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Blue Competence –
the VDMA sustainability initiative

The VDMA association “Foundry Machinery” is part of the VDMA Blue Competence initiative. Our members are committed to energy- and resource-efficient solutions for metal production and processing. Metals are the basis for innovative products and sustainable economic growth.

Our companies see themselves as partners of their customers and develop demanding technical solutions together with them.

Foundry machinery producers have always focused on the responsible handling of natural resources. Over the past few decades it has been possible to make significant improvements in energy utilisation and in the use of other natural resources. In view of the current environmental challenges and the resulting political requirements as well as the growing economic pressures as a result of rising energy and raw material prices, companies will realise further efficiency improvements.

This brochure is intended to inform you about what has already been achieved in the field of sustainable metal production and processing. It also indicates the contribution which our industry will make to sustainable development in the future.
1 Casting production – facts and figures

1.1 Casting production

Cast iron

Throughout the world, cast iron (including grey, nodular and malleable cast iron as well as cast steel) accounts for by far the greatest share in the production of metal castings. China alone has a share of about 45% in world-wide cast iron production and is by far the largest producer of ferrous metal castings. Over the past few years, Germany has been able to maintain its position as the leading European casting producer, with a share of about 34%.

Non-ferrous metal castings

Production volumes of non-ferrous metal castings (mainly aluminium, copper, magnesium, zinc and nickel) have been growing for years. Especially aluminium casting production has almost tripled since 1995 throughout the world, while the total growth in other nonferrous metal castings has only been about 10%.
1.2 Complex processes

**Casting processes**

With modern casting processes, it is possible to produce parts that are very close to the final dimensions required, avoiding or minimising the need for subsequent machining operations. This approach allows significant material, time and energy savings. Casting processes reach high metal and mould material recycling rates.

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**World casting production in 2014 – cast iron vs. non-ferrous metal castings**

- Grey cast iron*: 47%
- Nodular cast iron: 24%
- Cast steel: 11%
- Non-ferrous metals: 18%

Fig. 2

* Incl. malleable cast iron

Source: Modern Casting

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**Casting processes**

- **Gravity casting**
  - Lost moulds
    - With lost patterns: Precision casting, Full mould casting
    - With permanent patterns: Sand casting, Shell moulding
  - Permanent moulds: Permanent mould casting, Continuous casting

- **Pressure casting**
  - Lost moulds
  - Permanent moulds
    - Low-pressure sand casting
    - Die-casting
      - Low-pressure casting
      - Counter pressure casting
      - Special processes

Source: Fachkunde für gießereitechnische Berufe
Mould and core production

The type of bonding (physical or chemical) is a key criterion for the classification of mould and core production processes. Almost all ferrous metal castings are produced using lost or expendable moulds. In Germany, some 70% of the moulds used have a clay bond while 30% have a cold resin bond.

In core production, the (urethane) cold box process is used in about 60% of cases, with no other process accounting for more than 20%.

1.3 Energy efficiency potential

Energy efficiency and conservation of resources are also the key challenges for the foundry industry. As the automobile industry is the main customer of foundries, these requirements are closely connected with lightweight design. Nature is the great model for lightweight design. The topology of components is optimised on the basis of bionic principles. This means that the shape of the part is optimised to provide the required strength combined with the greatest weight saving. The complex shapes required can only be produced by smart design and calculation programs. The dynamic development in the field of aluminium casting is mainly the result of the growing use of lightweight parts in the automobile industry. About 75% of all the aluminium castings produced are used in this sector.

Rising energy and raw material costs provide many foundries with good reason for optimising their processes with reference to energy and resource use.
2 Examples of energy and resource efficiency

2.1 Efficient foundry technology

At all stages in the casting process, plant or process optimisation measures are already well established or available for improving energy and resource efficiency and reducing carbon dioxide emissions.

Example: cupola furnace

Key factors for the energy efficiency of a cupola furnace are as follows:

- Fuels, e.g. coke or natural gas
- Iron source, e.g. steel or cast iron scrap
- Fluxes and additives, e.g. limestone, gravel, FeSi, SiC
- Utilities, e.g. hot air, oxygen, carbon
- Cupola furnace design, e.g. lined, non-lined, pressurized siphon, dimensions
- Waste heat utilization

Taking the example of a cupola furnace with a capacity of 30 t/h, the heat loss via the furnace casing can be significantly reduced if it is lined. Assuming a cooling water flow rate of 100 m³ per hour and a temperature difference of 15°C with a non-lined design or 3°C with a lined design, the reduction in coke consumption is 176 kg per hour.

