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LOST FOAM PROCESS – THE CHANCE FOR INDUSTRY

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Summary. To produce ready parts for different sectors of industry, including automotive and agricultural applications, every year the foundry industry consumes milliards kJ of energy. This is the reason why studies are conducted to reduce the overall cost of casting manufacture. The trends in these studies are mainly oriented at the following goals:

- energy consumption in foundry processes reduced through its more effective use,
- improvement of product quality,
- processes friendly to man and environment.

The main trend in the currently conducted studies is to introduce new ecological and energy-saving technologies to the casting manufacturing process. The Lost Foam Process, also called the evaporative pattern technology, seems to be one of such solutions. According to the data published recently in USA, the application of Lost Foam Technology may improve the energy efficiency of a foundry process by 27%.

Keywords: Lost Foam Process, the present, the future, machines and tools, cast products.

INTRODUCTION

In the past years, the Lost Foam Process was widely used all over the world. According to the data published by Vulcan, in the year 1997, 460 thousand tons of castings were produced by this technology in the world, with Europe having its share in 125 thousand tons. In USA, 40 foundry shops manufactured over 115 thousand tons of castings by this method. In Europe, including France, Italy, Germany, Russia and Ukraine, the production volume of lost foam castings reached 60 thousand tons/year. The same value of 60 thousand tons of castings was also reported for Asia, including Japan and China.

The Lost Foam technology finds various applications all over the world. According to the statistical forecasts published in the United States, by 2007 the application of this technology is expected to show a 30% growth. Also in China, the Lost Foam process enjoys a growing popularity.

In Europe, on the other hand, especially in Germany, foundrymen seem to be rather sceptical about this technology. Examples are even quoted of foundries that give up this process. For this reason, knowing better the principles of using this technology is nowadays the main object of interest of the leading research and industrial centres in numerous countries all over the world. The said process is more and more often used to cast not only non-ferrous metal alloys but also

ferrous alloys and magnesium-based materials. In the world, to mention only the United States and Germany, foundries start making intricate castings from aluminium alloys, e.g. for the automotive industry (cylinder heads).

THE PROCEDURE

In this technology, patterns are made from foamed polystyrene (EPS). Foaming of the polystyrene is carried out not only to make patterns of the required configurations but also to achieve the required density. Using proper glues, patterns are joined together to make a solid assembly, composed of several patterns with a gating system. The ready pattern assembly is coated with a layer of ceramic material. Pattern assemblies are moulded, and moulds are compacted by vibrations. When the mould is poured with liquid metal, the latter is acting on the pattern and makes it evaporate. The key issue in this process is to determine the pattern properties during its evaporation when the mould is being poured with metal.

An opinion prevails that in the process of making castings from lost foam patterns, there are two main factors that decide about the success of this technology, namely:

- the properties of evaporative patterns,
- the process of mould filling with liquid metal.

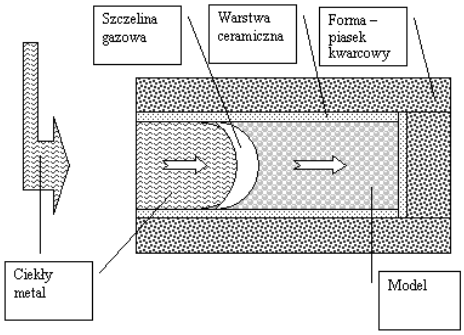

Fig. 1. Schematic representation of the pouring process

Fig. 2. The successive stages of the casting process, a-foamed polystyrene pattern, b- foamed polystyrene pattern coated with ceramic layers, c- mould, d- casting

The technology of evaporative patterns is used in the production of castings from various materials, especially from aluminium alloys. Castings are made in mass production or as individual

pieces in weight ranges varying from several grams up to a few dozen tons. For example, the following castings are made:

- automotive parts (transmission brake levers, heads, pistons),
- parts of machines (bodies of electric motors),
- cast parts used in sport games (golf clubs),
- castings for geotechnics (drill tips).

ADVANTAGES

There are numerous advantages resulting from the Lost Foam technology, to mention just a few:

- energy-savings,
- automatisation and mechanisation of the process,
- castings made from a large variety of materials, like non-ferrous metal alloys, alloys based on aluminium and magnesium, ferrous alloys,
- possible manufacture of near-net-shape, intricate elements, requiring nearly no machining, which considerably reduces the cost of finishing operations,
- short time required for the manufacture of large parts in piece production,
- no cores necessary,
- possible manufacture of thin-walled castings (wall thickness ≤ 3 mm),
- the weight of castings made by this technology reduced by 15 to 25%,
- parts produced so far as separate elements can now be made as one integral whole,
- castings characterised by the design and configuration impossible to be reproduced faithfully by other methods are now produced with adequate accuracy,
- reduced level of rejects.

ECONOMIC ADVANTAGES

According to calculations made by the US Department of Energy's Office of Energy Efficiency & Renewable Energy, investing in research and using next the energy-efficient processes should bring during one single decade the energy savings of as much as 10,84 trillions BTU.

