The 56th International October Conference on Mining and Metallurgy
22-25 October 2025, Bor Lake, Bor, Serbia
www.ioc.tfbor.bg.ac.rs

DOI: 10.5937/IOC25264P *Original scientific paper*

CREATION OF SINTERING CUP FOR LABORATORY SINTERING INSTALLATION

Petar Petrov

Faculty of metallurgy and material science, University of chemical technology and metallurgy,
8 "St. Kliment Ohridski" blvd., 1756, Sofia, Bulgaria
pbpetrov@uctm.edu, 0009-0006-6957-0097

Abstract

Globally, not all ores and concentrates in the field of ferrous metallurgy meet the requirements for direct processing into a final product. The concentrates obtained as a result of various enrichment operations, the fines from ore extraction, throat dust and others must be agglomerated before their next use. The importance of the sintering method has grown especially much due to the use of ever-increasing quantities of iron concentrates. On the other hand, the agglomerated products, which have sufficiently high strength, uniform granulometric and chemical composition, allow for the intensification of the blast furnace process. In the Republic of Bulgaria, there is currently no capacity for the production of agglomerated product for ferrous metallurgy. This limits the possibility of modern research on the sintering process of waste materials, such as throat dust from steelmaking, fine scale from rolling production, fine fractions of promising raw materials for our country, etc. In this regard, at the University of Chemical Technology and Metallurgy, Sofia, Department of Metallurgical Technologies, Electrical Engineering and Electronics, there is potential for experimentation in laboratory conditions on the agglomeration of fine raw materials of importance in metallurgy. However, it is necessary to create agglomeration equipment suitable for laboratory conditions. The aim of the development is to design and create a compact sintering cup as the first stage of the creation of a laboratory sintering installation.

***Keywords**: design and creation of a laboratory sintering cup*

1. INTRODUCTION

To design the elements of the sintering assembly unit (consisting of a cup, a collector and a stand), specialized literature was used, as well as an available semi-industrial sintering installation located in a laboratory hall at the Department of Metallurgical Technologies, Electrical Engineering and Electronics [1 - 4]. When determining the dimensions of the individual elements, the available technological space in the room where the sintering cup will be used was taken into account - a laboratory at the same department. The volume of the cup must meet the needs of the furnace units in the laboratory, in terms of the volumetric amount of charge that they can process. The elements of the cup and the collector must be made of a steel billet with a thickness of at least 3 mm, suitable for welding [5, 6].

2. EXPERIMENTAL

After careful analysis, it was found that it was necessary for the upper square section of the sintering cup to be 100 x 100 mm in size, and the lower one to be 80 x 80 mm. The height of the cup was determined to be 170 mm. This would form an effective working volume of 1000 cm^3. With regard to the collector, a constant square section of 100 x 100 mm in size was determined. Its height should be 140 mm [7 - 9]. The stand for the assembled unit should ensure relatively quick disassembly and relocation of the equipment for cleaning, repair, etc. It should be calculated so that the distance from the bottom of the collector to the base, where the assembled sintering unit will stand, is at least 50 mm [10]. Another key point in the design is to provide space for a sealing element between the cup and the collector. Therefore, it is necessary to have a rim of a certain width, both at the lower edge of the cup and at the upper edge of the collector. It is also planned

that the cup will be removable after the end of the temperature process, but during the process it will be firmly assembled to the collector. This leads to the creation of holes in the mentioned sides and their adhesion to each other by means of washers with metric bolts and nuts. The temperature reading and the vacuum reached will be controlled by thermocouples and a manometric system, for which holes will also be provided [10, 11]. Last but not least, it is necessary to create a hole in one of the walls of the agglomeration collector, through which air will seep through the agglomerating layer. The diameter of the hole is set to be up to 50 % of the height of the collector wall, and a pipe of the appropriate size with a flange to it will be attached to it for the purpose of further connecting the agglomeration unit with the rest of the agglomeration installation. It is necessary to create a grid between the cup and the collector to prevent the entrainment of larger particles from the batch as a result of the vacuum created under the grid during sintering [11].
As a result of the research study conducted, the individual elements of the agglomeration aggregate were schematically created, shown in points 2.1, 2.2 and 2.3.

