaces by up to 90%. The concept, execution and functioning of this new regeneration technology, together with results of its industrial utilisation, are the main focus of this paper.

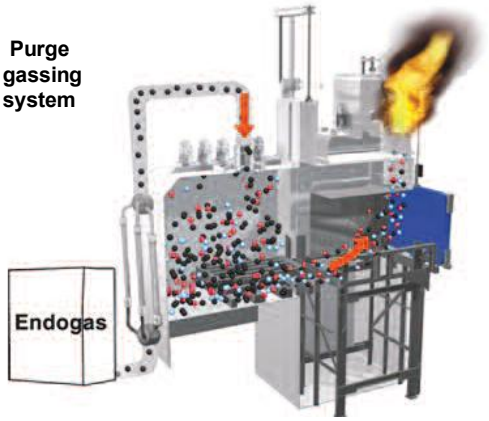
Introduction

Heat treatment furnaces are, with very few exceptions (nitriding with almost zero gas flow [1] and solution nitriding of stainless steels [2]), run with a continuous flow of process gas through the furnaces. The gases fed into the furnaces are either endothermic gas or nitrogen/methanol or only nitrogen. *Fig.1* shows schematically such a furnace gassing in the case of endothermic gas as process gas.
The necessity of such a continuous gassing is based on the establishment of:

- a sufficient high pressure in the heat treatment furnace;
- sufficient high carbon availability of the atmosphere in the case of carburising treatments;
- constant atmosphere composition throughout the carburising cycle [3].

As a consequence of this requirement of constant gas flow through the furnace, the consumption of process gas is not negligible, as *Table 1* shows.

Fig.1: Conventional endothermic process gas flow and burn-off in a sealed-quench furnace.



In industrial practice, a flow of about 2m³/h per m³ of furnace volume has proven to be sufficient to carburise in these furnaces, even with loads with a high surface area. Relatively-large sealed-quench furnaces therefore require flows of carrier gas in the range of 15 to 25m³/h. Large pusher furnaces need even more gas flow, in the range of 30 to 40m³/h, and open mesh-belt furnaces even higher, with amounts above 50m³/h.

Table 1:
Consumption of endothermic carrier gas in various sealed-quench furnaces.

Furnace size	Endothermic gas		*Cost per annum, €	
	Flow, m³/h	*Cost, €/h	6,000h	8,000h
RTQ-5	6	1.74	10,440	13,920
RTQ-10	12	3.48	20,880	27,840
RTQ-17	16	4.64	27,840	37,120
RTQ-26	26	7.54	45,240	60,320

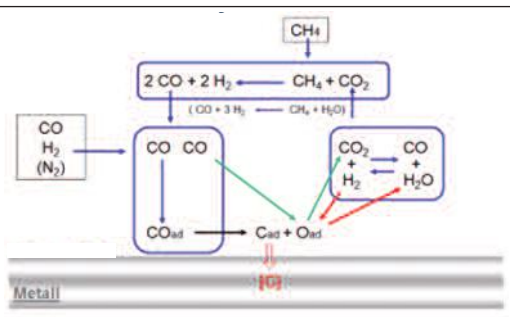
**Costs based on an average of 0.29€/m³ for producing endothermic gas in a heat treatment shop in Germany.*

Carburising gas reactions

In gas carburising in atmospheres based on CO and H_2, the carbon transfer into the surface of the steel component takes place via adsorption of CO molecules at the surface, followed by a subsequent decomposition of the CO molecules into adsorbed carbon and adsorbed oxygen. The carbon atoms diffuse into the steel and produce the carburising effect, while most of the oxygen atoms remain on the surface, producing a dense layer of adsorbed oxygen. This layer of adsorbed oxygen – if not removed - prevents any further adsorption of CO molecules and thus causes the carbon-transfer reaction to come to an end.
This is why hydrogen is needed in a carburising atmosphere. The H_2 molecules act to desorb the adsorbed oxygen atoms from the surface producing, as a result, water vapour (H_2O) in the atmosphere and, at the same time, creating new empty

This paper was delivered by Bernd Edenhofer at October's *Surface Engineering & Heat Treatment Industry Conference*, the last of his many world-wide presentations before retiring. *Hotline* wishes a good friend a long and happy retirement.

Fig.2: Schematic of the gas reactions at the gas-metal phase boundary.



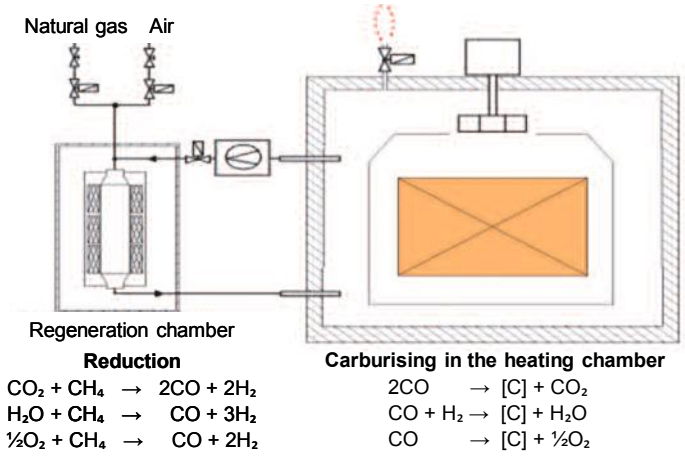


Fig.3: Schematic of a regeneration chamber connected to a carburising furnace.

locations on the metallic surface for new adsorption of CO molecules (*Fig. 2*). The CO molecules can also help to desorb the adsorbed O from the surface, thus creating CO_2 molecules in the furnace atmosphere.

Or, expressed differently, in gas carburising in CO- and H_2-based atmospheres, the carbon-transfer effect produces, as a direct result, the reaction products CO_2, H_2O and O_2 according to the reaction equations:

$$2CO \leftrightarrow [C] + CO_2 \quad (1)$$

$$CO + H_2 \leftrightarrow [C] + H_2O \quad (2)$$

$$CO \leftrightarrow [C] + ½O_2 \quad (3)$$

As the amount of these reaction products increases, the carburising capability of the furnace atmosphere is reduced; the reason being that these gases are oxidising and therefore also decarburising. It is thus vital, for the continuation of the carbon-transfer process, to reduce the reaction products and bring them back into their original state of CO and H_2.

This goal is reached by adding a so-called enrichment gas to the furnace atmosphere. Any hydrocarbon gas will do the job. Where natural gas is used as enrichment gas, it is basically methane (CH_4) that produces the reduction of the reaction products to CO and H_2, according to the following reactions (also see *Fig.2*):

$$CO_2 + CH_4 \leftrightarrow 2CO + 2H_2 \quad (4)$$

$$H_2O + CH_4 \leftrightarrow CO + 3H_2 \quad (5)$$

$$½O_2 + CH_4 \leftrightarrow CO + 2H_2 \quad (6)$$

Regeneration of furnace atmosphere

There have been efforts to not burn off the process gas, but to recycle it by filtering out the CO_2 and H_2O and then returning the cleaned carrier gas back to the furnace [4]. However, this technique was not successful as the filtering of the CO_2 and H_2O in large absorbers is too expensive and, in addition, the filters and absorbers required constant cleaning of soot and other particles created in the furnace atmosphere. The method of reconditioning the furnace atmosphere by filtering/cleaning is thus not a viable one for industrial gas carburising furnaces.

