LABORATORY 14 REPORT

Sand casting processes

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1. AIM OF THE LABORATORY

The aim of this laboratory session was to understand the fundamental principles and technological steps involved in the sand casting process, which is one of the most widely used methods for metal forming. During the exercise, a complete casting procedure was performed, including the preparation of the mould, pouring of molten metal and evaluation of the resulting casting quality.

The objective was to learn how the composition and properties of the moulding sand, mould design and solidification conditions influence the dimensional accuracy, surface finish and occurrence of defects in the final casting.

2. MOULDING SAND COMPOSITION

Table 1. Moulding sand composition

No.	Component	Fraction [%]	Discussion (the purpose of the application)
1.	silica sand	80-85	Main element of the moulding sand. It provides the basic structure of the mould, ensures dimensional stability and withstands high temperatures during metal pouring.
2.	bentonite (clay)	8-10	When mixed with water, it acts as a binder. It gives the moulding sand cohesion, plasticity and sufficient green strength, so the mould keeps its shape during handling.
3.	coal dust	2-5	Improves the properties of the moulding sand. During pouring, it creates a reducing layer on the mould surface, which helps prevent metal penetration and improves the surface finish of the casting.
4.	water	2,5-5	Activates the bentonite binder, giving the mould the required plasticity and strength. It allows the sand grains to bond properly and ensures the mould can be formed and compacted effectively.

3. QUALITY OF THE MOULD

The mould of our workpiece was (as all) created of two parts – upper, called cope, and lower, called drag. We first started with the lower part, which was not ideal, however as said during laboratories it is never perfectly similar to the pattern. To lower the number of imperfections we've cleaned loose grains and crumbles, as during the pouring process they would break down and create an imperfection on the molding. After creating the vent holes, allowing the resting air and steam to escape the mold and providing better quality, we've checked the hardness of our mould. The results were: 86, 88, 87, 88, 87 and 86, which are not optimal ones. As found during research, the best values for drag are placed in 90-95 range, which are not far from our results. To achieve higher value of this parameter, the ramming of the moulding sand should be done with higher force and frequence. This inaccuracy could create erosion and in the end misshape the workpiece. The upper part was also cleaned by us before pouring to achieve the highest quality of the molding possible. Here process was similar as before, and also in the end we've checked the hardness. The results were as follows: 85, 89, 84, 89, 92 and 85 which almost all are in the scope of cope parameter – 85-90.

Before closing the moulding frames with the patterns we also placed on both lower and upper special powder, called dry parting. It is because it allows to disconnect smoothly both parts of molding without breaking down the shapes.

4. SKETCH OF THE CASTING MOULD

Task 3: Make a sketch of the casting mould.

