



PSA Metz – ICBP
operating time : +11%
inside pages

Steel grades: a key
performance factor for ICBP
back page

Young and mature

Figureheads of the automobile industry, like PSA and GETRAG, are using these magazine to describe their long experience of low pressure carburizing. Oddly enough, this technology has quite rightly retained its youthful appearance because it is continuously at the leading edge of innovation. Some readers may thus be surprised to learn just how long some industries have been using this technique, and the experience that they have amassed to optimize their ICBP units.

Our technology is therefore both young and mature. Young, because it has almost the whole world to conquer: around 80% of steel heat treatment units still remain to be converted to low-pressure carburizing, on a world market that posts sustained growth year after year. Young, because there are limitless innovations waiting to be introduced: the latest is step & stop gas quenching which, when combined with low-pressure carburizing, gives unprecedented performance in terms of distortion control and mechanical properties (see Hot News Nos. 3 & 4).

As for its maturity, this edition gives adequate proof: scientifically modeled and predictive, low pressure carburizing is today a fully-controlled technology. I should like to take this opportunity to thank our clients for placing their trust in an innovative industrial technique, and for their foresight: yes, we now know that we made the right decisions.

Laurent Combaz
ECM, Chief Executive Officer

FIGURE OF THE QUARTER

130!

The number of ICBP heating cells in production in the USA to date. The US is one of the most open markets for low pressure carburizing. Almost all of today's machines are equipped with a gas quench system.

Flying start for GETRAG Italy in its twelfth ICBP year



At GETRAG Italy, heat treatment is 100% gas-quench ICBP since 1996

In 2008 GETRAG Bari will be playing an active part in producing new double clutch gearboxes for GETRAG's North American plants. A new challenge for this site that, from the very beginning, was equipped with gas-quench ICBP units. Results and prospects are courtesy of Luigi Granieri, heat treatment maintenance, GETRAG Italy.

In 2008, the GETRAG plant in Bari, southern Italy, will be at the forefront in producing part of the gearset for a new type of double clutch transmission, within the context of a project launched by the German group with Chrysler in North America. The components will be heat treated by six, 6-cell vertical ICBP units, which will be entering their twelfth year of service!

Yes, at GETRAG Italy, heat treatment is 100% gas-quench ICBP since the plant was opened in 1996. For this brand new plant, originally designed to manufacture new gearboxes for GM/Opel and Rover, the German group was one of the very first to integrate the machines directly in its machining lines.

A leading edge choice at the time, while today a solid choice with very solid results. "These machines are at the core of our production system. Thanks to them, we have successfully completed numerous projects, treated dozens of different types of components with just as many case-hardening formulas,

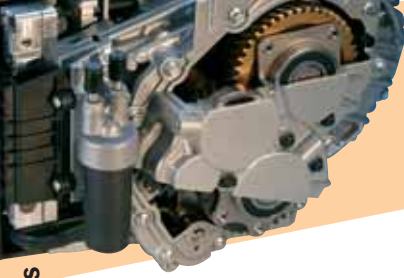
produced up to 500,000 gearboxes per year... and all this with a minimum of equipment changes", stresses Luigi Granieri. "This long service life is the major quality of the ICBP!" The only significant change in 10 years: installation of the STG technology (gaz treatment system), in collaboration with ECM – in order to oxydize carburizing gases before release to the atmosphere – as part of GETRAG's ISO 14000 green certification procedure. Next year, the new components will be produced without any further changes being made to the machines, except for renewal of the heating units and quenching cells, a standard requirement after a few years of service.

Up to
500,000 gearboxes
per year

GETRAG in a nutshell

With more than three million transmissions and a million axles produced annually, the German group GETRAG is the world's leading independent manufacturer of transmission assemblies. Established in 1935, the group today operates from 22 R&D and production sites, located in eight countries on three continents. It employs more than 13,300 people. (Source: www.getrag.de)

Continued next page >



Continued from page 1

92% availability

As is often the case (see our article on PSA Metz in this edition), this long service life results from a careful maintenance policy. After a relatively difficult first year, due to the innovative nature of the process, the maintenance plan was refined, and today it is performed in total autonomy by a team of seven GETRAG technicians. "ECM has always been on hand, organizing training courses and joint maintenance sessions. We have thus been able to undertake jointly several technical projects, like the loading system automation", says Luigi Granieri. And the results are considered to be highly satisfactory: "By planning maintenance work on Sundays, we have achieved an availability rate in

excess of 92%." A performance that has been built up over time.