2.1 Schematic representation of the elements of the sintering cup

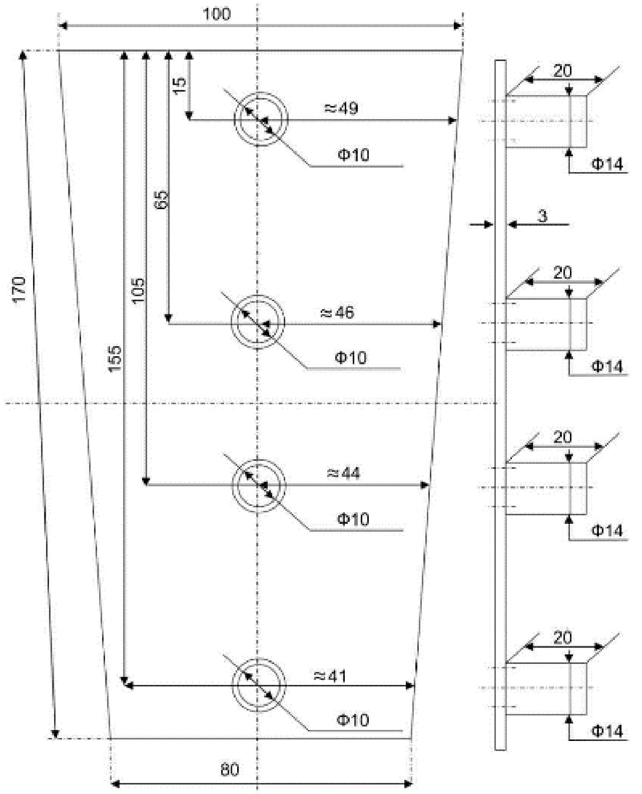

Figure 1. Wall (front) with thermocouple connections

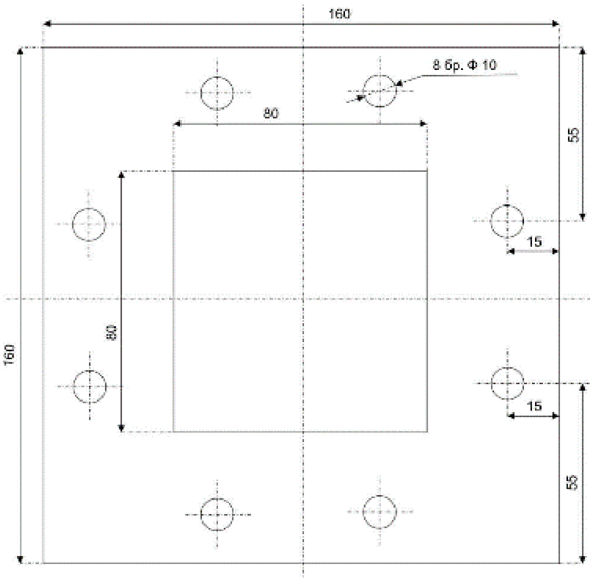

Figure 2. Wall (side) with handle, 2 pcs.

The back wall is designed like the front wall, but without the thermocouple connections.

