

## Article no. 1: THERMPROCESS from 16. to 20. June 2015

**Heat engineering: consistently important for metallurgical processes**

**THERMPROCESS 2015 – International Trade Fair for Thermo Process Technology**

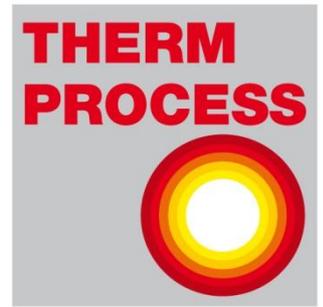
**Material and heat engineering are closely associated**

Energy – generally in the form of heat – is needed to smelt ores as well as to refine and cast the metal obtained as a result. Both while they are being formed and afterwards, metal components normally require heat treatment to give them specific mechanical properties. Heat is, however, also necessary to produce and process such non-metallic materials as glass, ceramics and polymers or building materials like cement. So it is no surprise that the thermal processes and the furnaces and other equipment required to carry them out are very varied. Plant manufacturers and users have many different ways to reduce operating costs by optimising their equipment and the thermal process chains – up to and including exploitation of discharged heat. New materials and new thermal / thermomechanical processes are opening up promising applications.

The following article highlights some of the special technical features involved when using heat in the metallurgical industry. The THERMPROCESS 2015 trade fair, which is taking place in Düsseldorf from 16. to 20. June 2015, will be giving an insight into the latest innovations in thermo process technology, the wide range of different applications and future developments.

### **Melting and casting**

Ferrous materials are the metallic materials that are in most common use. Steel, iron/carbon alloys with a carbon content between 0.01% and 2.06% and the addition of such metals as chromium, nickel or manganese form the largest group. Pig iron, the basic material, is



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Messe Düsseldorf GmbH  
Postfach 10 10 06  
40001 Düsseldorf  
Messeplatz  
40474 Düsseldorf  
Germany

Telefon +49 (0) 2 11/45 60-01  
Telefax +49 (0) 2 11/45 60-6 68  
Internet [www.messe-duesseldorf.de](http://www.messe-duesseldorf.de)  
E-Mail [info@messe-duesseldorf.de](mailto:info@messe-duesseldorf.de)

Geschäftsführung:  
Werner M. Dornscheidt (Vorsitzender)  
Hans Werner Reinhard  
Joachim Schäfer  
Bernhard Stempfle  
Vorsitzender des Aufsichtsrates:  
Thomas Geisel

Amtsgericht Düsseldorf HRB 63  
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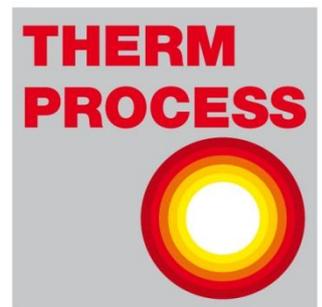
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produced in blast furnaces, in which iron ore, additives and coke are smelted. The result is molten pig iron, which is at a temperature of about 1,500°C when it leaves the blast furnace. Global production of crude steel in 2013 amounted to 1.6 billion tonnes. Molten crude steel, steel scrap and alloy metals are refined into steel in converters or electric arc furnaces. Steel that is required in large quantities is given its final form by continuous casting followed by hot rolling while the strand is solidifying. Depending on the composition of the steel, continuous casting is carried out at temperatures of up to more than 1,600°C, while hot rolling temperatures are as much as 1,250°C.

If the forming process is carried out by casting, temperatures of 1,500 to 1,700°C are required for steel casting, while 1,340 to 1,480°C are needed for cast iron, iron/carbon alloys containing more than 2.06% carbon. Major non-ferrous metals have the following casting temperatures: zinc die-casting alloys: 420 to 580°C, aluminium and magnesium die-casting alloys: 620 to 730°C, copper/zinc alloys (“brass”): 960 to 1,160°C and titanium casting alloys: 1,700 to 1,800°C.

