



Manufacturing Processes

BEng Energy & Environmental (Level 4)

**Materials and Introduction to Manufacturing
(M4X01163)**

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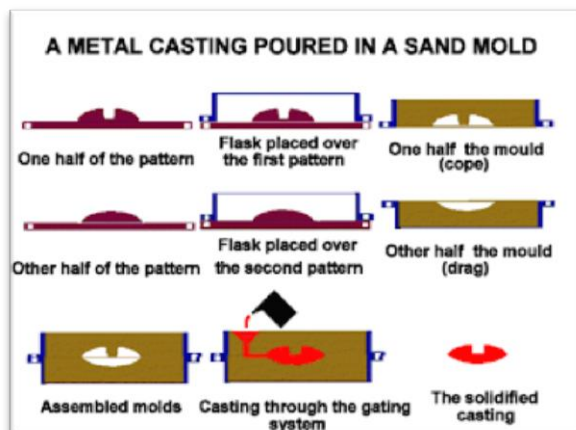
1. INTRODUCCION

The purpose of this report is to advise two manufacturing processes that unlike sand casting process will not only help the company reaching the surface quality that is desired but it will also help to reduce the cost and material waste of the procedure, as under my point of view, the main aim of every company is to grow by supplying the best quality products spending as little as possible on the product making.

2. RESEARCH ON SAND CASTING

I. SAND CASTING: BACKGROUND, ITS ADVANTAGES AND DISADVANTAGES

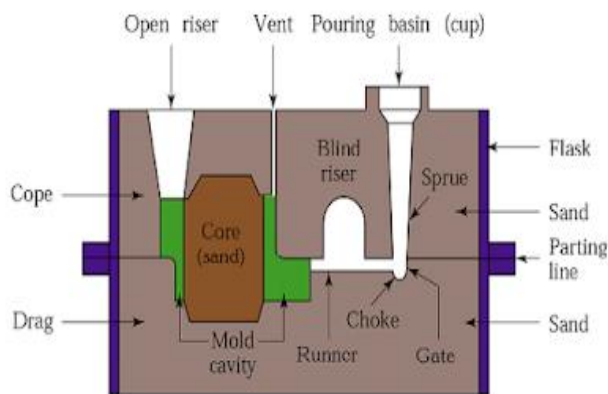
Sand casting has been the foremost used metal casting method in manufacturing since the twentieth century, once the automotive and machine building industries began to become additional in style.



In this process, a reusable pattern that is outsized to permit the melted metal to contract throughout cooling is formed of the form half to be forged. Once the pattern has been placed into the moulding box, this can be then fill with refractory sand that has been mixed with hardening agents to make a solid mould.

The moulding box is formed of two parts, top half also known as cope, where the drag part of the pattern is allocated. After creating the mould cavity, the entire pattern is then taken out of the mould and the box is finally placed together and clamped.

The metal goes to the mould cavity through a feeding system that is incorporated within the cope part of the moulding box. This feeding system consists of a pouring cup, a funnel that enables melted metal to be poured into the sand mould; a sprue, the channel through which the metal enters the mould;



the runner, a horizontal channel that directs the molten metal from the sprue to the mould cavity; filters, to get rid of impurities and finally, risers, reservoirs within the mould whose function is to supply liquid metal for the casting to compensate for shrinkage during solidification..

The cast part is removed by breaking the mould once the metal solidifies, which makes it impossible to use the same mould again, whilst the sand can be reused after going through a conditioning process.

There are some reasons why sand casting is so popular among manufacturing industries:

- Low tooling cost: there is almost no tooling during the casting method due to the sand being used as the tooling material.
- Versatile: there is not size limits or tough shapes to be cast.
- Wide variety of metals that can be cast: considering the sand resistance to high temperatures, sand casting is one of the only processes available on the market which enable metals with high melting temperatures to be cast.

Although sand casting is by far the most commonly used type of casting, there also are some disadvantages to using it, as for example:

- Finishing machine procedures are required: second machine processes are needed to polish the roughness or simply to regulate the dimensions of the metal parts created.
- Rough surface: this roughness could be a result of: rough porosity, due to the bubbles that the gas forms within the material as it cools; pouring metal defects caused by a lack of fluidity in the molten metal or cross-sections that are too narrow; metallurgical defects because of the used of bad quality metal or shrinkage defects, generated when material solidifies later than the surrounding sections and stops the metal flow impeding material fill into the section.
- Not acceptable for a mass production: since moulds are not re-usable, the time required for the preparation of each mould makes of sand casting a not appropriate possibility for a large batch production.