A much better procedure for re-using the furnace atmosphere is the reduction of the carburising products CO_2 and H_2O to reinstate the original CO and H_2 atmosphere.

The reduction of the carburising reaction products CO_2 and H_2O in the furnace chamber requires a large amount of hydrocarbon gas. Especially in times of high carbon-transfer rates, as is usually the case in the starting phase of a carburising cycle, the reduction of the reaction products is incomplete and leaves a large amount of non-reacted methane in the furnace atmosphere, making a frequent exchange of the furnace atmosphere, by purging with a high gas flow, necessary.

This is where the new technology comes in. It uses the gas reduction cycle but diverts it from the furnace chamber into a separate regeneration chamber. The temperature in the regeneration chamber is independent of the furnace temperature and can thus be run sufficiently high that, in conjunction with a special efficient catalyst, the reduction reactions (4) to (6) take place in an almost complete manner (*Fig.3*).

During the atmosphere regeneration, the process gas is no longer burned off. A valve installed at the gas burn-off flap is closed, and the process gas is delivered by a hot gas blower from the furnace to the regeneration chamber. There, a small amount of natural gas (or other hydrocarbon gas) is added to the process gas. This gas mixture passes through the reaction retort of the regeneration chamber where the carburising reaction products of CO_2 and H_2O are reduced to CO and H_2 before the thus-regenerated gas is delivered back into the furnace.

The possibility of using the regeneration chamber in a double function, both as a catalytic reduction chamber and also as a catalytic gas generator which produces endothermic carrier gas, is surely the main factor of the success of this technology. This double capability has led to naming this technology *HybridCarb*®.

Using the regeneration chamber as a gas regeneration system during the whole carburising, carbonitriding or hardening cycle, including the periods of heating, carburising, diffusing and quenching, surely would not work. Especially during heating and quenching, the furnace atmosphere is heavily polluted with evaporated residues of washing detergents or cutting oils or with fumes of the quench oil which, if carried into the regeneration chamber, would quickly reduce its efficiency. That is why in these periods of the heat treatment cycle the atmosphere regeneration is not active. Instead, in these phases, the *HybridCarb* system delivers endothermic carrier gas continuously to the furnace, purging out all polluting atmosphere constituents and burning them at the open gas exhaust valve. Such a three-step carburising cycle is shown schematically in *Fig.4*.

The control of the carbon potential of the furnace atmosphere remains unchanged. The carbon potential is measured as

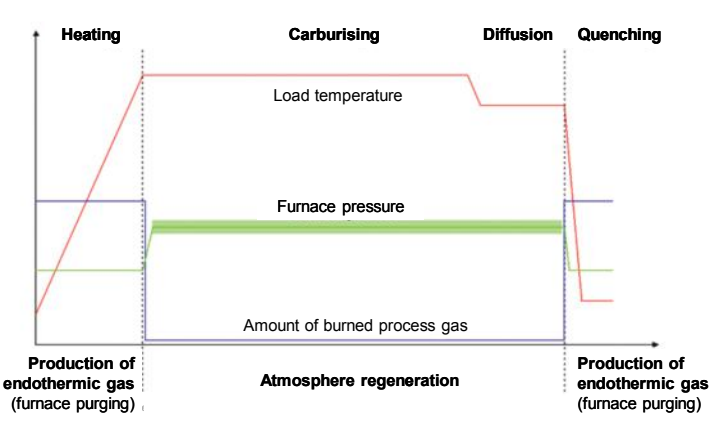


Fig.4: Schematic of a carburising cycle with purging and atmosphere regeneration periods.

usual, mostly using an oxygen probe, and its value is raised or lowered by admitting enrichment gas or air directly into the furnace.

Important for the effectiveness of the system is the fast and frequent circulation of the furnace atmosphere into the regeneration chamber and back.

Industrial utilisation

As opposed to many patented ideas of process technology which have never made it to industrial utilisation, the use of *HybridCarb* in industry has started. Several large sealed-quench furnaces are running in various countries in Europe with this technology. They have replaced endothermic and nitrogen/methanol gassing systems in small, medium and large sealed-quench furnaces. Large sealed-quench furnaces and long carburising cycles lend themselves especially to the utilisation of the *HybridCarb* regeneration system because they produce the largest savings in consumption cost.

However, the system is not only useful for deep-case carburising. Its use is also attractive for short cycles and shallower cases.

Fig.5 shows, as an example, the cycle printout for a load of 1850kg case-hardened in a TQ-17 furnace to a case depth of 0.7mm. Total cycle time is 9.16 hours at 910°C and 840°C. Again, in the print-out, nothing hints that the cycle was run with process gas regeneration. The carbon potential and the carbon monoxide curves are perfectly normal and equivalent to those of conventional carrier gas continuous purging cycles.

In addition, the carburising results, with respect to surface carbon content, carbon profile, carburising depth CD, effective case depth CHD and surface hardness, as well as microstructure, are completely according to expectation.

The consumption data of natural gas for this 9.16-hour cycle are:

- regeneration box: 5.97m³ of natural gas;
- furnace: 2.30m³ of natural gas;
- total consumption: 8.27m³ of natural gas.

A comparable cycle with continuous carrier gas purging would consume 172m³ of endothermic gas, amounting to (including the consumption of enrichment gas) a natural gas equivalent of 43.9m³. Thus, even for such a short cycle, a saving of 81% is achieved utilising process gas regeneration.

Even with very short heat treatment cycles, like straight hardening with cycle times of only 2 or 3 hours, savings in the range of 75% can be achieved.

An overview of consumption data for deep-case and shallow-case carburising cycles, as well as straight hardening cycles, for loads of various weights in furnaces of size 17 (TQ and RTQ), is given in *Table 2*. This shows that the savings in process gas consumption with carburising loads are between 80 and 90%, whereas with very short cycles, as in straight hardening treatments, the savings are in the range of 75%.

These savings are in relation to carrier gas purging processes using endothermic gas. Where the process gas regeneration system replaces a nitrogen/methanol gassing system, the savings potential is even higher due to the high price of methanol and the additional costs for the liquid gas tanks.

The atmosphere regeneration system was, until recently, operated by connecting a *HybridCarb* box to a sealed-quench furnace. Shown in *Fig.6a*, such a box has dimensions of 1400 x 1300 x 900mm and weighs 350kg.

For newly-manufactured sealed-quench furnaces, there is now also the option of integrating the *HybridCarb* system, with its gassing system being part of the furnace gas panel, its electric controls integrated into the furnace electric unit, and the regeneration chamber located underneath the hot chamber of the furnace (*Fig.6b*).

An additional very positive effect, next to

Fig.5: Cycle print-out of a 1850kg load carburised in a TQ-17 furnace to an effective case depth of 0.7mm.

