Global Scientific Review
A Peer Reviewed, Open Access, International Journal
www.scienticreview.com
Volume 6, August 2022
ISSN (E): 2795-4951

Improvement of Technology of Liquefaction of Gray Cast Iron Alloy

Saidmakhamadov Nosir
PhD candidate, Tashkent state technical university, University Street 2, Tashkent, Uzbekistan
Turakhodjaev Nodir
DSc professor, Tashkent state technical university, University Street 2, Tashkent, Uzbekistan
Abdullaev Kamol
docent, Namangan engineering – construction institute, Islam Karimov Street 12, Namangan
Khasanov Jamshidbek
PhD student, Andijan Machine – Building Institute, Bobur Shox Avenue 56, Andizhan
Tadjiev Nuritdin
researcher, Tashkent state technical university, University Street 2, Tashkent, Uzbekistan

Abstract: In the article, the technology of liquefaction of thin – walled lifting window detail was developed and summarized. Due to the lack of a model of the lifting sunroof detail, the lifting sunroof detail was first cast in a special vacuum box mold from duralumin alloy using a combustible model. Then it was poured into a sand – clay mold from Ch 24 cast iron alloy. The chemical composition and microstructure of the poured sample were examined using a scanning electron microscope. As a result, a quality cast product was obtained.

Keywords: ferrous metals, gray cast iron, sand – clay molds, graphite structure, pearlite, cementite, ferrite, vacuum furnace, model, thin – walled surface, ferroalloys.

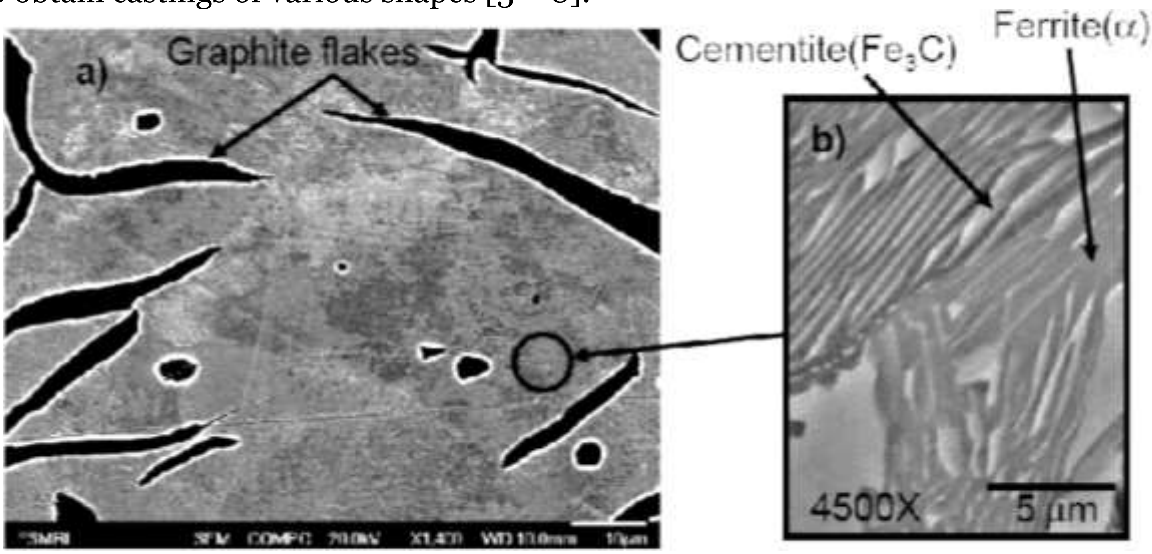
Introduction

Today, ferrous metals are widely used in industry due to the high demand for ferrous metals, their important physical and mechanical properties, as well as the fact that iron ores are widely distributed in nature, the production of steel and cast iron is cheaper than other non – ferrous metals and it is easy to produce.

The mechanical properties of gray cast iron depend on the composition of the alloy, as well as the shape and size of the graphite inclusions. Pearlitic gray cast irons are stronger and ferritic gray cast irons are more plastic. Due to the low strength of graphite and the fact that cast iron is not bonded to iron, the base metal of the cast iron, the areas occupied by the graphite are voids and cracks can form there. They show the influence of strength and plasticity of cast iron.

It is very important to obtain resource – saving, uncomplicated molding process, quality and cheap, competitive casting products by casting thin-walled cast products made from gray cast iron in sand – clay molds. Although thin – walled details are produced in various ways, their production in sand – clay molds is a complicated process [1, 2].

