



ASM International, Pune Chapter Chapter News Letter

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May 2014

EDITORIAL...✍



Dear Friends,
It gives me immense pleasure to be editing the current newsletter. I am sure you and your colleagues will benefit from the contents and information published here.

I have got a second chance to touch base with you all after 6 years. I had last edited the newsletter for the chapter in June 2008(Ref: Issue 2008/02).

Have always felt that in today's world of information and technology, the best way to communicate and share your thoughts with industry and chapter members is by chapter newsletters and website.

I have got the rare privilege of interacting with both the mediums this time. First as the editor of this newsletter and as the chairman of the web committee.

ASM, Pune Chapter, has recently relaunched it's website, with a whole lot of information about the current team, forthcoming events, members, archived newsletters, materials camp, workshops, membership forms(with a direct link to RBI for the latest Forex rates), etc. and links to various ASM publications.

(Visit us at: www.asmpunechapter.com)

I take this opportunity to appeal to all the readers of this newsletter to support the chapter activities by:

- Bringing in new members,
- Sponsoring events
- Recommending speakers for monthly technical presentations
- Sending in your contributions for the newsletters and website.

I would like to record my appreciation for my team of Shri L.D.Deshpande & Shri L.F.Vaz for their valuable inputs for the website & of course to Shri Unmesh Deshpande for developing the website.

Hemant K. Zaveri

Technical Presentation on 3-D Printing of Metals - Promises and Challenges

By Steve Feredon



Steve Feredon being felicitated by Mr. B.R.Galgali (ASM Pune,Chairman)

ASM International Pune Chapter and Indian Institute of Metals, Pune, held a technical presentation on 3-D Printing of Metals - Promises and Challenges By Steve Feredon, Director, Global Engineering Services (Fuel Systems), Cummins Inc., Coulmbus, IN, USA - At College of Engineering Pune.on 10th February 2014

Topic: An additive process, 3-D printing technology is rapidly becoming globally popular in prototyping particularly in Automotive, Aerospace, Military and Engineering applications.

Summary of the current state of the art, including process basics, candidate materials, advantages, challenges and on-going development activities at Cummins, were presented & discussed in the presentation,

More than 50 delegates participated actively in the presentation.

We are thankful to Mr Babu of Cummins for arranging the speaker for the occasion.



Controlled Gas Nitriding / Nitrocarburizing

A Technical Presentation on Controlled Gas Nitriding / Nitrocarburizing: Process control and pre-calculation possibilities by Uwe Redmer, Global Sales Director, Stange Elektroniks, Germany was held at Hotel Pride on 12th Mar 2014

Controlled gas nitriding is recognized as optimization of component properties by creating nitride layers with a defined layer structure corresponding to the demands.

The parameters required to obtain optimal properties in nitriding were explained in detail by Mr. Redmer. The presentation was well received by an audience of 55 technical participants.



Uwe Redmer, delivering the lecture.

Laser Material Processing for Automotive & Engineering

By Dr. Xuan Haung,

Senior Market Development Manager , Coherent Inc

Was held at Hotel Pride on 21st Apr 2014

Laser process is new generation Material Processing technique. CO₂, Diode Lasers has wide applications in Automotive & Engineering Industry. Laser cutting, Laser Welding, Cladding, Micro-machining are few applications. Laser Heat treatment is also emerging as a new application.

The presentation covered Laser Cutting, Welding, Cladding, Micro-machining & Laser Hardening.

The above topics were well covered with illustrations by Dr. Haung and appreciated by the 40 odd participants.



Dr. Haung & Mr. M. Rathod Lighting the Inaugural Lamp



Dr. Haung delivering the technical talk.



METALLURGY FOR NON METALLURGIST'

A Three Day Proficiency Improvement Programme on 'METALLURGY FOR NON METALLURGIST' was held from 25th to 27th April 2014 at ARAI-FID, Pune.

The programme was held jointly by ASM International Pune Chapter & ARAI, Pune

The faculty was drawn mostly from ASM, Pune Chapter members.

There were forty participants for the Proficiency Improvement Programme.