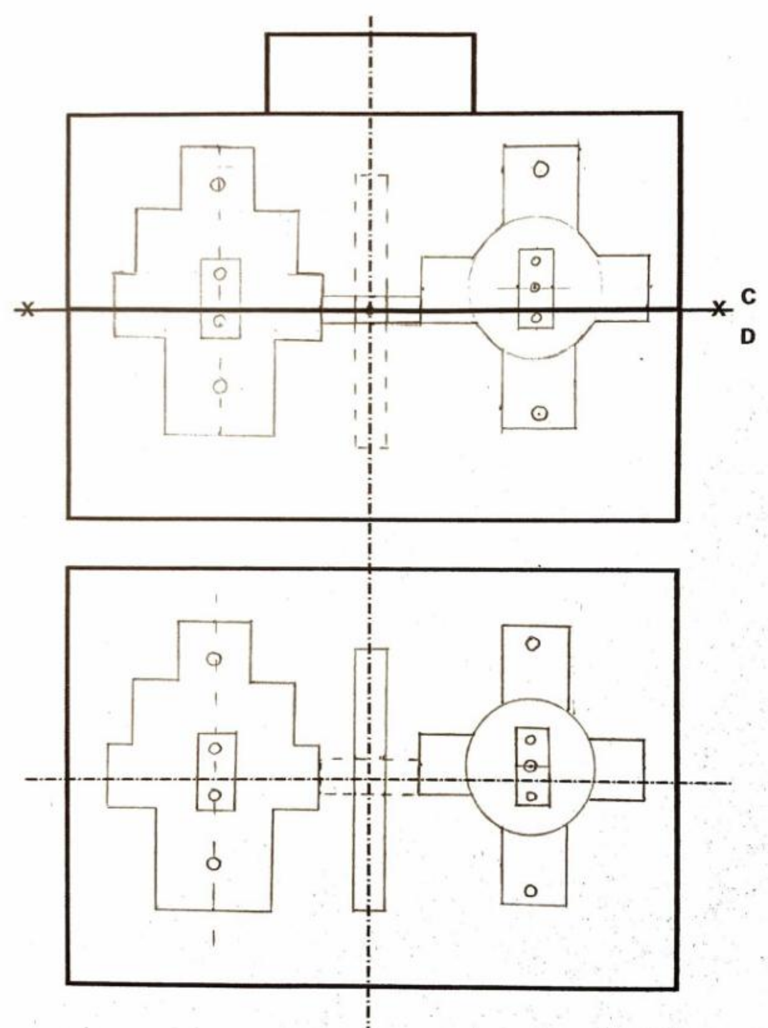
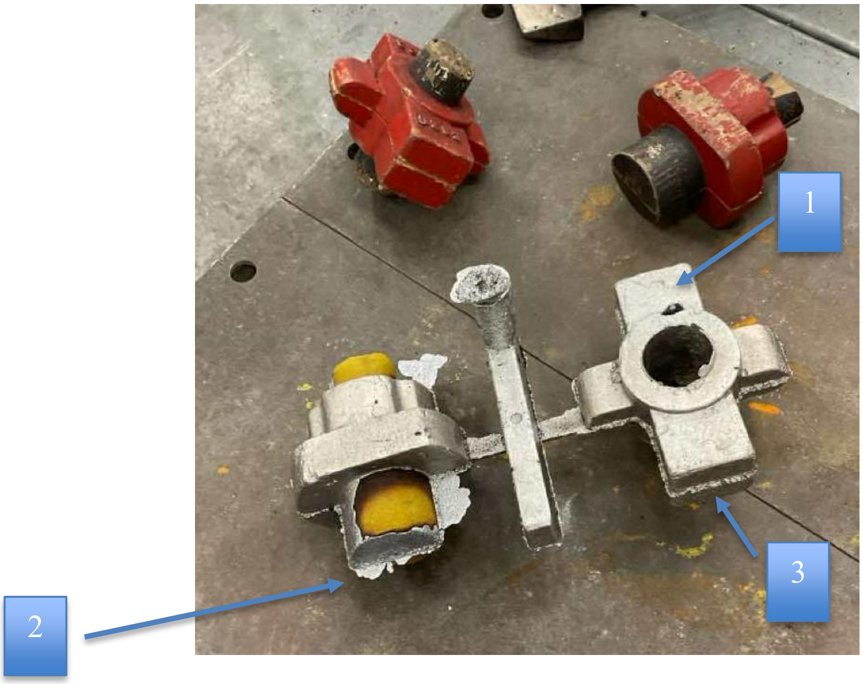


Figure 1. Sketch of the casting mould

5 . QUALITY OF THE CASTING



The sand casting carried out in the laboratory shows several visible defects that reduce the overall quality of the casting.

First, a clear hole defect can be seen, caused by shrinkage during solidification when the metal was not properly fed as it cooled, leading to internal voids and local weakness.

The second defect is the excessive distance between the two functional parts of the casting, which indicates dimensional inaccuracy of the mould and poor control of pattern positioning, making assembly and fitment difficult.

The third defect is the presence of irregular, “weird” edges and flashes along the parting lines, which is typical for sand casting because the mould is made of relatively coarse, granular material, by contrast, in investment casting using wax patterns and ceramic shells the edges are much sharper and almost invisible.

Surface roughness is also clearly higher in this sand casting: the softer, less compacted mould surface and relatively large sand grains imprint their texture on the metal, producing a rough finish. In general, the harder and more densely packed the mould surface, the smoother the casting, therefore processes like die casting, which use hard metallic dies with fine surface finish, produce much better quality and smoothness, as can be seen when comparing this sand cast piece with the die-cast part visible in the second photograph.