With the advent of the new project, Luigi Granieri can look back serenely over these past 11 years of partnership with

"If we had to do it again? I wouldn't change a thing!"

ECM. "If we had to do it again? Even with hindsight, I wouldn't change a thing!" Adding with a smile: "I am very satisfied with the ICBP technology and I expressed this to my colleagues in the GETRAG Group that use another low-pressure carburizing technology." It always sounds better coming from a client...



By optimizing maintenance work on Sundays, GETRAG Italy has achieved an availability rate in excess of 92%.

ECM launches new website

ECM's new web-site is now on line! You will find a detailed presentation of our solutions, their advantages and applications, as well as the latest innovations of the group. Designed as a web portal, the site also gives access to the ECM sites in each country. The site will be regularly updated. In particular, you will find back-copies of all *Hot News* issues in pdf format. Get on to your browsers and check it out! <http://www.ecm-ip.com>



Diary dates for the coming quarter

Gear Expo

From 7 to 10 October at the Cobo Center in Detroit, Michigan-USA. The ECM team will be pleased to welcome you to Booth No. 417. Don't miss the presentation to be given by Aymeric Goldsteinas, Business Development Manager, on "improving fatigue strength of transmission gears by carbonitriding and gas quenching."



AWT annual Heat Treatment Congress

From 10 to 12 October, Wiesbaden (Germany). In particular, you will be able to attend a presentation to be given by Benoit Rossignol, R&D manager (ECM), on the subject of "Considerations on the process and choice of steel grade in low pressure carburizing".

12th International Exhibition on Heat Treatment

21 to 23 November, Beijing – China. ECM's China team will be participating in this event organized by the China Heat Treatment Society. Ma Xiaoli, metallurgist engineer, will give a presentation on the "ECM method to reduce the Gearbox components distortion during Low Pressure Carburizing and Gas Quenching by controlling the key factors".



Industrial Club of Japan: swords on show

On 10 July last in Toyko, ECM Japan presented the latest innovations and ECM's future prospects, at the inaugural session of the 5th conference on surface treatment technologies at the Industrial Club of Japan. The 200 people present were able to discover among other things the ICBP technology (continuous low pressure carburizing line... to be described in detail in the next issue of *Hot News*!). The conference ended with a demonstration by a Japanese master craftsman of the unrivalled thousand-year-old traditional method of making sword steel.



Technical seminar in the USA: a success!

The technical seminar organized by ECM USA in Plymouth, Michigan, brought together 65 clients and prospective clients representing 34 companies. These guests were able to discover for the first time or enrich their knowledge of low pressure carburizing and its applications, thanks to ten themed presentations – from steel grades to carbonitriding, and from ICBP maintenance to gas quench cells. This day was also marked by speeches from three guests eager to share their experience of ICBP: E.Hutton (Bodycote Thermal Processing), O. Finot (Ascometal) and D. Kopka (Daimler-Chrysler). We are extremely grateful for their participation, and to all who attended...



New application in the USA

The modular ICBP technology has now infiltrated the professional tooling world. The American group Milwaukee Electric Tool Corporation, one of the world leaders in this market, has just ordered its first direct-quench and tempering ICBP from ECM. This installation will be integrated in the group's saw blade production lines in Spring 2008.

Integrated Maintenance at PSA Peugeot Citroën Metz ICBP operating time: +11% !

The PSA plant in Metz has achieved exceptional performance figures in terms of operating continuity of its ICBP units, by improving and internalizing preventive maintenance of the machines.

With 1.6 million gearboxes per year, PSA's Metz plant produces the lion's share of the transmission systems fitted to the French car manufacturer's vehicles – from the 207 to the 807, and from the C3 to the Jumpy Expert utility vehicle. The components involved are heat treated on site using two horizontal ICBP units and six traditional pusher furnaces. "The availability rate of our furnaces, which treat all of our production components prior to their delivery to the assembly shops, is obviously a key performance factor for the plant", says Michel Cervulle, maintenance process manager, who runs a service employing 370 people, including thirty or so working only on heat treatment. A large workforce is necessary since preventive maintenance is carried out 100% in-house, and with quite remarkable results. "In all, just 160 hours of downtime – outside preventive maintenance periods – in 2006 for our two machines!" stresses Michel Cervulle.