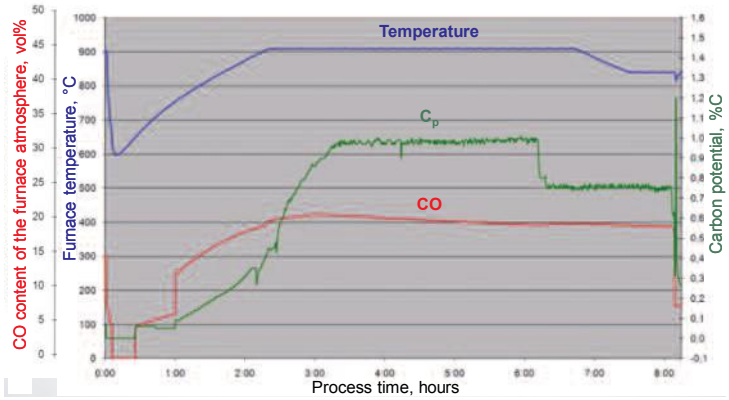


Table 2: Consumption data expressed in natural gas equivalent for various loads in an RTQ-17.

Process	Effective case depth, mm	Load weight, kg	Process time, h	Gas consumption for one cycle		Savings, %
				Endothermic & enrichment gas, m³	*HybridCarb®*, m³	
Carburising	2.5	2000	32.5	154.4	23.6	**84.7**
Carburising	1.7	1500	18.7	89.1	11.0	**87.7**
Carburising	1.0	450	9.5	52.0	6.2	**88.1**
Carburising	0.7	1850	9.1	43.9	8.3	**81.1**
Hardening	-	615	2.3	10.5	2.7	**74.3**
Hardening	-	1000	3.1	14.6	3.4	**76.7**

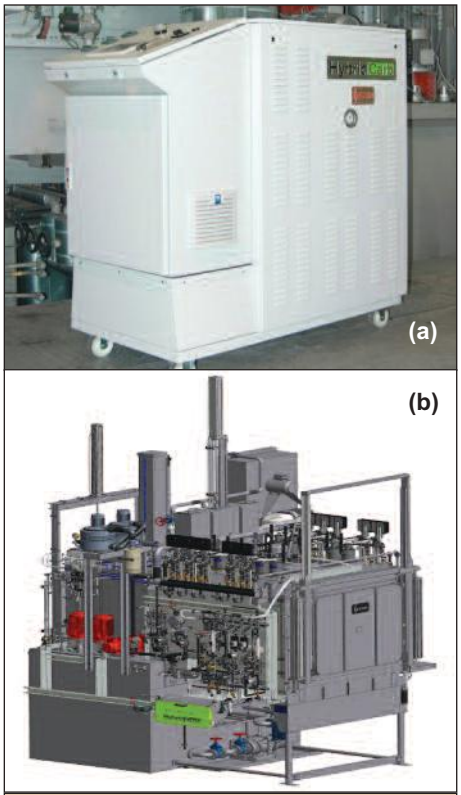


Fig.6: (a) HybridCarb box for existing furnaces and (b) as the integrated version (green) for new furnaces.

the pure cost savings in gas consumption, comes with respect to the environment. Using the regeneration technology reduces the carbon dioxide emissions of the process gas burn-off to the environment by 80 to 90%.

Up to now, the process gas regeneration system has only been installed with sealed-quench furnaces. Naturally it can be utilised with other closed furnaces, like pit furnaces, or continuous furnaces such as pushers. However, due to the necessity of cycling the furnace atmosphere for regeneration, gas-tight furnaces with a positive furnace pressure are needed. Therefore the *HybridCarb* system is not suitable to be used on open furnaces, like belt furnaces, without an entrance vestibule.

Summary

With the new regeneration system, the process gas of heat treatment furnaces is no longer burned off uselessly, but recycled. The system allows the regeneration of the process gas of a furnace in a separate catalytic retort and the return of the new reactive process gas as fresh gas into the furnace. Thus, this system replaces endothermic gas generators and liquid gas tanks.

The new technology can be used for case-hardening cycles as well as for straight hardening or annealing cycles.

It enables savings in process gas consumption of between 75 and 90% achieving, at the same time, a reduction of the carbon dioxide to the environment by up to 90%.

Despite the non-existent purging of the furnace atmosphere during 80 to 90% of the cycle time of the heat treatment process, the new regeneration technology shows a remarkable precision of control of the carburising atmosphere in the furnace. The metallurgical results, with respect to precision and uniformity of the surface carbon content and case depth, are comparable with those achieved with similar loads in furnaces run with continuous purging technology, using endothermic gas or nitrogen/methanol.

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Lack of steel availability leads to loss of orders

Roger Haw, *Managing Director of Sheffield-based Flame Hardeners Ltd, explains how the short-sightedness of steelmakers and suppliers is putting the future of some small specialist manufacturers in jeopardy.*

The myth is constantly being perpetuated that manufacturing in the UK is dying. It may be true that the huge engineering enterprises that were once prevalent are now considerably fewer in number but, according to Engineering UK's 2015 report '*The State of Engineering*', in the twelve months to March 2013 the number of engineering enterprises in the UK grew by over 2%.

5.4million workers (19.3% of all people in UK enterprises) are employed in engineering, and the collective turnover of UK engineering enterprises is £1.17trillion.

But the face of engineering has changed, in line with market demands, and 97.1% of businesses are now either small or micro, with 86.9% having fewer than ten employees. This reflects the change of focus towards niche and high-specification sectors of the manufacturing market, which has led to the increase in small specialist suppliers.

However, the short-sightedness of materials manufacturers is putting some of these specialist businesses in jeopardy.

The design and specification of any engineering component requires consideration of the intended application, the stress levels involved, the material to be used and any treatments required to enhance the material properties.

There are many companies specialising in a specific field of expertise such as gear manufacture, cam making, guide and slide making. Manufacturers of equipment and machinery no longer produce such items in-house as they prefer to buy in components from experts, taking advantage of high quality and competitive prices.

Many companies, therefore, have established a reputation for the supply of individual specialist items: a prime example of this is roller manufacturing.

Steel for rollers

Defining a roller as a cylindrical component with a length to diameter ratio (the aspect ratio) between 10/1 and 40/1, these items are used in a variety of applications, such as printing, coating, metal processing, textile manufacturing, food manufacturing, conveyors, and glass making.

Rollers usually require a high surface hardness level and a ductile core, and must have resistance to surface wear and loading with a minimum of deflection. The method of manufacture is to machine to pre-hardening dimensions, surface harden by either flame or induction hardening techniques, and finish by grinding. The steel must have sufficient carbon to promote a hardness level of 60/65HRc and sufficient alloying elements to give good hardenability, thereby producing hardened depths between 2mm and 10mm. Depending upon geometry and diameters, greater hardened depths can be achieved on rollers with an aspect ratio of between 1.2/1 to 1.5/1.

The steels meeting this requirement are carbon/chrome steels; e.g. BS970:1955 En31, BS970:1970-72 535A99.

Roller hardening at Flame Hardeners Ltd.

However, whilst this evolution has led to this country having a small group of world-class roller manufacturers, they face an ever-increasing difficulty in obtaining carbon/chrome steels. The requirement for a typical order for a batch of, say, 20 rollers, is 10 tonne of steel. But steel producers are reluctant to supply less than a mill quantity and stockists do not carry the range of diameters or quantity that may be required.

This unacceptable situation is leading to failure to gain orders or even inability to quote against enquiries for potential work.

It's time for materials manufacturers and suppliers to wake up and realise that the face of engineering in the UK has changed. Is another successful niche industry to be lost to us because we are no longer prepared to produce small quantities of specialist steels?