5. CONCLUSIONS

Jakub Ejtaszewski 257122

Sand Casting is an efficient and cost-effective process allowing to produce complex shapes made from metal. Thanks to this, it is widely used in many industries, such as automotive, aerospace, marine and much more. During our laboratories we've had possibility to take part in the whole process, f. ex. on forming the mold, pouring the melted metal and observing the results of work. They were not ideal – many defects such as holes, inaccuracy in the dimensions and edges along the side of the molding could be distinguished. According to research, it occurred due to shrinkage of the material during bad cooling process and not ideal pattern positioning. Summing all the things up, sand casting process is not a complex one, however to achieve ideal shape and characteristics of the molding, different points in the process need to be considered.

Karol Chądzyński 257092

This laboratory session gave us a practical understanding of the sand casting process, highlighting the direct link between mould preparation and the quality of the final piece. We observed that our mould hardness, particularly in the lower part, was slightly below the optimal range, which taught us that more forceful ramming is necessary to prevent erosion and shape distortion. The analysis of the cast workpiece revealed typical defects such as shrinkage holes and a rough surface finish, caused by issues like improper feeding and the coarse texture of the moulding sand. Ultimately, comparing our results to other technologies made it clear that while sand casting is effective, it naturally yields a rougher finish and lower precision than methods like die or investment casting.

Natasza Beczkowska 257090

This laboratory session allowed us to understand the sand casting process and evaluate how mould preparation, material properties and pattern quality can influence the final outcome of the casting. We observed that the hardness values for the drag were slightly below the optimal range, showing that the moulding sand was not compacted firmly enough, which can lead to surface defects on the casting. Also, the patterns used in the laboratory were rather old and worn, and contributed to surface imperfections and inaccurate dimensions. The rough surface finish and occurrence of defects such as shrinkage holes or irregular edges confirm that sand casting is not a high-accuracy method. Despite these drawbacks and the lengthy process time observed for a single part, sand casting is very cost-effective and suitable for making parts with complex shapes.

Sofía Ramos Garcia 905734

In conclusion, while the core process (compaction) was strong (Hardness > 85), the ultimate quality failed due to insufficient feeding system design and the limitations imposed by old tooling tolerances.

Lavinia Sarmiento Puente 905486

Sand casting is more than just melting metal, it's a careful balance where skillful hands ensure the part's correct size and shape. A mould with the right hardness is the best defense against defects, showing that the quality of a metal product starts with the strength of a handful of sand.

Michał Ogłuszka 257104

Our laboratory meeting definitely revealed the importance of moulding sand properties, particularly hardness. The resulting casting exhibited several typical defects: a clear shrinkage hole due to inadequate molten metal feeding during solidification, excessive dimensional inaccuracy shown by the wide gap between functional parts and irregular flash along the parting lines. Taken into account tje old tooling tolerances and system overall this roughness and weird edges confirm the limitations of using a coarse, granular mould material compared to high-precision processes. Ultimately, the exercise demonstrated also that ramming consistency and solidification control directly dictate the dimensional accuracy and surface finish of the final component.

Julia Lubnauer 257101

This laboratory session helped us understand sand casting process and how mould preparation and pattern condition influence the final product. The hardness measurements of the drag were a bit below the recommended range, showing that the sand was not packed tightly enough, which increases the chance of defects during casting. We also saw that the patterns used in the exercise were worn, which directly affected the surface and accuracy of the cast parts. The finished castings showed typical sand-casting issues, such as shrinkage holes, uneven edges and a rough surface. These observations confirm that sand casting has limited precision compared to more advanced casting methods. Despite these drawbacks and the longer processing time, sand casting is still a low-cost and practical technique, especially when producing complex shapes where very high accuracy is not required.