Participants and Faculty members at the programme



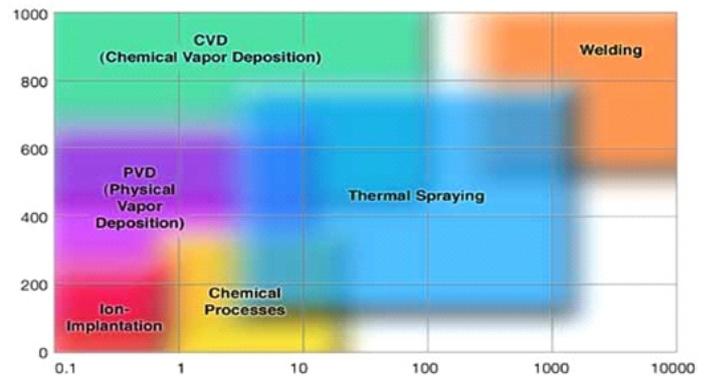
Mr. Vineet Marathe delivering a technical talk on Joining of Metals

Technical Article.

Vacuum & Plasma-based Material Bulk / Surface Treatments

By M.A.K. ('Max') Babi

Synopsis : There has been a leapfrogging advancement in both vacuum- and plasma-based bulk and surface treatments of metallic materials, especially those that were always difficult to handle or posed a variety of problems in treating. Distortion in case of sensitive metals and alloys, when bulk treated for hardening or tempering, for instance, brought to the fore, vacuum hardening and vacuum hardening. With advancements in high pressure gas quenching, even metallurgical problems or bottlenecks were also cleared up increasing equipment sophistication. Plasma nitriding in half a century of its worldwide usage has proved to be the workhorse technique, combining low cost with high quality results. Finally, there is a huge number of plasma assisted vacuum-based or low-pressure based treatments and the PVD (physical vapour deposition) along with PACVD (plasma assisted chemical vapour deposition), with the top rung in this pyramid occupied by DLC (diamond like carbon) coatings. This article briefly discusses all these topics for the industrial users.



A comparison of various surface treatments (Case Depth in microns on X-axis and Temperature in Deg-C on Y axis)

Introduction : Let's start with the vacuum-based heat treatment which spanned longer durations in technology of this group of advanced materials treatments. defeating, we all know that all types of steels that are hardenable are heated and quenched since a century. Tempering however is less widely used, only in applications where the bulk hardness of a heat treated component has to fall within rather a narrow region of specified hardness levels. Thus one can employ tempering also for homogenizing or lending a uniform nature to the bulk hardness, and avoid the over-hardness levels in edges and



corners. Vacuum hardening and tempering came into the picture half a century ago, and let's face it, in the beginning it was cumbersome tedious and less reliable than the high precision set of hardening and tempering treatments used today. Actually combination of vacuum heating and liquid quenching seemed rather absurd, since fluids would be sucked off in copious quantities by the ever-hungry vacuum pumps. It was only much later with the advent of the gas pressurized quenching that the technology began to get noticed. Even gas quenching led to further development with high pressure gas quenching which removed the final barriers and limitations in the earlier technologies.



Vacuum tempered gears

In hardened steels the ratio of retained austenite to the martensite formed by quenching has always been a little difficult to control, despite the advanced human skills and the limited technological versatility of older systems. Today, this scene has been turned around to the great benefit of the heat treaters, because what used to be simple heating and gas quenching systems among the vacuum heat treating equipment, are far more sophisticated now. They not only employ very high gas pressures up to 12 bars (atmospheres) or more, and at the same time also have heat exchangers built into the system. Thus heating and cooling rates can be precisely regulated, even programmed and monitored -so that the heavy dependence upon human experience and skill can be reduced greatly.

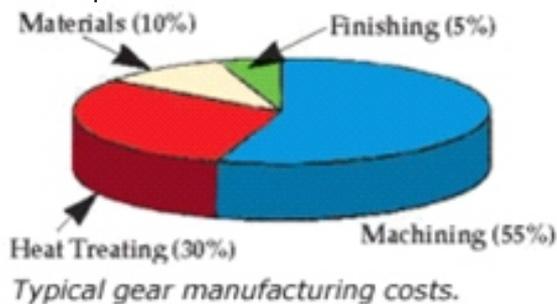


A typical vacuum furnace for tempering

It is an interesting oxymoron that very small or thin-walled parts and the very bulky dies/moulds when heat treated in vacuum, tend to benefit the most. Very small parts and thin-walled parts tend to get over-hardened or distorted unless special precautions are in place, and the very bulky materials usually tend to be less uniformly heated or quenched due to difficulties in maintaining the right rates of heating and cooling. This can be understood only when we study the thermodynamic of metallic bulk materials and keep in view the undeniable fact that the temperatures at the core or the bulky part may differ from the surface temperature and that a lot of time and energy would be needed to equalize these.