## Forming

Heat is needed not only to melt and cast metals but also to influence the internal structure of semi-finished and finished products, because specific strength properties can be produced in this way. It is typical for metal atoms to be arranged like a lattice. Some metals and alloys, combinations of at least two metals, form different three-dimensional lattices depending on the temperature. One outstanding example is iron, the atoms of which form two types of three-dimensional lattice depending on the temperature: body centered cubic and, at higher temperatures, face centered cubic. The “Atomium”, the landmark of the Belgian capital of Brussels, is a model of a body centered cubic elementary iron cell magnified 165 billion times. The balls, eight of them at the corners and one in the middle of a cube, represent the iron atoms. The phase, i.e. the range, in which the iron atoms in steel have a body centered cubic structure, is called  $\alpha$ -iron or ferrite, while the other phase is known as  $\gamma$ -iron or austenite. Steel can be formed more



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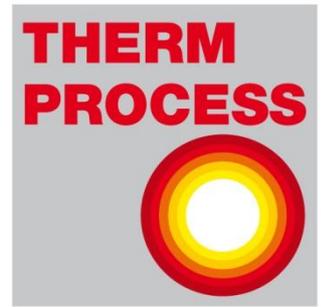
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easily in the austenite range, i.e. at higher temperatures, than in the ferrite range. Since the lattices in  $\gamma$ -iron have more space to accommodate the comparatively small carbon atoms than the body centered cubic lattices of  $\alpha$ -iron, specific strength conditions can be created via thermal processes. For example, if a piece of steel in the austenite range is cooled down very quickly into the ferrite range, the carbon atoms are unable to leave the lattices and are trapped, which leads to high tension. The piece of steel is then very hard and strong, while being very brittle too. Annealing makes it possible for some of the carbon atoms to leave the iron atom lattices, which eases the tension. Localised areas of some steel can be heated by such processes as induction annealing or laser radiation with subsequent targeted cooling, so that – for instance – a hard, wear-resistant surface can be produced, while the inside of the workpiece remains ductile (“tough”). Gear wheels and other transmission components need to have properties like these. Apart from purely thermal processes, there are also thermochemical and thermomechanical processes with which components made from specific kinds of steel are give specific strength properties.

Heat can be used to reduce structural tension that develops in cold forming too. The difference between cold and hot forming is that the structure is merely distorted below a certain temperature threshold, which leads to an increase in hardness and strength, while the structure is rearranged constantly above the temperature threshold. The rolling of aluminium strip material could be used as an example here. Feedstock in ingot form is first of all preheated to temperatures of 500 to 600°C and is hot rolled into strip a few millimetres thick. Processing is continued by cold rolling. Since the material becomes increasingly solid during this process, it needs to be made “soft” again via intermediate annealing at 350 to 400°C. The aim is to give the finished rolled strip the properties it requires for further processing. The strip, which is heated up to 150°C or more by the energy applied in cold rolling, is cooled down to below 60°C after the rolling operation. In accordance with a specified time/temperature program, it is then annealed at 480°C, after which it is cooled down again to room



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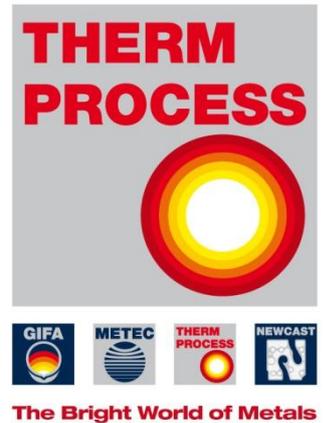
temperature. It now has the properties that are needed to manufacture such articles out of it as car hoods/bonnets, offset printing plates, beverage cans or yoghurt tub lids.