Stemming the rising tide of energy costs

David Cockshott, *Chief Commercial Officer of the Inenco Group, comments on the dramatically-increasing non-commodity charges on energy bills…*

Recent steel mill closures have put energy costs for energy-intensive industries back under the spotlight. With the manufacturing sector facing budget pressures from every direction, creating a long-term energy strategy and identifying opportunities to reduce costs is becoming an ever-increasing priority as the price of energy is steadily rising year on year.

Those with only a passing interest in energy may wonder why it is cited as such a significant cost concern when commodity prices have consistently dropped over the past 18 months: wholesale energy costs are currently around £40/MWh, compared with up to £50/MWh in the not too distant past. However, wholesale prices are only half the story. Industrial energy users may be enjoying some relief from volatility in the power and gas markets, but non-commodity charges have carved out a 50% share of the bill and it's these charges that are causing so much pain.

Non-commodity costs cover everything from the cost of transporting energy and keeping the system balanced, to the cost of green taxes and levies that are passed through the energy bill to pay for low carbon and renewable policies.

Transportation costs (TNUoS) have tripled in the past decade, and green taxes and levies have risen by up to 600% since 2005. An energy-intensive industrial plant will have seen their total non-commodity costs rise by over 160% over the same timeframe, despite some of the exemptions that have been put in place to keep British energy-intensive industries competitive.

Some progress has been made in supporting the most energy-intensive users - the latest energy-intensive relief package, to be introduced in early 2016, should alleviate the cost of the Renewable Obligation and Feed in Tariff scheme to a tune of around £12/MWh.

However, should commodity costs return to 2013 levels, it would add a further £10/MWh on to cost of wholesale energy. What's more, the full impact of carbon and renewable policies on industrial and commercial users is set to rise from £15/MWh today to £42/MWh by 2020 - not to mention the added cost of subsidising new nuclear build such as Hinkley Point, which alone could exceed £3/MWh.

Whilst the commodity cost element of the bill can be controlled through an effective risk management strategy, non-commodity costs are largely out of the hands of a business. Government is currently undertaking a review of business energy efficiency taxes but, as a fiscally-neutral review, it is aiming to simplify rather than reduce costs that end-users must pay.

A proactive approach to controlling costs

The need to focus on alleviating budget pressure through greater innovation and proactive steps to reduce costs has never been greater.

Load management is one option – from participating in demand-side schemes to help the grid keep balanced to simply avoiding peak prices by optimising how and when plants use energy. National Grid's *Winter Outlook Report* stated that 0.13GW has been secured through Demand Side Response (DSR) schemes to help keep the system balanced during peak demand for winter 2015/16.

One such option is National Grid's Demand Side Balancing Reserve (DSBR) scheme. In short, DSBR enables the grid to stay balanced. At peak periods between November and February (usually between 4pm and 8pm) National Grid asks large energy users to reduce their usage or switch to self-generated energy sources. In return for this reduction in usage, the National Grid pays cash to those businesses that participate. Organisations need at least 3MW of flexible capacity to participate on their own, but those with less capacity can still join demand aggregators to take part.

Outside of incentive schemes, organisations can still avoid high transmission and distribution costs by using proactive load management – for example, turning down consumption during peak periods to avoid high distribution network costs (avoiding red zones) and high transportation costs (avoiding triads).

Since April 2014, Climate Change Levy (CCL) exemptions have also been in place for energy used in mineralogical or metallurgical processes such as heat treatment. A Climate Change Agreement allows other eligible energy-intensive sectors to receive up to 90% reduction in the Climate Change Levy (CCL) if they sign up to energy-efficiency targets agreed with the government. Operators who commit to the scheme and the energy-reduction targets are entitled to relief on the CCL charge seen on their energy invoices.

Energy efficiency should be high on the agenda. Some 10,000 of the largest organisations in Britain will soon be in possession of a whole list of measures and opportunities in their business when their Energy Savings Opportunity Scheme (ESOS) report lands on their desk, detailing the results of energy audits across each organisation's operations and processes. Inenco's ESOS team has consistently identified opportunities with short pay-back periods. Whilst constraints may mean budget for larger projects is limited, Government is considering the introduction of financial incentives for energy-efficiency projects as part of a wider review of business energy-efficiency taxes.

Take an integrated approach

Risk management still has an important role to play in controlling the wholesale element of the bill, but the growing impact of non-commodity costs really drives a need to integrate energy procurement and management to minimise consumption (and cost). There's a pressing need for a long-term energy strategy to seriously help mitigate the impact of future costs.

We talk about energy strategies in plural: a business might have an energy procurement strategy, an energy management strategy and sustainability targets with reduction strategies built into them – but turning that into one single long-term strategy means far greater focus and a joined-up approach to energy management that should extend to board-level buy-in. At Inenco, we work with businesses to help create and implement an integrated energy strategy encompassing all aspects of a business's energy needs.

Purchasing flexibly from the wholesale market continues to make financial sense for many organisations. That purchasing strategy needs to be linked to energy-reduction plans to ensure procurement of the right volume and avoid sell-back penalties. Load management and commercially optimising how plant is run will also help to avoid excessive network charges and curb costs, particularly if on-site generation can also be called upon.

Ultimately, the end goal for an energy strategy has to be about minimising consumption and optimising business processes and equipment to achieve greater efficiency. At a time when energy costs are only travelling in one direction, organisations must do all they can to take back control and put in place a long-term plan to mitigate rises wherever possible.

What has Nadcap done for the heat treatment industry?

THE VIEWS OF ACCREDITED CHTA MEMBERS

Hotline *141 featured the Performance Review Institute (PRI) article "What has Nadcap done for the aerospace industry?", celebrating Nadcap's 25th anniversary and implying, amongst other things, a reduction in multiple audits from the aerospace sector. We asked Nadcap-accredited CHTA members, as special process suppliers, to comment…*

Iain Mackenzie, Aerospace Technical Manager UK / AD&E, Bodycote Heat Treatments Ltd

Having presented to the recent Birmingham Nadcap Symposium "A suppliers view of Nadcap", it's easy to focus initially on what some people may perceive to be the negative answers to the question posed atop this page: increased cost; the time spent preparing for audits and on the audits themselves; and not forgetting resolving the non-conformances (NCRs) raised. But, on reflection, I can also see benefits to the industry.

The first thing is a reduction in the number of periodic surveillance or process audits. Some Nadcap prime subscribers have really taken this to heart and, unless there are problems, or a new approval or new parts, there are some you just don't hear from or see from one year to the next. You still see others from time to time, but only for audits that are outside the Nadcap remit: critical part audits, delegated authority audits.

As with everything, there are still some that insist on coming in every year to perform their own audit, sometimes even using the Nadcap check sheet, but overall the number and duration of audits is down.

Nadcap has meant that the flow down of information from the prime is now critical. No longer can we, as heat treaters, just look at the instructions from our immediate customers. We need to hope that the original information, drawing, specifications and special instructions flow down from the prime, possibly through several different subcontractors, to us at the bottom of the chain. All too often, there is a break somewhere along the line and we are forced to flow up requests for the original information, delaying jobs and potentially causing frustration and, at times, anger from our customers!

It is getting better? Those customers with Nadcap accreditation themselves know what to do but, for others, it probably feels like a "jobsworth" at the other end stopping their work! In the best cases this causes delays; in the worst, we have seen jobs removed by customers to be processed elsewhere.