A typical load for a vacuum tempering furnace

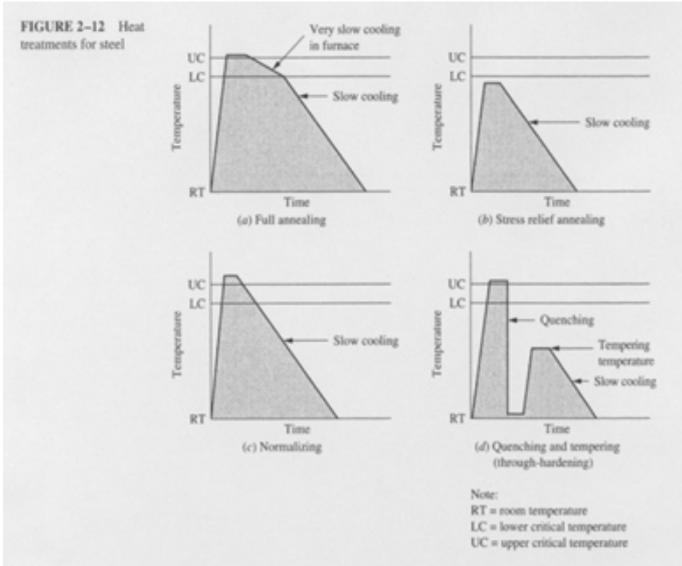


Tempering : Any temperature under the lower critical temperature (A_{c1}) can be used for tempering, but it is the balance of hardness, strength, and toughness required in service that determines the final tempering temperature. Tempering in the range of 150°C to 200°C (300°F to 400°F) is common for gearing, producing a slight increase in toughness that is adequate for most applications requiring high strength and fatigue resistance where loading is



primarily compressive, Double tempering is sometimes performed on gears to ensure completion of the tempering reaction and to promote stability of the resulting microstructure. All steel components hardened via any hardening process usually require tempering for several reasons, firstly, the stresses get equalized, secondly the hardening through cross-section, edges and corners etc. gets homogenized and finally, more accurate hardness levels can be ascertained. Vacuum hardening is usually followed by vacuum hardening.

strength, or impact resistance. Note that the electrical and thermal conductivity are slightly altered. As with most strengthening techniques for steel, Young's modulus is unaffected. Steel has a higher solid solubility for carbon in the austenite phase; therefore all heat treatments, except spheroidizing and process annealing, start by heating to an austenitic phase. The rate at which the steel is cooled through the eutectoid reaction affects the rate at which carbon diffuses out of austenite. Generally speaking, cooling swiftly will give a finer pearlite (until the martensite critical temperature is reached) and cooling slowly will give a coarser pearlite. Cooling a hypoeutectoid (less than 0.77 wt% C) steel results in a pearlitic structure with δ -ferrite at the grain boundaries. If it is hypereutectoid (more than 0.77 wt% C) steel then the structure is full pearlite with small grains of cementite scattered throughout. The relative amounts of constituents are found using the lever rule. Why Use Vacuum : Vacuum Heat Treatment is the process in which metallic/steel parts are exposed completely or partially to time-temperature sequences in order to change the mechanical and/or corrosion properties. There are numerous application areas, e.g.: All of these processes need a temperature up to 1.000 °C and higher as well as especially developed furnaces to achieve such ranges. Use of vacuum in tempering ensures that :



Note, LC = lower critical temperature which is temperature at which transition from ferrite to austenite begins. At the upper critical temperature UC the transformation is complete!

Note, Stay as close to UC as possible.
 Medium Carbon Steel, UC = 1500 F (or 780 C)

Note, LC = lower critical temperature which is temperature at which transition from ferrite to austenite begins. At the upper critical temperature UC the transformation is complete! Note, Stay as close to UC as possible. Medium Carbon Steel, UC = 1500 F (or 780 C). To make the steel less brittle and more usable, another process called tempering is used; the steel is slowly heated to just below the transformation temperature and then slowly cooled. Through Hardening, Quenching and Tempering (and then slow cooling): - Heat above the austenite temperature (or UC) until the composition is uniform. Cool rapidly (Quench). Result: strong but brittle martensite structure. So temper and slow cool to improve toughness at the expense of strength. The purpose of heat treating carbon steel is to change the mechanical properties of steel, usually ductility, hardness, yield

- there is absolutely no oxidation due to either residual air or leakages
- there is absolutely no chemical contamination due to presence of chemicals in the atmosphere, or due to presence of leftovers from cutting fluids, lubricants even coolants,
- there is no risk of de-carburization (as there is no oxygen available for reaction with carbon)
- there is no risk of carbon pick -all of the contaminants named above can contribute unwanted carbon traces to the tempered product and thus ruin its metallurgical chastity.
- dimensionally there is better control on distortion or warpage.