Adam Jóźwiak 257097

During this laboratory session I learned that the quality of the casting depends mainly on how well the sand mould is prepared. Even small mistakes in ramming, moisture or the condition of the patterns caused visible defects such as shrinkage holes, uneven edges and incorrect dimensions. Most problems came from the early stages of preparing the mould rather than from the metal pouring itself. The coarse structure of the sand also limits how smooth the final surface can be, which is normal for this casting method. Despite these limitations, sand casting is still very useful because it is inexpensive, flexible and good for producing parts with complex shapes. Overall, the exercise showed that careful work at every step is necessary to achieve a casting of acceptable quality.

Maciej Gara 257093

The overall quality of the sand casting was determined by deficiencies in the work process and the limitations of the moulding materials. Insufficient ramming force led to sub-optimal mold hardness, creating higher cast surface roughness than typical of sand casting. The failure to provide adequate feeding and metal's shrinkage resulted in the hole defect. Poor control over pattern positioning, mould alignment as well as material exhaustion led to a significant dimensional inaccuracy observed as an excessive distance between functional parts. Consequently, to achieve higher quality it is recommended to increase ramming power, buy newer parts and use more experienced worker than students.

Julia Pietrzak 257125

The aim of the laboratory was achieved, as we carried out the complete sand-casting process and clearly observed how each step influences the final casting quality. The whole process, from preparing the mould to removing the casting, took 35 min 35 s, plus about 5 min of cleaning, and we carefully recorded the time of every stage so we could see the progress of the operation. The casting showed several typical sand-casting defects, such as shrinkage holes, large gaps between the two parts, flashes along the parting line and a rough surface, confirming the strong influence of moulding sand composition, ramming, mould design and metal feeding. Comparing our sand-cast part with the die-cast piece also demonstrated that better control of these parameters can significantly improve dimensional accuracy, surface finish and quality. In general, the experiment helped us understand how process parameters influence defects and how the sand casting process can be improved in future work.

Kinga Berenc 257117

Sand casting is a relatively inexpensive method for obtaining complex shapes. During the labs, we had the opportunity to familiarize ourselves with the mold-making and the casting process. The production time for such a mold is long - in our case, it was exactly 35 minutes and 35 seconds. The quality of the casting depends, among other things, on the hardness of the sand in the mold, which in our case was between 85 and 89. This turned out to be the cause of the rough surface of the casting. The harder the sand, the smoother the surface. Other defects also appear on the casting, such as holes, uneven edges, inaccurate dimensions, and a mark along the parting line. These are the results of material shrinkage, the quality and positioning the patterns. All these observations allow us to conclude that sand casting is an effective method when perfect accuracy is not required. It is influenced by many different factors, especially during mold creation.

Zofia Walas 257131

This laboratory session showed how strongly mould preparation and pattern condition affect the final casting quality. The defects we observed, such as dimensional inaccuracy , rough surfaces and shrinkage holes, resulted mainly from insufficient mould hardness and worn tooling. These issues confirmed that even small errors in ramming or alignment can significantly influence the result. Despite its limitations in precision, sand casting remains practical and cost - effective for producing complex shapes. Overall, the exercise helped us understand how each step of the process contributes to the final outcome.

Stanisław Kotowicz 257100

While previous conclusions have correctly identified the trade-off between cost and precision, a deeper analysis of our data reveals that the primary failure mode was not just general “low hardness,” but specifically the asymmetry between the Cope and the Drag.

The measurements indicated that the Cope (upper part) achieved acceptable hardness levels (up to 92), whereas the Drag (lower part) consistently fell below the optimal 90-95 range. This discrepancy is critical because the Drag supports the hydrostatic pressure of the molten metal. The “excessive distance” defect and dimensional inaccuracy were likely inaccuracy mold wall movement in the softer lower section under this pressure, rather than just pattern positioning errors.

Furthermore, there is a likely correlation between this mechanical weakness and the thermal defects observed. The “shrinkage hole” is typically attributed to poor feeding, but in this case, it was likely exacerbated by the mold walls expanding in the soft Drag. This expansion increased the casting's internal volume beyond what the feeder was designed to supply, creating a vacuum during solidification. Therefore, the presence of coal dust to improve surface finish was rendered ineffective because the fundamental mechanical stability of the sand—governed by the water-bentonite activation—was compromised in the lower half of the assembly. Future improvements should prioritize equalizing compaction force across both mold halves to maintain volumetric stability.