There has been a demise in the "black arts" of heat treating! By that, I mean the works metallurgist using all his knowledge and education to say if a 5˚C overshoot or 30 extra minutes at temperature has had no effect on parts processed, and then sending to customers as conforming parts. The normal call was "the hardness / tensile result met spec so it's all ok!"

These "minor" non-conformances are now all being flagged up and dealt with through the proper channels. Initially, for some, this has been hard to take, thinking that their integrity has been called into question. This has resulted in skilled and knowledgeable people leaving the industry as they couldn't move into the Nadcap era. In fact, what has happened is that closer process controls have been necessary to reduce the number of these "internal NCs". This has a beneficial effect in the quality and consistency of processing of customer parts, these benefits applying to all work performed on the sites.

Initially it was felt that Nadcap audits were sucking in far more resources than any others. The reality of this is that previous process audits were normally hosted by quality managers alone, with very occasional special appearances from others on site. A Nadcap audit will require a team of people to prepare, front and respond to an audit; a team approach is the only real way to "cope" with a Nadcap audit. If the preparation is correct, the outcome will be better for the site.

*At the **Nadcap Supplier Symposium** in Birmingham on 9th November: CHTA Secretary Alan J Hick flanked by Performance Review Institute Nadcap administrators Joe Pinto (left), Executive Vice President & Chief Operating Officer, and Jerry Aston, Associate Program Manager for Heat Treating.*

In fact, Nadcap has led to better training throughout the organisation. Improving training, working instructions and procedures leads to better workplace control,

*Bodycote Heat Treatments' **Iain Mackenzie** provided a candid assessment of virtues and drawbacks in his excellent November symposium presentation "Nadcap-accredited supplier perspective".*

fewer non-conformances, easier audit preparation and, in the end, less preparation as the site knows and understands what they are doing and why. So Nadcap has led to a better-trained workforce working to better instructions and procedures, reducing non-conformances all round, again benefitting all work on site, not just aerospace.

Overall, Nadcap has put cost into the business. On reflection, possibly for full compliance and to help move our business forward, these costs should have been in there prior to Nadcap.

Ensuring correct flow down of customer/prime information has led to potential delays in processing work, but this has meant a reduction in the number of non-conformances (both declared and undeclared). For the prime suppliers, this will be seen as a reduction of risk heat treatment puts into their parts and an overall improvement in safety and reliability of aircraft.

Yvette Lawlor, TTI Group Quality Manager

Nadcap has undoubtedly improved the heat treatment industry by burying the "black art" label and creating a controlled process approach which, through the Nadcap program, is audited to be consistent across all our competitors around the world, alongside EN/AS9100 Rev C (which has changed beyond recognition over the last few years). In doing so, our quality departments spend many days hosting site audits and many weeks of preparation through our own internal audit process.

Question: Has this reduced the number of customer audits? Answer: Yes and no!

Our customers still like the "comfort-factor" feeling that they have audited our sites themselves. In fact, in accordance with CAA regulations, this is a must as they need to ensure that *their* sub-contractor is under *their* control. The more "progressive" customers manage this by review of Nadcap audits alongside supplier development, but these customers tend to be in the minority.

In addition, there are customer-specific requirements to manage. At TTI we hold in excess of 100 approvals, so it's a difficult and time-consuming task to understand and comply with all of the differing standards, especially as most customer specifications are based on their historic in-house processes, or their own metallurgists' understanding, rather than on national or international standards. This makes compliance to multiple and different specifications a very onerous job indeed!

Therefore, although Nadcap and AS9100 have given our industry a solid base for the audits, they must be very much a part of our everyday working practices and cultures because, aside from these third-party audit days, we can expect at least an additional 20 days per year of customer audits.

Do we have a choice? I don't think so! Not unless, or until, the primes are confident enough that Nadcap auditors and assessments understand the depth of their individual specifications. Add to this the fact that they (Nadcap auditors) tend to be process-type experts, and many of our customers' auditors quite like their jobs, and the answer to the question of choice is an even more emphatic "No"!

A further complication is that ITAR/EAR* can only be audited by "Green Card holders" so, where these parts are processed, the auditors' knowledge tends to be very much US-based. Maybe it's time for a "Specialist prime allocated auditor" and allowing European auditors to audit ITAR !!!

In my opinion, it is without doubt that Nadcap has improved the heat treatment industry and has given an equalised global market in regards to processing quality. However, the promise of reduced auditor days has not been totally realised and, until the primes and our customers focus on auditing the important criteria, instead of repeating the Nadcap checklist, it is inevitable that this situation will not change.

Richard Burslem, Business Development, Wallwork Heat Treatment Ltd

The *Hotline* 141 article focused firmly on the original equipment manufacturers (subscribers) and the benefits of Nadcap to them. But what of their suppliers?

When we decided to break into the aerospace market some years ago, we found ourselves in a *Catch 22* situation: aerospace component manufacturers could not use us because we were not approved by them and would not approve us because we were not suppliers to them!

Obtaining Nadcap accreditation presented our credentials to these potential customers and the list of Nadcap-approved suppliers is a useful marketing tool, enabling new customers to find us rather than us having to find them. With hard work, good systems and a dedicated staff, the Nadcap Merit programme can be achieved and means that the audit frequency can be extended to two years, so reducing the audit burden. We still have customer audits, which indicate that many companies are still not prepared to rely 100% on Nadcap accreditation as their quality control.

My one criticism of Nadcap is that the process is very prescriptive and does not allow for innovation by the supplier. However, when you consider that the system is designed to achieve consistent quality for aircraft components, this conservative approach is quite understandable.

Hotline *asked PRI to comment on multiple audits, the elimination of which was a major objective when Nadcap was introduced 25 years ago…*

Joe Pinto, Executive Vice President and Chief Operating Officer, Performance Review Institute

There are many reasons that an aerospace subscribing prime or their sub-tiers may audit a supplier - from initial qualification of the supplier to product oversight or because they have specific concerns. From a Nadcap perspective, these are not considered redundant audits. Every customer has the right and the responsibility to oversee their supply chain and ensure the end product is fit for purpose.

A redundant audit, as defined by the Nadcap Management Council, is one in which "a subscribing prime conducts an audit using criteria covered in the scope of the suppliers' Nadcap accreditation"; i.e. auditing a special process or using the Nadcap audit checklist to carry out the audit.

Anyone who feels they have had a redundant audit is strongly encouraged to share their experience via the Nadcap Supplier Survey* at: *www.surveymonkey.com/r/HW3G9JW.*

**The International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR) are two important United States export control laws that affect the manufacturing, sales and distribution of technology.*

**Note that the survey referenced is open until mid-February 2016.*

Good people are hard to find

Hotline *141 reproduced Gord Montgomery's editorial from August's* The Monty *and invited CHTA members to comment…*

Richard Burslem, Wallwork Heat Treatment:

Gord Montgomery raises three interesting points: good experienced people are hard to find; few people choose heat treatment as a career; and automation might be a solution.

Good experienced people can be found but sadly this is often because of a shrinking manufacturing base resulting in redundancies. This has the additional problem that it usually raises the age demographic of these skilled people within the business.

Heat treatment is a small industry and it is difficult to raise our profile when competing for younger employees, who may feel more secure working for a well-known national or multi-national company. I think the underlying problem here is that, at school age, many youngsters discount a career in manufacturing or technology, some of whom may well find their way into heat treatment at some stage. Manufacturing is not seen as rewarding in any sense and is often presented as the career of last resort.