- High cost: longer time needed for the preparation of single moulds also means a higher labour costs

II. WHAT CAN BE IMPROVED FROM THE USED OF SAND CASTING?

Saving costs: industries should satisfy customer's expectations efficiently with a minimum number of rejections, as that is what will bring client's loyalty along higher profits. Considering the poor surface quality of metals that have gone through sand casting, high costs on secondary machine processes to improve those defects are necessary. Different metal casting methods which rich a higher quality surface at first will not only save the cost of going through those secondary machine techniques but will also prevent the company on employing more staff to perform the finishing processes.

Larger batch over smaller quantities: sand casting is mostly designated to cast small quantities of metals due to the large amount of time taken to design moulds, something that holds an organization from producing large batch of products and with it to achieve a higher profit.

Reduce environmental harms: the sand from sand casting is reusable in most of the occasions. 'However, sand fines develop with reuse. These particles are too small to be effective in moulds and have to be removed and often landfilled' (R. Masike and M.J. Chimbadzwa, 2013, p.29). Zinc, cadmium, copper and other metals may be found in wasted sand in quantities that could be lethal for the environment.

Surface quality: it is an undeniable fact that metals that have been cast through sand casting process do not show the best quality surface considering the roughness of the outside, condition that must be corrected in order to prevent the product from being rejected.

3. ALTERNATIVE METHODS TO SAND CASTING

I recommend two casting methods to substitute sand casting to manufacture metal products: die casting and investment casting.

Die casting was invented and patented in the mid-1800s to manufacture movable printing machine parts. Due to the success of this casting procedure on the printing industry, it soon began to be used in other sectors.

Die casting consists on pouring molten metal into a steel mould where the metal is then forced using high pressure. The mould or die is made from steel and if it is well maintained it can last hundreds of cycles before needing to be replaced

Advantages of die casting on manufacturing processes:

- High rates production: the majority of the times secondary machine processes are not necessary as the whole process is almost completed within the casting.
- Easy for mass production: Little or no machining is needed once the casting has finished, what means that it can produce small batches as well as large ones.
- Strength, weight and long lasting products: with die casting, thinner walls can be produced compared to other casting methods. Due to the strength of the walls, the metal produced will also last longer.

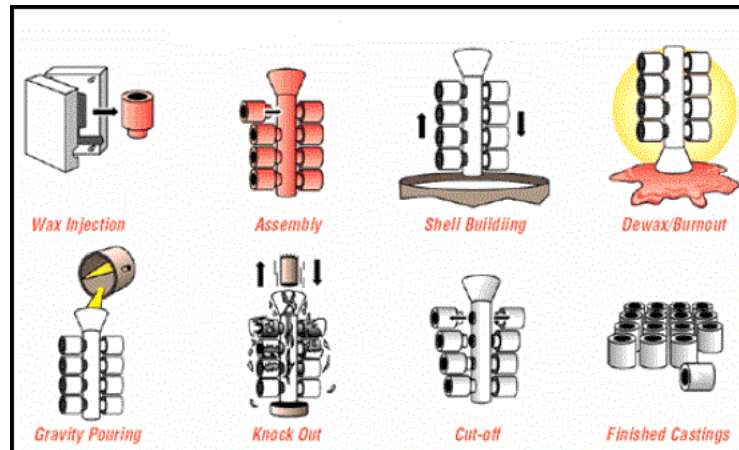
Disadvantages of die casting:

- A small variety all metals can be cast: die casting is mostly suitable for low melting metals and alloys, which reduce the possibility of materials to work with.
- High cost: casting machines dies and other related components are of a high cost.
- Porosity problems: "porosity occurs when air is found within the metal. This happens for numerous reasons: filling a mould too slow, the air used to force the metal into the mould has been able to escape or when gaps are left at the top of the die."
- Limited design options.

Investment casting or lost- wax casting is one of the oldest forms of casting, but it was not until the 19th century when its use became more popular, when dentists began using it to create dental pieces as crowns, inlays, veneers, etc. This usage augmented even more during the World War II due to the demand for "precision net shape manufacturing for specialized items which were not able to be shaped by more common method".

Investment casting is a process in which wax patterns are created by injecting wax into a metal mould. Once the wax patterns are created, they are attached to a wax bar and then dipped in wet ceramic until it gets dry and a ceramic layer is formed over the surface of the pattern. The next step after obtaining a ceramic layer is to heat the wax bar so that the melted wax drains out, leaving only the ceramic

which the
will be cast.
mould carries
heated to
degrees to
the mould
rid of any
as it can be
Afterwards,
is poured into
ceramic



mould in
metal pieces
The ceramic
on being
around 1000
strengthen
itself and get
materials left
wax or water.
molten metal
the hot
mould until

the material sets. The final step is to break the ceramic mould by vibrations and cut the individuals parts from the bar, leaving metal pieces with accurate dimensions and smooth surfaces.