Vacuum Carburizing or Low Pressure Carburizing :

Even if we eschew going into the fundamental details of the carburizing process, we are aware that carburizing is yet another surface hardening or case hardening treatment that produces a fairly deep case -upto 2.00 mm, which is far deeper than what nitriding or nitrocarburizing can provide. As mentioned earlier, there were severe technological constraints just ten or fifteen years ago when the simultaneous application of heat and its quick dissipation could not be housed inside a vacuum reactor. Vacuum quenching with fluids or liquids was oxymoronic, impractical and risky (due to explosion risks). However gas quenching came to the rescue of the vacuum heat treating



fraternity hardly two decades ago and how we see even high pressure gas quenching. How high is this pressure actually? More than 20 bars, that is 20 times the atmospheric pressure. That too it floods the entire vacuum furnace in seconds. This leads to unprecedented rates of heat dissipation, and one would think that such excessive cooling rates must involve distortion. That has been taken care of by the inspired designers of the new generation of vacuum heat treatment furnaces, what they do is include a heat exchanger in the vacuum reactor itself. Some designs involve two or three chambers, so that the heated parts on a trolley can be pushed with remote control into the next chamber where they would be subjected to the immensely powerful gas quenching.

Low pressure carburizing was not popular till a decade ago but with the advent of the high pressure gas quenching, the LPC-HPGQ (Low Pressure Carburizing - High Pressure Gas Quenching) became one of the workhorse type bulk treatments for automotive parts in the last decade. It is not uncommon today to see as many as 6 LPC-HPGQ furnaces in one single plant manufacturing transmission boxes along.

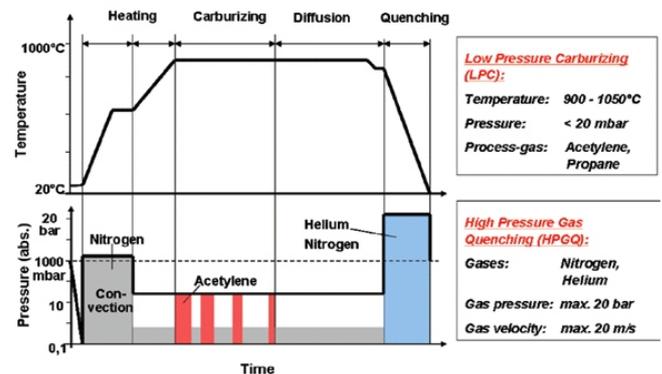
LPC - HPGQ : Low pressure carburizing, as well as atmospheric carburizing is a technology applied to parts made of low-carbon steel. Usually this is steel with C content within the range of 0,1-0,25%; sometimes, however, steel with higher content of carbon, even up to 0,4% is subject to carburizing. After carburizing, parts undergo quenching and tempering, usually low-temperature tempering. It is customary that quenching is followed by cold working and then tempering. The purpose is to obtain variable hardness of the section of machine parts undergoing this process- the highest in the edge layer and the lowest in the core, also to get a favourable stress pattern, namely, the compressive stress in the edge layer and the tensile one in the core.

In practice, quality requirements for parts being quenched refer to surface hardness, agreed upon thickness of the quenched layer (for example, defined by the distance from the edge to the depth with the hardness of 550 HV), core hardness, microstructure of the layer and the core as well as deformations of parts. Generally, furnace manufacturers believe that the result of hardening of carburized parts is affected by:

- chemical composition of steel,
- carbon profile in the carburized layer,
- hardenability of steel and the carburized layer,
- temperature and time of austenitizing before quenching,

- intensity and a method of cooling down. Generally, the manufacturers believe that : - application of low pressure carburizing for parts made of alloy steels gives very good results provided, however, that parts undergoing hardening have a section adjusted to hardenability of the steel and the carburized layer. High pressure gas cooling, due to smaller intensity as compared to oil cooling, can be used for parts with smaller sections or for parts with higher hardenability.

- surface quenching of parts made of low hardenability steel, for example carbon steels, performed by means of low pressure carburizing and using machinery for low pressure carburizing does not lead to satisfactory results. Positive results are in this case ensured by applying the technology of low pressure carbonitriding. Nitrogen in the presence of carbon has a synergizing effect on the increase of hardenability of diffusion layer, at the same time making its hardening easier. LPC is a case hardening process that is performed in a pressure of only a few millibar in a protective atmosphere. In most applications acetylene is used as the carbon source. The advantages of LPC compared to conventional gas carburizing are: no inter-granular oxidation and no surface decarburization; faster carburizing; and higher carburizing temperatures, leading to significantly shorter cycle times.