Is automation the future? You can't automate unless you have the technologists who understand the process, the engineers to maintain the equipment and the programmers to programme the equipment. Sounds like the same skilled people we need today, albeit with a slightly different skill set.

What's the answer? I think Gord has supplied it: heat treatment is a "family affair". We certainly have many employees who recommend friends and family for jobs. This takes some of the risk out of the heavy cost of training because the business has increased confidence that the new employee will be able and will stay a reasonable time to recoup those costs.

We also need to extend the family from the traditional sense and engage with local schools, apprenticeship providers, colleges and universities so that their students, the employees of the future, can picture what a career in heat treatment might be like. This however is a tall order for smaller companies with limited resources.

We are not alone!

Gord Montgomery's editorial in the August issue of North America's The Monty (www.themonty.com) *highlighted a global problem…*

GOOD PEOPLE ARE HARD TO FIND

There is no doubt in our minds that the number-one issue facing the heat treating industry these days is the lack of good experienced people. An experienced maintenance individual, a qualified metallurgist, an estimator or a qualified heat treat sales person are all equally as hard to find.

It's a shame as this is a good, respectable well-paying industry but the fact that it is such a little known facet of the manufacturing process means that very, very few people get into the business as a choice; rather for most it is a "family affair" and the examples of this abound.

The solutions are obvious but will not be achieved overnight. For instance there is the Japanese model of increased automation which reduces the number of qualified people required and this model should be coupled with a determined plan to get more young people aware of the industry right out of high school.

Neither are an overnight answer but the health of the industry depends upon getting more young people involved. Food for thought.

Comments to mail@chta.co.uk.

TTI Group spokesperson:

With limited experienced people in the market to draw from, we need to develop our own talent, now more than ever, to support business growth and provide the industry specialists for the future.

One area that is gaining more focus over recent years, due to the changes in school leaving age and the increased costs of university fees, is the growing need for good apprenticeship programmes. In-house apprenticeship programmes are relatively easy to implement and, as they are supported by recognised providers, the individual develops the necessary training and support to start to build their foundations for the future. More talented youngsters are moving into this route now, as an alternative to the traditional university route.

In addition to this approach, we need to work more closely with outside apprenticeship providers. We can be encouraged with, as an example, a visit to the Manufacturing Technology Centre (MTC) based in Coventry, where it is clear that they are helping to develop and change the way we educate our future engineers. We need to ensure that at least some of the talented individuals who complete their apprenticeship programmes via this route want to pursue their career in our industry.

To support these individuals, and our existing employees, who are already on their career journey, we need strong mentors in the business who can share their knowledge and experience. This is a skill in itself and is often difficult to complete effectively, with workloads and conflicting business priorities. An effective succession plan can only be achieved if individuals are allowed to dedicate time to learn and develop new skills. With the ever-increasing demands within current roles, this is hard to achieve.

Any form of development takes time and is really only half of the story. We must continue to openly recognise and value our employees and the contribution they make to our businesses and industry. People now expect more from their employer. In order to remain competitive, we must establish an effective employee proposition that not only delivers on salary, but provides the focused career development opportunities and employee benefits that support individual lifestyle choices.

With ever-increasing recruitment costs and a diminishing pool of people, growing talent and succession planning are now more important than ever before.

Member news

NAME CHANGE FOR TTI GROUP

TTI Group Ltd have announced that all of the heat treatment companies belonging to Aalberts Industries NV, which includes TTI Group, are changing their name to Hauck Heat Treatment.

For many years the heat treatment companies owned by Aalberts Industries NV have operated as a group, co-operating in business and sharing people and best practice.

However, this relationship, and strength as one of the world's largest heat treatment groups, is not widely known. Therefore it was decided, by realising all possible synergies and levering the whole heat treatment expertise and resources within the corporate group, to unite the European business under one strong name.

HAUCK HEAT TREATMENT

Starting January 1st 2016, all 27 of their heat treatment plants in Europe will change their name to Hauck Heat Treatment.

This change does not influence any operating business, which will remain local, and does not have any further administrative changes besides the name change.

MELTHAM THERMAL ENGINEERS ON THE MOVE

Presently based in Meltham, West Yorkshire, CHTA member Meltham Thermal Engineers Ltd (MTE) is celebrating after a September visit from local MP Jason McCartney put it firmly on the road to growth, having received good news from Leeds LEP on a capital investment grant.

Despite being born mid-recession, MTE has been consistently successful and quickly reached capacity in its current home. In order to achieve its full growth potential, the company is planning a move to purpose-built factory premises in nearby Slaithwaite in early 2016.

The 32,000ft² unit will give MTE an additional 12,000ft² of useable space which will house two new state-of-the-art Ipsen furnaces, with room to add a third within two years. The £70,000 LEP grant will partially fund these world-class furnaces, which will be the first in the UK.

They are set to increase capacity by 25%, whilst reducing running costs by 50% due to their extreme efficiency. This capital investment will create seven new jobs, and take the total growth investment by the business to £3.5million.

MTE Director Geoff Windas said: "We enjoyed showing Mr McCartney around

Jason McCartney MP flanked by Meltham Thermal Engineers' Nigel Dyson (left) and Geoff Windas.

and explaining our growth plans to him. The whole team is eager to progress with the move and the MP is known for supporting local businesses. It's great to know that he believes MTE to be a good example of a company with growth potential."

Jason McCartney, MP for Holme Valley, Colne Valley and Lindley, added: "I thoroughly enjoyed hearing first-hand about the growth which capital investment will facilitate for Meltham Thermal Engineers. The company is maintaining the region's reputation for excellence in heavy engineering and this substantial investment in equipment will position it at the forefront of the heat treatment industry."

Ipsen, through UK and Ireland agents Vacuum and Atmosphere Services Ltd, were chosen to supply two *Atlas* RTQF-10 sealed-quench furnaces, DL-10 temperer, WPSD washer and uni-loader, to be installed and commissioned by VAS in February. The new *Atlas* design comes complete with Ipsen's *Carb-o-Prof* 4.0 control system and the new *HybridCarb* high-efficiency atmosphere regeneration system. The complete installation will be "water-free".

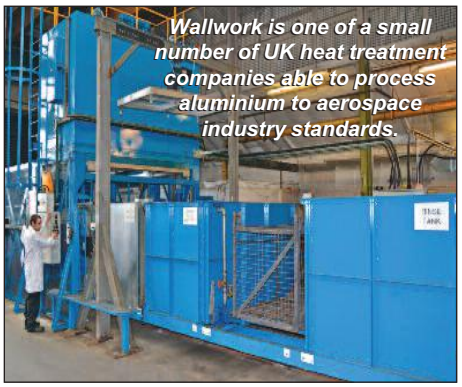
NADCAP APPROVAL FOR WALLWORK NON-FERROUS HEAT TREATMENT

The Wallwork Group report that their Nadcap approval has now been extended to cover both their aluminium and magnesium heat treatment processes.

The company is one of a small number of UK heat treatment companies able to process aluminium to aerospace industry standards. There are even fewer companies that have the rare ability to heat treat magnesium.

Wallwork processes complex components, from satellite and aircraft parts through to motorsport and sports cycle equipment. Parts processed vary from fabrications and castings to small pressed-metal parts. Within their high-tech furnaces, the company can heat treat loads of up to 2m³ in each process cycle.