Investment casting advantages:

- Smooth surface: an excellent surface finish is achieved with no secondary machine process.
- Fast and cheaper production: as there is almost no machine needed after casting, the production of metal materials is faster as well as cheaper compare to many other casting methods.
- Excellent dimensional accuracy: as a general rule, the smaller the casting the greater the dimension accuracy

Disadvantages of investment casting:

- Long process: due to the long cycle to cast metals, it is not economical to produce high volumes of products.
- High cost procedure: to achieve the perfect accuracy of metals that have gone through investment casting, they have to go through many complex steps that make the process relative expensive.
- Size limitation: considering equipment size, casting is limited to small size metals.

I. COMPARASION BETWEEN SAND CASTING AND DIE CASTING

Sand casting and **die casting** are the main metal casting processes used by manufacturing industries.

When comparing both methods it is worth pointing out the **costing**. While sand casting requires low investment on tooling, due to the low price of the patterns and sand that are used, die casting demands a higher cost because of how expensive dies can be. Dies or moulds in the die process can last hundreds of cycles, which makes it a more economic technique, as the moulds in sand casting are not re-usable and also the sand must be landfill most of the times. Furthermore, while in sand casting secondary machines techniques are needed to achieve a smooth surface, they are not necessary in most of die casting, considering the perfect smooth finish after the casting process.

As well as the costing, **sells volume** has to be taken into consideration. Sand casting is not able to produce a mass volume of metals as a result of the long-time taken to create moulds. On the other hand, a bigger production and with it an increase on sells is possible with die casting, since metals rarely need the action of secondary machines after being cast.

From an **environmental point of view**, sand casting consumes a great amount of energy compared to die casting, as a consequence of secondary machines use. Also, the sand from sand casting that is landfilled contains a wide variety of chemicals which are harmful for the environment. Even though die casting also causes harm to the environment, it is more eco-friendly considering that dies can be reused at the end of their lives; “dies are retooled to by shipping directly to specialty mills”.

Taking the **surface finish** into consideration, it is worth pointing out the big difference between metals that have been cast through sand casting and die casting. While sand casting provides a rough texture that is adopted from the sand mould, die casting produce metals with a smooth surface due to the rapid solidification of the metal.

II. COMPARISON BETWEEN SAND CASTING AND INVESTMENT CASTING

Due to the precision and accuracy of the investment casting process, **costs** can be significantly reduced as wasted materials are low when producing finishing components. Furthermore, the number of stages that are required to obtain finished pieces is minimum compared to sand casting, due to excellent surface finishes that are produced right out of the mould.

It is unquestionable that sand casting is more suitable than investment casting to produce a **high volume** of metal parts, considering that investment casting requires longer production cycles than any other casting process. However, unlike sand casting, exceptional **surface qualities** are achieved with investment casting, what results in preventing a company from wasting time and money.

When it comes to the **environment impact** that a casting process can cause, investment casting is not as harmful as sand casting, as wax can be reused most of the times unlike sand from sand casting. Also, since secondary machine processes are not needed with investment casting, energy consumption is reduced significantly.

Despite the already mention poor **quality surface** finish of sand casting metals, bodies produced by investment casting have the best quality surface finish. The surface quality of the casting is adopted from the smoothness of the wax pattern.

4. RECOMMENDATION

If die casting and investment casting are compared, they appear to be two very similar processes. Although investment casting produces the best quality surface that can be achieved through a casting process, I highly recommend die casting as the main casting process to use for the manufacturing of bushes and sleeves. My recommendation is based on the following reasons:

- ❖ Even though investment casting tooling is cheaper, die casting tooling is more reliable as well as last longer, which makes of die casting a better option on the long run. Therefore die casting is ideal for larger productions and increase the annual volume of metal products when compared to investment casting, what also leads to an incremental profit.

- ❖ In order to understand which process could reduce costs from sand casting, it is necessary to know which method cycle takes longer as this may impact the supply quantities affecting the downtime and resulting in a loss of productivity. Investment casting cycles take longer and is also more laborious than die casting, therefore die casting would reduce costs.
- ❖ Both, die casting and investment casting are eco-friendly and generate almost no waste material.

5. CONCLUSION

The overall conclusion is that sand casting is not as good to manufacture sleeves and bushes as die casting or investment casting could be. Even though sand casting has a low cost for tooling and may cast any size and type of materials, there are other processes, as for example die casting and also investment casting, which could significantly improve surface quality of metals produced and reduce company cost as well as waste materials.

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