The Metz plant produces 1,6 million gearboxes per year

Transfer of know-how

When the ICBP units were installed in 2000, the situation was very different. Maintenance was subcontracted to ECM with provisions made for a standard maintenance work plan. As is often the case, certain operations scheduled in this work plan proved to be unsuited to the specific manner in which these machines were used and to the site organization. "For example, it was not possible to check cable lengths because of accessibility problems: we were better off scheduling their renewal once a year."

For these reasons, from 2000 to 2004, the maintenance team redesigned all maintenance operations. Each operating problem was analyzed in detail, in collaboration with the ECM teams. "We used FMECA cause analysis methods. In 70% of the cases, the solution was found thanks to close liaison between ECM and PSA. In particular, we undertook a major rethink of the loader in order to improve protection of the encoder and proximity detectors."

At the same time, PSA made preparations for all maintenance operations to be taken over by

"For one extra hour of downtime for preventive maintenance, we reduce failure downtime by five hours!"

its own in-house teams. Whenever maintenance was required on the machines, the car manufacturer's teams accompanied ECM's operators. "Transfer of know-how directly on site was an essential requirement in order to achieve independence and flexibility", explains Michel Cervulle.

Complete autonomy

In four years, this dual strategy of internalization and customization of the maintenance plan has been a great success. PSA teams handle maintenance of the ICBP units in virtually complete autonomy. The efforts made to extend the working time limits of the maintenance teams have been paid back by a significant reduction in curative downtime. The total number of downtime hours – curative and preventive – is reduced by 43% in one year, equivalent to an 11% gain in overall equipment effectiveness! "For one extra hour of downtime for annual preventive maintenance, we reduce failure downtime by five hours", explains the maintenance manager, smiling. "Unpleasant surprises have become something of a rarity!" And PSA does not intend to stop there. Next objective: planning all maintenance operations during the weekend – this was carried out on Mondays for logistical reasons up to now.



PSA Peugeot Citroën Metz: preventive maintenance is carried out 100% in-house

Michel Cervulle, maintenance process manager:
"In all, just 160 hours of downtime – outside preventive maintenance periods – in 2006 for our two machines!"

Steel grades: a key performance factor for ICBP

Thanks to the flexibility of low pressure carburizing, the choice of steel grade becomes a key factor in the mechanical performance of the parts. Having conducted more than 200 experiments on real loads, ECM has succeeded in accurately characterizing the influence of material hardenability on case-hardening depth and core hardness. A decisive step in the construction of a comprehensive predictive model that will be a valuable addition to our Infracarb simulation software.

When a new series of parts is ready for production, numerous questions may arise for an ICBP user. Should the same carburizing gas be used? What diffusion time and what temperature should be adopted? Oil quench or gas quench? Thanks to its modularity, the ICBP technology can be used to define an extremely wide range of processes by varying up to 50 parameters. This flexibility often leads to a "detail" being ignored: the steel grade.



Ken Picket, metallurgical expert with ECM USA: "Hardenability (DI) is the most relevant factor for classifying steel grades"

"Industrialists tend to overlook the fact that they always have a choice of material", notes Kenneth Picket, metallurgical expert with ECM USA. "As a result they try and find the heat treatment process best suited to achieving the mechanical performance required. But it is in fact generally easier to change the steel grade rather than rethink the entire process!" And this initial adjustment, as we shall see, is the key to achieving an optimized, controlled heat treatment process.

Hardenability: the differentiating factor

To characterize the influence of choice of steel grade on the results obtained in ICBP, Kenneth Picket's team carried out more than 200 specific experiments using real furnace loads. "We have identified the hardenability (DI) as the most relevant differentiating factor for classifying steel grades", explains the metallurgist. "This parameter, given by manufacturers for each steel grade, in fact varies continuously over the entire range of steel grades used in the industry." In 2006, the ECM team conducted an unprecedented comparative study of nine different steels, with corresponding DI values ranging from 1.02 to 4.13. Under identical load configurations, each of these steels was subjected to the same series of nine different ICBP heat treatment processes: three formulas (corresponding to three required case-hardening depths) and three types of quench (N₂, CO₂He and oil). Two output variables were measured: the effective case-hardening depth

and the core hardness. The results are most informative...