Ian Lacey, business development manager for aluminium and magnesium heat treatment, explained, "Since diversifying into this field two years ago, we have steadily grown market share, increased capacity and expanded our knowledge and experience. We have core customers in demanding fields, such as aerospace for example, who rely on our ability to develop suitable heat treatments to meet their precise needs and then deliver consistently high-quality standards supported by expert technical services."



Wallwork is one of a small number of UK heat treatment companies able to process aluminium to aerospace industry standards.

The furnace model used by Wallwork has integral quench facilities to give a transfer time of just ten seconds or less from furnace to quench. Depending on the treatment specification, components may be air cooled, hot or cold water quenched or polymer quenched. In addition, components can be subjected to post-quench freezing to prevent age hardening.

The Wallwork Nadcap approvals fall within

the Merit Programme, whereby successive audits with no or low non-compliances automatically extends the interval for full audits to two years. In addition to Nadcap accreditations, the company also has prime approval from Moog and is seeking specific approvals from other aerospace primes.

Wallwork laboratories provide a range of post treatment testing services including hardness, conductivity and mechanical testing. A nationwide collection and delivery service, using company-owned dedicated vehicles, enables a typical 24 to 72 hour turnaround on commercial work and 7-10 day return on aerospace work, where more extensive post-treatment quality assurance is required.

BODYCOTE EXPANDS METAL JOINING CAPACITY

Bodycote has announced the installation of further electron beam welding (EBW) capacity at its Cambridge facility. EBW is a specialist metal joining technique, used to create high-integrity joints with minimal distortion, by employing a focused stream of high-energy electrons to apply very localised treatment.

The Cambridge facility's new high-power machine, with the expanded work chamber which accommodates even larger parts, complements its existing EBW capacity and will help service an increasing customer base which includes scientific, pharmaceutical and research companies in and around the South-East of England.

The new capacity addition is in response to an increase in demand driven by regional manufacturers and their markets.

A long-established centre of excellence for metal joining processes, the Cambridge facility has recently secured continued 'Merit' status following a recent Nadcap audit by PRI. The Nadcap Merit program exists to reward superior performance in Nadcap audits, underlining the high standards of quality achieved at Bodycote Cambridge.

CLEANER GREENER COMPONENT DEGREASING FROM WALLWORK BIRMINGHAM

Ultramodern eco-friendly degrease facilities are the latest addition to the developing capability at the Wallwork factory in Birmingham. The heat treatment specialist has installed the newest spray/vapour solvent cleaning equipment from Höckh for the cleaning of ferrous and non-ferrous components prior to thermal processing. Certification of the process to AS9100 is in line with other approved processes on the site and makes it fully compliant with the European aerospace quality standard.

Serving aerospace, motorsport, nuclear, oil and gas and other demanding industries, Wallwork continually invest to improve their process quality, service delivery and lessen their environmental impact. "Thorough cleaning is essential to achieving heat treatment goals. However, traditional processes, such as the use of trichloroethylene, aqueous cleaning and tumbling, all have drawbacks. The newly-installed Höckh washer uses perchloroethylene, a solvent commonly used by dry cleaners, for effective cleaning in a closed process where solvent is recovered and reused," explained business development manager, Mark Ferguson.

The new cleaning machine has high capacity and good cycle times. Single items or custom-made baskets containing

The new degreasing equipment at Wallwork.

small components, with a volume up to 2.5m³, can be turned around quickly. The process is suitable for castings, tubes, pressed components and machined parts. "The efficiency of this process means that we will have spare capacity and so will be offering local manufacturers a competitive degrease service, backed-up by our dedicated collection and delivery fleet to return treated parts quickly," Mark noted.

Spread the word by proclaiming your CHTA membership

For use on company letterheads, literature, websites and advertisements, members can download CHTA's logo from the Members Area of the Association's website.

*CHTA-member participants constituted 62% of the 29 delegates at another successful Wolfson **Understanding Heat Treatment** course on 13-15 October (l. to r.): Nick Holleron and Vince Hewett (both TTI Group), Darren Wilstrop (Bodycote Heat Treatments), Andy Day (Wallwork Cambridge), Robert Williams and Jonathan Hunt (both Bodycote Heat Treatments), Grzegorz Kowzan, Stephen Pugh and Steve Davies (all Wallwork Heat Treatment, Birmingham), Craig O'Toole (TTI Group), course organiser/chairman/lecturer Derek Close (Wolfson Heat Treatment Centre), Daniel Hawksworth (TTI Group), Daniel Morgan (Wallwork Heat Treatment, Birmingham), Sam Jones, Mandy Perry, Georgia O'Donnell, Chris Le Moir and Kevin Brunisholz (all TTI Group). The course will be repeated for the 81st time on **11-13 October 2016**. Details: www.sea.org.uk/whtc.*

Advertiser news

ALMOR ACQUIRES WELLMAN FURNACES

UK-based furnace engineers Almor Ltd purchased Wellman Furnaces from Robey Wellman Boilers & Furnaces Ltd on July 31st this year. From August 1st, Wellman Furnaces has been trading as a division of Almor Ltd.

Almor's enhanced furnace engineering team will underpin Wellman Furnaces' ability to deliver its long-established portfolio of new furnace installations along with enhanced after-sales support and service.

Wellman Furnaces will continue to trade from the UK, based in the West Midlands where a phased transition to Almor's existing West Midlands site (at Tipton) is planned.

The same personnel at Wellman Furnaces remain ready to meet customer needs.

CHTA MEMBERSHIP FEES

The annual CHTA membership fee for a single-site company remains unchanged at £610+VAT for 2016. For multi-site companies, the additional fee will continue to be £155+VAT per extra division.

The 2016 fees are being invoiced on behalf of CHTA by SEA/BATF.

NEW MD FOR HEAT TREATMENTS NORTHAMPTON

Having started my employment at Heat Treatments Northampton (HTN) over 48 years ago, on a temporary basis until I could find a "proper job", I have finally decided to take retirement.

I was the second employee of the company back then and have witnessed it grow from a tin hut with a couple of salt baths to the established company that it is today.


Shaun Rowlands

Shaun Rowlands has now taken the role of Managing Director and Nichola Mitchell has been rewarded for her 20 years of loyal service and is now a Director. Nichola has been Quality Manager for the last twelve years and has taken the company successfully through TS16949 and CQI-9. She also has qualifications in Business Management.

I am sad to be leaving the company, but the time is right for the next stage in its development. It has sound foundations and, I am proud to say, is in the strongest position in its history. With a further extension to the factory due for completion in the early part of next year, the future looks to have exciting times ahead.

So, in closing, I would like to say farewell to all acquaintances that I have made during my time at HTN and wish you all the very best for the future.

Phil Brothers


Phil Brothers and Nichola Mitchell flank SEA's Dave Elliott at this year's CHTA AGM.