Graphical representation of the LPC-HPGQ process

LPC is usually combined with the HPGQ process, during which the load is quenched using an inert gas stream instead of a liquid quenching media. Nitrogen or helium are usually used as the quench gas. In Indian industrial environs, helium is not used since it is rarely available since it is mined only in USA, and enormous costs are involved. High purity nitrogen gas is equally inert and effective.

Advantages : The advantages of LPC compared to conventional gas carburizing are: {} no inter-granular oxidation {} no surface decarburization; {} faster carburizing; and {} higher carburizing temperatures,



leading to significantly shorter cycle times. The benefits of HPGQ compared with liquid quench are numerous, including : {} reduced distortion in most applications; {} clean surfaces after heat treatment (even in blind holes); {} environmentally friendly, {} with no post washing of parts required; and {} heat treatment can be integrated into the production line. Applications : LPC & HPGQ are popular for fuel injection components and for the latest generation of transmissions, such as double clutch transmissions or 6/7/8 speed automatic transmissions.



Special gears LPC-HPGQ treated

Plasma Nitriding : We are familiar with plasma nitriding as a surface treatment, low pressure, between 1.0 to 10.00 Torr is usually employed and the surface of the workpieces gets enriched in nitrides, mainly of some alloying elements. Predominantly these are nitrides of aluminium, chromium, molybdenum, titanium etc., which are often commonly found in alloy steels that respond best to plasma nitriding surface hardening or 'case hardening' treatment. However not many are aware that oftentimes when the cross-sectional thickness is not heavy, plasma nitriding can be used as a bulk hardening process too.

The author recalls one of the leading exporters of pressure die cast electrical plug and socket pairs in Chakan area, who used to face repeated low bulk

hardness levels in the core pins or 'ejector pins' used in their dies, due to an old and obsolete hardening salt bath type treatment. The failed core pins could not be used, hence they were experimentally sent for plasma nitriding to see if there could be an overall improvement in the bulk hardness since the diameter of the pin was barely 6.4mm with a length of about 300 mm. The results were astoundingly successful because there was an overall rise in bulk hardness along with the surface hardness. The average hardness level had shot up from 58 HRC to more than 64 HRC which lent the pins more rigidity and lack of distortion. This aided their use in insertion and removal both.



Nitrided ejector pins used in pressure die casting

Summing Up : Increasing sophistication in high performance machines has led to better processing techniques, and we have just cursorily examined a few of the high-tech bulk and surface treatments here. This is a sunrise industry which progresses day and night, with not stopping in sight.

About The Author



M.A.K. ('Max') Babi is a metallurgical engineer of 1971 vintage from M.S. University of Baroda. He has worked at senior positions with Electrotherm group of companies, Multi-Arc India Ltd., and is busy with consultancy and training. He is teaching a new course on plasma technology with COEP, Pune. He conducts seminars, workshops and training sessions extensively. He may be contacted on +9198900 38051.



Know Our Member



Manoj Madhavan

Mr. Manoj Madhavan is currently working in Tata Motors, Car Plant- Pune. Mr Manoj holds a Bachelor's degree in Metallurgical Engineering from Govt. College of Engineering (COEP), Pune. He has got rich functional experience, of around 10 yrs, in various functions which includes both Manufacturing and Quality. Prior to joining Tata Motors he has worked in organisations like Hindalco and Bosch. Major part of his experience is with Heat Treating. Mr Manoj has got hands on experience in Sealed Quench Furnaces, Continuous Carburising and Hardening Furnaces as well as Vacuum Furnace. After joining Tata Motors he worked in Transmission Shop looking after the Heat Treatment related activities. He also got an opportunity to work in the Transmission assembly line. Along with the regular responsibilities, additionally he was working as the coordinator for Kaizen, Quality Circles and TQM for the whole Transmission shop. Currently he is working as an Executive Assistant to Plant Head, Car Plant.

Mr Manoj Madhavan has undergone many specialised training programs like Total Quality Management, Tata Business Excellence Model, Quality Circles, Kaizens, Statistical Process Control, Bosch Production System etc. He has also conducted many training sessions in the company viz TQM, Problem solving techniques, TBEM, QC, HT etc.

His interest includes Sports esp Cricket and he's very much fond of Movies and Music.

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"Members who have not paid their Annual Membership fees may please do so."

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