As forecast by the US Department of Energy Office of Energy Efficiency & Renewable Energy, the development of modern methods of measurement and in-process monitoring of mould and pattern properties before and during the operation of mould pouring in with lost foam patterns should give the energy savings of 0,274 trillions BTU by year 2008, of 2,74 trillions BTU by year 2018, and of 4,94 trillions BTU by year 2028.

The same US Department estimated that in 1988 in the USA the value of casting production by the Lost Foam Process was 5 000 000 $, going up to 800 000 000 $ in 2002, and with a tendency towards further increase.

When castings, both small and medium size, are made by the lost foam process from non-ferrous and ferrous metal alloys in a weight range of up to 3,9 kg for, e.g., the automotive industry, the mechanised application of ceramic layers enables the cost to be reduced by as much as 70 % compared to the initial machine-related cost.

TRENDS IN FUTURE ACTIONS

In various countries, USA in particular, the technology of lost foam patterns is considered a fully innovative process which, when applied in industry, is expected to bring the following advantages:

- energy consumption reduced by 20% by the year 2020,
- improved competitiveness of foundry industry,
- reduced emission rate of pollutants,
- possible manufacture of castings from magnesium alloys,
- innovations in foundry technology,
- manufacture of castings for various sectors of industry, e.g. machine building industry, parts for automotive and agricultural applications.

For effective application of the Lost Foam process in castings manufacture, a technical and economic analysis should be made. An analysis of this type examines the risk and risk-related problems, like quality, surface, price, overall cost, the time spent for research and making pilot lot of castings. All these problems should be discussed and examined with due care.

EXAMPLES

The technology of lost foam patterns is used in various countries for the manufacture of castings characterised by intricate shapes, poured from different materials, like aluminium alloys, or ferrous alloys. The castings are used by various sectors of industry, e.g. automotive industry, machine building, agricultural applications, and building sector.

In the Czech Republic, for example, they have recently produced a casting of the lever for transmission shaft with braking system. The casting made from LKG for a German company Lenze has a weight of 0,5 kg, which means a 20% reduction respective of the previously cast element. The cost of the finishing treatment is also lower. The next example is a 100 kg weighing cast body of electric motor made from LLG for the Swedish ABB Motors Company.

The casting offers high dimensional accuracy and the weight reduced by 25%. Using foamed polystyrene patterns, it has been possible to make bodies of electric motors in different configurations and weight ranges.

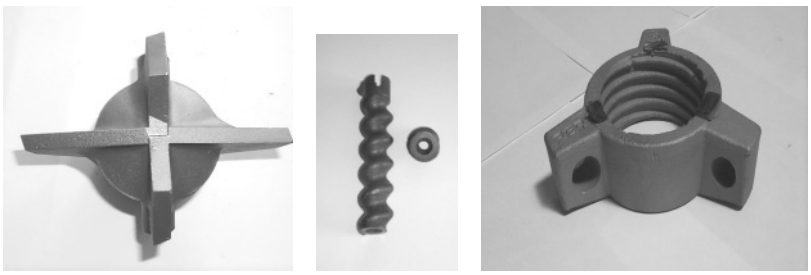

Fig.3. Cast machine elements made by the lost foam process

The BMW Company in Germany developed a set of principles valid in the implementation of new technologies used for the manufacture of passenger car elements. This undertaking means entering the so far unknown field of casting manufacture, i.e. making a six-cylinder head and body

of an engine (R6ZK) cast by the LF (Lost Foam) process. The lost foam process used by BMW offers numerous ecological and economic advantages.

CONCLUSIONS

The use of lost foam patterns in the manufacture of castings from different materials finds growing application, especially in countries with the highly developed sectors of industry, e.g. automotive industry (USA, Italy, France). The leading example is manufacture of near-net-shape elements for car engines (bodies, camshafts). There are specialised companies supplying equipment necessary for construction of a technological line manufacturing patterns and castings, providing, moreover, the components for mould manufacture.

The lost foam technology finds application in the manufacture of products that are later applied in automotive industry, aircraft and machine building sector.

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TECHNOLOGIA MODELI ZGAZOWYWANYCH – SZANSA DLA PRZEMYSŁU

Streszczenie. Przemysł odlewniczy wykonujący gotowe części dla różnych gałęzi przemysłu, w tym dla przemysłu samochodowego i rolniczego, zużywa rocznie wiele miliardów kJ energii. Prowadzone są badania zmierzające do zmniejszenia kosztów wykonania wyrobu. Przyjęte kierunki badań preferują następujące główne kierunki działania: zmniejszenie zużycia energii w procesach odlewniczych poprzez bardziej efektywne jej wykorzystanie, poprawa jakości wyrobu, procesy przyjazne dla człowieka i otoczenia. Takim kierunkiem badań jest wprowadzenie do wykonywania odlewów nowych, ekologicznych i energooszczędnych technologii, do których zaliczona została technologia modeli zgazowywanych (Lost Foam Technology). Wg danych amerykańskich, zastosowanie technologii modeli zgazowywanych może poprawić sprawność energetyczną procesu o 27%.

Słowa kluczowe: technologia modeli zgazowywanych, teraźniejszość, przyszłość, maszyny i narzędzia, wyroby odlewane.

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