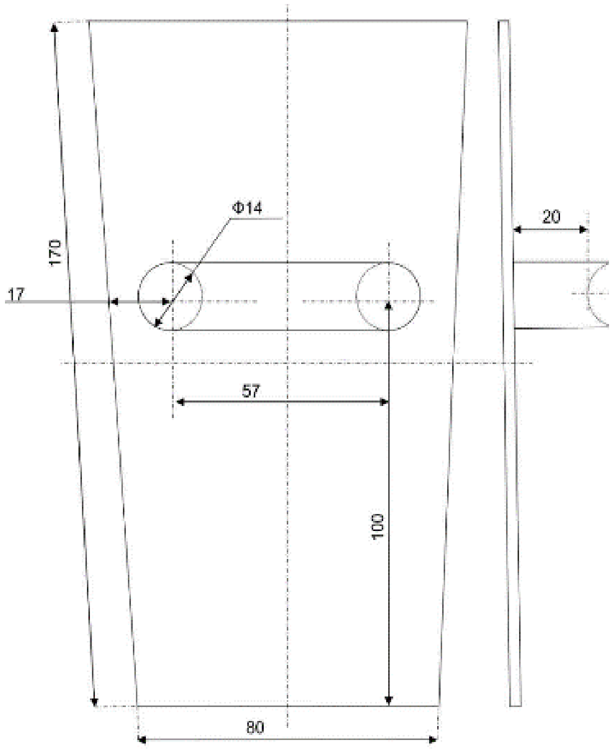

Figure 3. Bottom rim

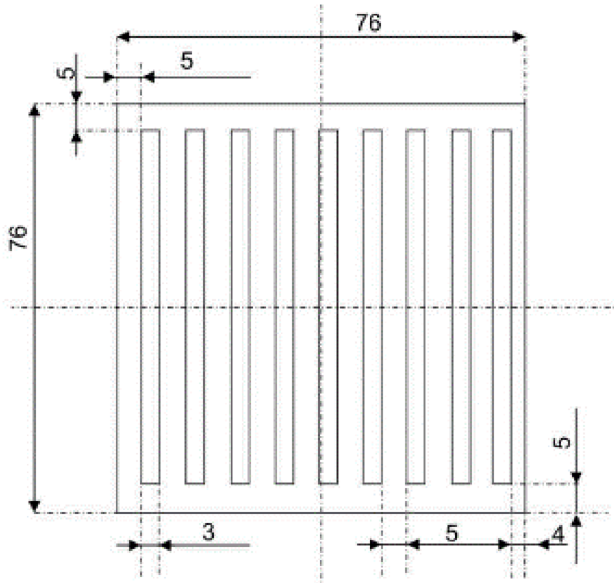

Figure 4. Grid

The upper rim is like the bottom rim, except for the eight holes, which are not needed, and the internal dimensions are 100 x 100 mm.

2.2 Schematic representation of the elements of the sintering collector

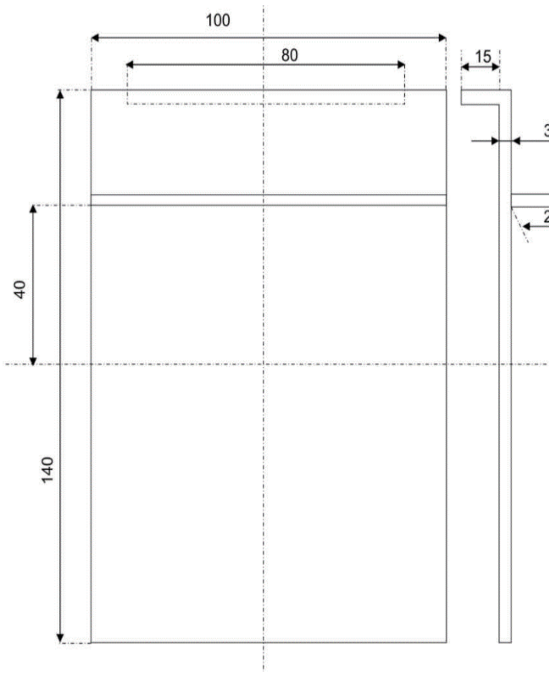

Figure 5. Wall (front and rear) with bases for grid and stand, 2 pcs.