For each of the nine heat treatment processes tested, there is a very clear relationship between DI and the properties of the components after treatment (effective case-hardening depth and core hardness). Even better: this relationship is linear with, in each case, good regression coefficients. "This is a very important result", exclaims Kenneth Picket, "because it enables us to extrapolate the results obtained, by extending the graphs, for other DI values!" The door is open for the construction of a predictive model. An initial model was rapidly developed on the basis of the nine sets of experimental conditions studied. "For a given DI input value, this model calculates the results of the nine formulas studied", explains Kenneth Picket. The output values produced will soon be validated by a new series of experiments.

From experiment to model

Of course, the adventure doesn't stop there: ECM is carrying out numerous other tests, intersecting experimental conditions, refining the model. "This major research effort has enabled us to confirm and exploit the stable and highly deterministic nature of the ICBP technology", stresses Kenneth Picket. It will culminate in the construction of a comprehensive model allowing total control of all the parameters involved in ICBP heat treatment, by means of data charts: steel grades, choice of formulas, type of quench, etc., as a function of the mechanical properties required. A real revolution, that will offer ICBP users an unprecedented level of flexibility and control to optimize their heat treatment processes. That model will be a valuable addition to our Infracarb simulation software. In the meantime, you can contact ECM for advice on your formulas... AND on your steel grades!

DI: an American standard

The DI (ideal diameter) of a steel grade represents the diameter of a round bar of this material that will harden at the center to 50% martensite after quenching. Frequently used in the United States to characterize the hardenability of a steel, the DI value is not widely known in Europe, where industrialists tend to use Jominy tests for this purpose.

Material	DI	%C	%Mn	%Cr	%Ni	%Mo
4023	1.02	0.24	0.84	0.18	0.06	0.22
8620	2.22	0.19	0.84	0.55	0.62	0.3
4320	2.31	0.22	0.58	0.49	1.76	0.19
8822	2.65	0.22	0.85	0.55	0.61	0.32
4130	2.77	0.29	0.62	0.92	0.08	0.2
4130	3.48	0.32	0.88	0.91	0.05	0.12
51023	3.24	0.24	0.87	1.17	0.05	0.16
8319	4.13	0.23	1.37	0.74	0.33	0.17

Fig. 1 Composition and DI value of the nine grades studied

Process Step	Temperature (°C)	Time Minutes
Preheat	750	6
Ramp to	950	45
Soak	950	61
Carburize	Per Design Matrix	
Diffuse	Per Design Matrix	
Ramp to	880	15
Soak	880	15
Quench	Per Design Matrix	

Control Factors

- Recipe and Load Configuration
- Carburizing Gas (C3H8) Flow and Time
- Diffusing Gas (N₂) Flow and Time

Experimental Factors

- Material DI
- Depth of Carburizing
- Quench Media

Response Variables

- Core Hardness
- Effective Case Depth

Fig. 2 The experimental process - fixed and variable parameters

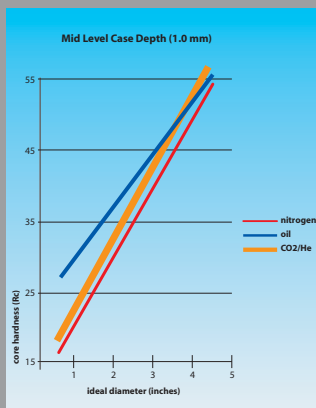


Fig. 3 Linear relationship between effective case-hardening depth and DI value, for the three types of quench studied.

Headquarters: ECM France
Technisud
38029 Grenoble cedex 2
France
Tel. : +33/(0)4 76 49 65 60
Fax : +33/(0)4 38 49 04 03
E-mail : ecm@ecm-tp.com

International contacts:
ECM USA : +1/262 805 4810
ECM China : +86/10 858 02642
ECM Japan : +81/3 6848 6187