### Technical trends

Material manufacturers are co-operating with research institutes on the optimisation of existing metal materials and the development of new ones that have properties which can be increased by thermal or thermomechanical processes. In liaison with plant manufacturers, new production processes are also being developed, while conventional ones are being optimised. In the production of individual parts, such as components of vehicle transmissions, progress is being made in integration of heat treatment in the manufacturing lines. "Press-hardened steel" (PHS), which is used – for instance – in sheet metal form in the automotive industry, is another example of the successful co-operation between specialists from different disciplines. It is heated for processing, is fed into the forming press in this state and is given its shape and strength properties during the forming operation. According to the World Steel Association, the central association of the steel industry, only one third of the steel originally needed to build the Eiffel Tower in Paris would be required if it was built with modern steel. The optimisation of industrial furnaces and other heat treatment plants as well as of thermal process chains (up to and including the exploitation of discharged heat) also has tremendous potential to reduce operating costs.

### The THERMPROCESS 2015 trade fair

Energy and raw material efficiency have high priority at companies that carry out thermal processes. Modern heat treatment plants play a major role in this context. The international trade fair THERMPROCESS, which is taking place in Düsseldorf from 16. to 20. June 2015 at the same time as the trade fairs GIFA, METEC and NEWCAST that feature associated fields and all share the same motto (The Bright World of Metals), will be providing information about this and the innovative developments that are being made.



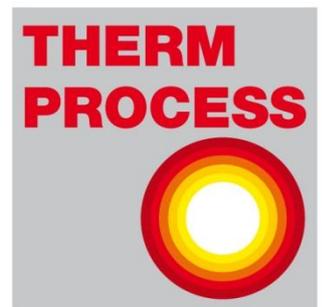
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The four international technology trade fairs GIFA (International Foundry Trade Fair), METEC (International Metallurgical Trade Fair), THERMPROCESS (International Trade Fair for Thermo Process Technology) and NEWCAST (International Trade Fair for Precision Castings) are being held in Düsseldorf from 16. to 20. June 2015. Visitors from all over the world will be coming to the city on the River Rhine for five days at this time to focus on castings, foundry technology, metallurgy and thermo process technology. A programme of high-quality additional events will again be taking place alongside the trade fairs, involving seminars, international congresses and lecture series. All four trade fairs and the programmes co-ordinated with them will be concentrating on the issue of energy and resource efficiency. A total of 79,000 experts from 83 different countries visited the stands of the 1,958 exhibitors at the previous events in 2011. Further information is available in the Internet at [www.gifa.de](http://www.gifa.de), [www.metec.de](http://www.metec.de), [www.thermprocess.de](http://www.thermprocess.de) and [www.newcast.de](http://www.newcast.de).

Messe Düsseldorf organises not only GIFA, METEC, THERMPROCESS and NEWCAST with the joint motto "The Bright World of Metals" but also other high-quality trade fairs for the metallurgical and foundry industries all over the world. They include FOND-EX (International Foundry Fair) and Stainless in the Czech Republic, Metallurgy India, Metallurgy-Litmash (International Trade Fair for Metallurgy Machinery, Plant Technology & Products) and Aluminium Non-Ferrous in Russia, indometal in Indonesia, metals middle east in Dubai, ITPS (International Thermprocess Summit) Americas and Asia and the Aluminium trade fairs in China, India, the United Arab Emirates and Brazil. The range of events held for the metal industries at the Düsseldorf location is rounded off by: Valve World Expo (International Trade Fair and Congress for Industrial Valves and Fittings) and ITPS Düsseldorf as well as the international trade fair ALUMINIUM organised by Reed Exhibitions and Composites Europe.

Further information and photos are available at [www.thermprocess.de](http://www.thermprocess.de)

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November 2014

Press Department GIFA, METEC, THERMPROCESS, NEWCAST 2015

Tania Vellen

0049211/4560-518

[vellent@messe-duesseldorf.de](mailto:vellent@messe-duesseldorf.de)

Brigitte Küppers

0049211/4560-929

[kueppersb@messe-duesseldorf.de](mailto:kueppersb@messe-duesseldorf.de)

  
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