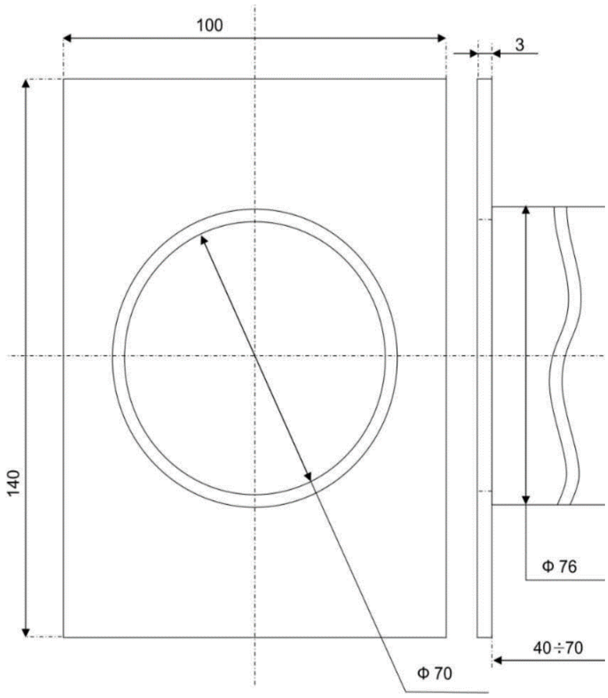

Figure 6. Wall (side) with outlet to filter

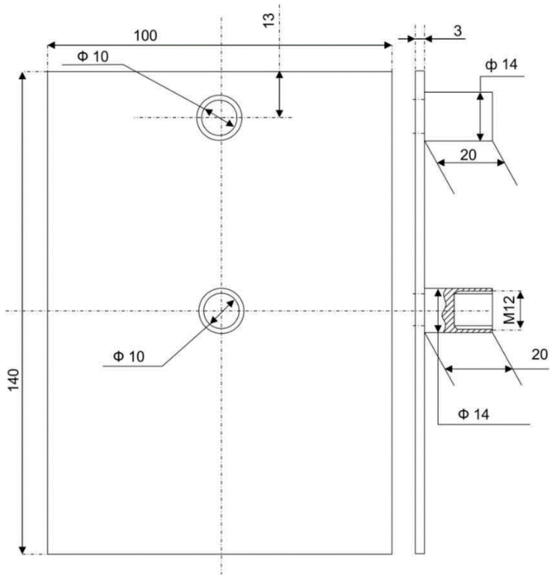

Figure 7. Wall (side) with connections for pressure gauge and thermocouple

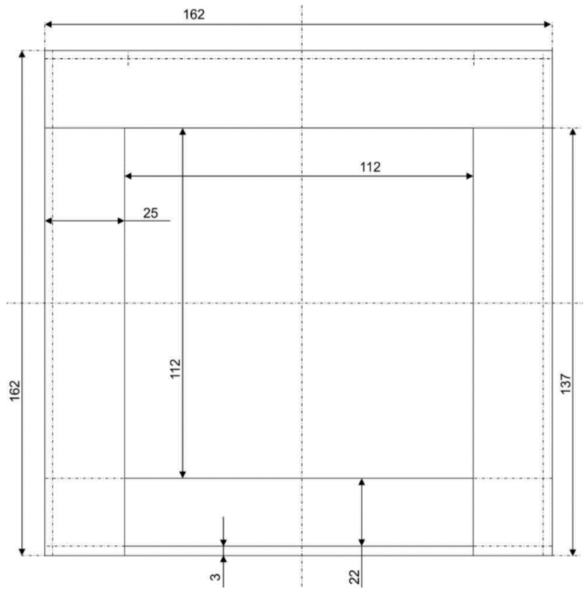

Figure 8. Stand – top view

The bottom of the sintering collector is designed as a flat square plate with dimensions of 110 x 110 mm.
The collector has one rim with the same dimensions as in Fig. 3, with the inner square opening measuring 100 x 100 mm.

2.3 Schematic representation of a stand

The total height of the stand is set to be 190 mm, and the distance from the base to the top is 165 mm.

3. RESULTS AND DISCUSSION

In accordance with the designdocumentation and with the help of a cutting machine, a series of cut-out boards were made, representing blanks for assembling the cup, collector and stand, Fig. 9.

Figure 9. Cutting of steel plates

Figure 10. Forming the necessary holes for thermocouples, pressure gauge and exhaust gases

The fabrication of the holes for thermocouples, pressure gauge and exhaust gases is presented in Fig. 10.
Using a welding machine, the individual cut-out panels were joined to form a sintering cup, collector, and stand for them, shown in Fig. 11.

Figure 11. Welding of elements according to the design

Figure 12. Assembled sintering facility

The final stage of the fabrication is the assembly of the sintering unit, using bolts and nuts through the rimes of the cup and the collector. The assembly is shown in Fig. 12.

4. CONCLUSION

A small sintering cup with the possibility of application in laboratory conditions has been designed and created. The compact size of the facility is expected to intensify research activities related to sintering of fine fractions of materials, which are raw materials for metallurgy. Using the cup in a laboratory will allow students to become practically acquainted with the operation of such a sinter unit and to gain a more detailed understanding of the sintering process.

ACKNOWLEDGEMENTS

The author thanks graduate engineer Anislav Dimitrov, majoring in Metallurgy, for his assistance.

REFERENCES

[1] B. Drakaliyski, Ts. Tsanev, Cast Iron Metallurgy, Technics, Sofia, 1998. (in Bulgarian)
[2] A. Avramov, I. Ivanchev, T. Tsanev, Iron Metallurgy, Technics, Sofia, 1994. (in Bulgarian)
[3] E. Wegman, Influence of the height of the charge layer on the process of sintering of agglomerate under pressure, Bulletin of the Ministry of Ferrous Metallurgy, Moscow, 1975. (in Russian)
[4] E. Wegman, Production of iron ore sinter and pellets, ITN, v. 17, 1977. (in Russian)
[5] A. Kamenov, Complex modeling of agglomeration and pelletizing of ores, Metallurgy, M., 1978. (in Russian)
[6] Yu. Yusfin et al., Production of sinter and pellets, Directory, Metallurgy, Moscow, 1984. (in Russian)
[7] A. Sigov, V. Shurkhal, Sinter process, Technique, Kyiv, 1969. (in Russian)
[8] A. Zhunev et al., Improvement of the sinter processing unit – one of the ways to improve the quality of sinter, Works of Uralmekhanobr, Sverdlovsk, 1984. (in Russian)
[9] V. Korotich, Fundamentals of Theory and Technology of Preparation of Raw Materials for Blast Furnace Melting. Metallurgy, Moscow, 1978. (in Russian)
[10] L. Heng, J. Whiteman, ISIJ International, 29 (1989) 24-32.
[11] I. Valchev, Ts. Tsanev, Manual for exercises in cast iron metallurgy, Tehnics, Sofia, 1979. (in Bulgrian)