Season's Greetings to all our readers

chta

FORTHCOMING EVENTS

Diary

January 21-22 2016
INTRODUCTION TO PYROMETRY
Bristol, England
www.equalearn.com/learncenter.asp?id=178409

January 28 2016
CHTA PUBLICITY SUBCOMMITTEE*
Birmingham, England

February 9 2016
PRINCIPLES OF HEAT TREATMENT
Macaw, Tyneside, England *www.amrctraining.co.uk*

February 11 2016
CHTA MANAGEMENT COMMITTEE*
Birmingham, England

February 11-12 2016
NADCAP SPECIAL PROCESS COURSE: HEAT TREATING (OWNER)
Birmingham, England
www.equalearn.com/learncenter.asp?id=178409

March 9 2016
BIFCA course: BURNER TECHNOLOGY
West Bromwich, England *www.bifca.org.uk*

March 9 2016
PRINCIPLES OF HEAT TREATMENT
London, England *www.amrctraining.co.uk*

March 9-10 2016
INTRODUCTION TO PYROMETRY
Derby, England
www.equalearn.com/learncenter.asp?id=178409

April 7 2016
BIFCA course:
INTRODUCTION TO INDUCTION HARDENING
West Bromwich, England *www.bifca.org.uk*

April 18-22 2016
23RD IFHTSE CONGRESS: ADVANCED THERMAL PROCESSING
Savannah, Georgia, USA
Co-sponsored by IFHTSE and the ASM Heat Treating Society. *www.asminternational.org/web/ifhtse/home*

April 21 2016
BIFCA SAFETY & STANDARDS SEMINAR
West Bromwich, England
Presentations on important topics to the furnace community. *www.bifca.org.uk*

April 28 2016
CHTA PUBLICITY SUBCOMMITTEE*
Birmingham, England

May 11-13 2016
3RD INTERNATIONAL CONFERENCE ON HEAT TREATMENT AND SURFACE ENGINEERING IN AUTOMOTIVE APPLICATIONS
Prague, Czech Republic
www.htconference-prague2016.cz

May 12 2016
CHTA MANAGEMENT COMMITTEE/ AGM*
Birmingham, England

May 12 2016
BIFCA course:
FURNACE & BURNER CONTROLS
West Bromwich, England *www.bifca.org.uk*

June 7-9 2016
SUBCON 2016
Birmingham, England *www.subconshow.co.uk*

June 8-9 2016
A3TS 2016
Nancy, France
43rd congress on heat treatment and surface engineering.
www.a3ts.org/

July 28 2016
CHTA PUBLICITY SUBCOMMITTEE*
Birmingham, England

August 11 2016
CHTA MANAGEMENT COMMITTEE*
Birmingham, England

Members wishing issues to be raised at CHTA meetings should notify CHTA's Secretary, well beforehand at mail@chta.co.uk

Market Movements

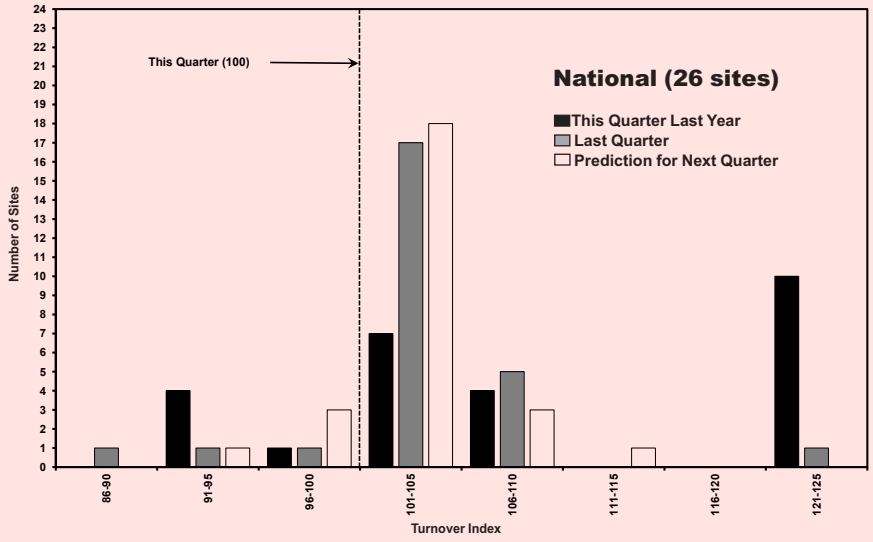
ANALYSIS OF QUESTIONNAIRE REPLIES RELATING TO 26 CHTA MEMBER SITES

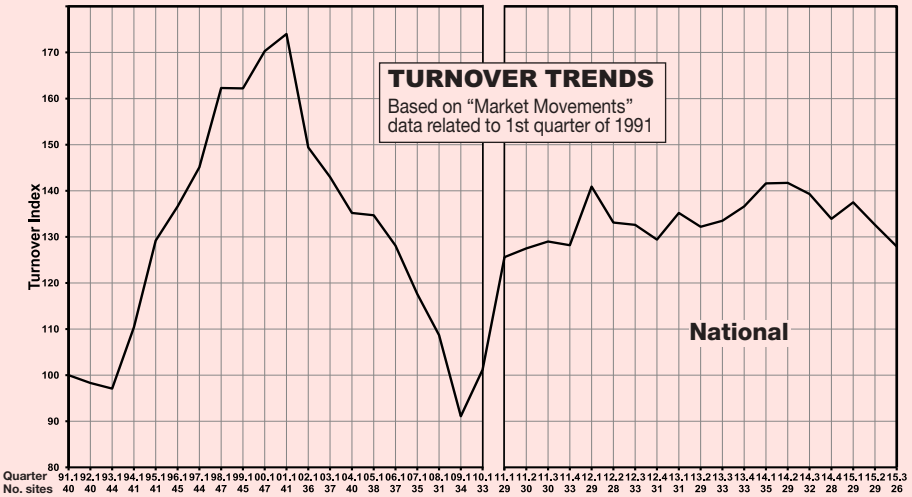
"THIS QUARTER" =

1 JULY – 30 SEPTEMBER 2015

= TURNOVER INDEX 100

OVERALL ANALYSIS (26 SITES)	Mean index
This quarter last year	109.3
Last quarter	103.7
Predicted next quarter	103.4





September 13-15 2016
HEAT TREATMENT 2016
Moscow, Russia *www.htexporus.com/*

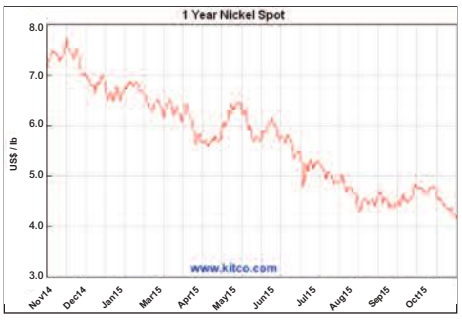
September 19-22 2016
HEAT TREAT MEXICO
Queretaro, Mexico
Organised by ASM Heat Treating Society, this conference/ expo addresses advanced thermal processing technology:
www.asminternational.org/web/htmexico

September 26-28 2016
3RD MEDITERRANEAN CONFERENCE ON HEAT TREATMENT AND SURFACE ENGINEERING
Portorož, Slovenia *mchtse2016.com/.*

October 5-6 2016
FURNACES NORTH AMERICA 2016
Nashville, TN, USA
The Metal Treating Institute's conference and exposition:
www.furnacesnorthamerica.com

October 11-13 2016
UNDERSTANDING HEAT TREATMENT
Birmingham, England
81st repeat of Wolfson Heat Treatment Centre's course.
www.sea.org.uk/whtc

NICKEL PRICE (US$/lb)



Please send comment and news items for March's *Hotline* 143 to: *mail@chta.co.uk*
Deadline: February 17th