Other measures which reduce coke consumption are as follows:

- Minimising the surface area of tuyeres
- Adaptation of hearth height
- Air heating and use of oxygen are the most important factors which affect the thermal efficiency of a cupola furnace
- An increase of 100°C in hot blast temperature reduces coke consumption by about 1.4%
- 1% – 1.5% oxygen addition saves about 1.5% coke
- Use of scrap with low surface-to-mass ratio
- Adjusting the furnace dimensions according to the current melting capacity
- The use of a pressurised siphon boosts the iron temperature, reducing undesirable silicon loss

There are also various possibilities of using excess process heat in neighbouring processes and saving fossil fuel. These include paint or core drying, steam raising for cement consolidation or food drying, and heating or cooling. In some cases, it is possible to use all the waste heat available.
Example: die-casting machine

Die-casting machines are normally hydraulically powered. Key factors with an impact on energy efficiency include:

- The type and control system of hydraulic pumps
- Pressure and flow control
- Approach to the supply of hydraulic power
- Design of piping system and hydraulic blocks
- Leakages in hydraulic system

Depending on the design and age of the machinery concerned, various measures may be taken to improve energy efficiency:

- Installation of software for automatic shut-down of hydraulic equipment that is not required for a considerable time
- Software update for the improved delivery of hydraulic power in the machine cycle (savings of 5% to 30%)
- Limited modifications to hydraulic system to reduce base-load consumption of machine (savings up to 5%)
- Reconstruction of hydraulic system (savings up to 40%)

If special attention is paid to energy efficiency during the design of a new hydraulic system, savings of up to 30% can be achieved.

Example: die-casting shop

Apart from the die-casting machine, temperature management has a decisive influence on the energy demand of a die-casting shop. Energy savings of up to 30% can now be achieved by using appropriate temperature management.

Energy efficiency can be improved by taking the following action:

- Adapted spraying to reduce compressed air demand and stabilise the temperature equilibrium
- Shorter cycle times and avoidance of downtimes; this shortens idle times and improves the thermal energy balance
- Minimisation of re-melted material by reducing rejection rate and using innovative tool technologies
- Optimum temperature conditioning of tool using modern temperature conditioning systems

Source: Oskar Frech


3 Downstream potential

Apart from the direct and indirect efficiency improvements that are possible in metal production and processing, the potential available in connection with the use of metal materials also need to be taken into consideration.

Example: nodular cast iron

Nodular cast iron (cast iron with spheroidal graphite) features a graphite phase in the form of spheres in the microstructure. This material offers considerable advantages for cast iron users. Thanks to its outstanding mechanical properties including uniform distribution of hardness and strength in the component, good workability and relatively low-cost production, this material is widely used in industry. Of the total production of 24 million tons of nodular cast iron per year (compared with 50 million tons of grey cast iron and 11 million tons of cast steel), about 50% are used for the production of castings in the automobile industry. Many components which were previously made from cast or forged steel or fabricated by welding are now being replaced by considerably less costly nodular iron castings. This also allows the use of lower wall thicknesses (lightweight design), an approach which saves energy and conserves natural resources. Especially safety-relevant components such as crankshafts, camshafts, connecting rods, suspension links, wheel hubs, truck wheel spiders, axle sub-frames and pivot bearings, etc. are cast from nodular iron. About 30% of the material is used for the production of pipes with diameters from 60 to 2400 mm by centrifugal casting.

Example: aluminium

The use of aluminium castings in automobile production offers considerable potential for weight reduction. Depending on the individual model, weight savings of up to 44 kg can be realized. If this figure is extrapolated to the total number of vehicles and the kilometres driven, it is clear that this offers vast potential for carbon dioxide avoidance and fuel savings.

Similar considerations apply to highly turbocharged engines which are increasingly being manufactured from high-performance alloys for weight saving reasons. Both the downsizing effect and the weight reduction as a result of the use of lightweight castings contribute to resource conservation and emission reduction.

4 Outlook

The member companies of the VDMA association Foundry Machinery offer efficient, environmentally compatible and competitive technological innovations in the key areas of:

- Energy efficiency
- Environmental protection
- Ergonomics and safety

The companies participating in the Blue Competence initiative will continue to work in the future in cooperation with customers on technical solutions that help to achieve these goals. At the European level, they are working on the definition of the best available technologies and creating global benchmarks. By offering plant designs which are both economical and sustainable, these companies are contributing to low-emission, resource-efficient casting production not only in Germany or Europe but also for customers throughout the world.
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