Today, the most ductile alloy among metals and alloys is gray cast iron. Therefore, today in the field of gray cast iron casting, the alloy with good fluidity properties fills the cavity of the mold well and ensures a quality casting. Gray cast iron contains a large amount of carbon in the form of free graphite. The main reason why it is called gray cast iron is that when this type of cast iron is broken and the broken part is seen, the broken part appears gray due to reflection. Therefore, such cast iron is called gray cast iron. Gray cast iron is also known as cast iron due to its high ductility to the mold. In cast iron, graphite dampens vibrations well and is resistant to resonances. In addition, the high fluidity of graphite gray cast iron makes it possible to obtain castings of various shapes [3 – 8].



1 – picture. SEM microstructure of pearlitic gray cast iron, showing (a) graphite particles surrounded by a pearlitic matrix, (b) cementite (Fe3C), ferrite and black graphite

Figure 1 shows pearlite, cementite, ferrite and graphite structures. Therefore, the presence of free graphite in free gray cast iron is one of the important factors for increasing the fluidity of the alloy [9 – 14].

MATERIALS AND METHODS

Currently, several research works are being carried out under the cooperation of Tashkent State Technical University, Tashkent State Technical University, Uzbek – Japanese Youth Innovation Center and JSC "Uzmetkombinat" enterprise. 2 – the thin – walled sliding roof used in the rolling shop was cast from SCH 24 – 44 cast iron in the "Casting – Mechanics" shop of "Uzmetkombinat" JSC enterprise using new innovative casting technologies.

Due to the complex shape of the raised window detail, a vacuum furnace was used to cast its model. In this case, the model was first prepared from polystyrene material on a CNC Router digital machine. When preparing the part of the raised window, it was first prepared in 3 parts due to the complexity of the model. The pieces were then glued together to make the model whole. The process of making the model can be seen in Figure 2.

2 – picture. The process sequence of the part of the raised window made of polystyrene material on the CNC Router digital machine

The prepared model was coated with fire – resistant paint and dried in the open air for 12 hours.

The dried model was placed in a vacuum box at the "DetalMash" LLC production enterprise.

First, sand with a large fraction was placed in the cell up to a thickness of 200 mm 3 – picture.

3 – picture. The process of placing the model in a mold with a special pocket

4 – picture. The ready state of the mold with a special pocket

Next, a prefabricated model with two injection channels and four feeders was deployed. The cage was then filled with sand and sealed with an airtight synthetic bag over the top of the sand. The main purpose of this is to provide a vacuum when air is drawn from a special vacuum forming mold 4 – Fig. 5 atm from a special box mold. under pressure, air was sucked through special pipes until the liquid alloy was poured into a mold with a special pocket from the bottom of the mold.

In an induction furnace, Al alloy was liquefied by adding one percent of Cu. Duralumin alloy was poured into two ladles heated at 680^{o} C and poured into a specially prepared mold with a cell. The pouring process can be seen in pictures 5, 6.

5 – picture. The process of heating duralumin alloy

6 – picture. The process of casting the alloy in two buckets into a special pre-made pocket mold

The cast model was removed from the special cell mold and the model was polished on a polishing machine to smooth its thin – walled surfaces. The process of extracting the casting from the mold with a special pocket can be seen in pictures 7, 8.

7 – picture. The process of extracting a casting from a mold with a special cell

8 – picture. View of the finished model

Then, in the induction furnace of 180 kg, the composition of SCh 24 – 44 gray cast iron was calculated according to the requirements of GOST, and the furnace was first loaded with large solid materials, after metal liquefaction, and then with small solid materials [15 – 20]. The recommended chemical composition for SCh 24 – 44 gray cast iron is presented in Table 1.

Table 1

Recommended chemical composition for SCh 24 – 44 gray cast iron

Cast iron brand	Chemical composition, %							
	C	**Si**	**Mn**	**P**	**S**	**Cr**	**Ni**	**Cu**
SCh 24 – 44	2,9 – 3,2	1,2 – 1,6	0,8 – 1,2	0,1 – 0,2	0,10 – 0,15	0,2 – 0,3	0,3 – 0,5	0,2 – 0,4

After complete liquefaction, the alloy was removed from slag and FeSi 65 and FeMn 90 ferroalloys were added to the furnace, M 10 copper phosphorus as a modifier. Liquid metal was poured into a ladle at a temperature of 1450 – 1460° C and poured into a pre – prepared casting mold at a temperature of 1430 – 1440° C.

After four hours of cooling, the cast product cast in the foundry mold was removed from the mold, and the surface of the sand was cleaned of mold sand to cast a smooth thin – walled skylight detail.

Result

After 6 hours of standing in the sand – clay mold, the thin – walled cast product was removed from the mold, the sand on the surface of the cast product was cleaned, and its mechanical and physical properties were checked.

The chemical composition of the sample was determined on a spectral analyzer model "SPECTROLAB – 10 M" and is given in table 2.

Table 2

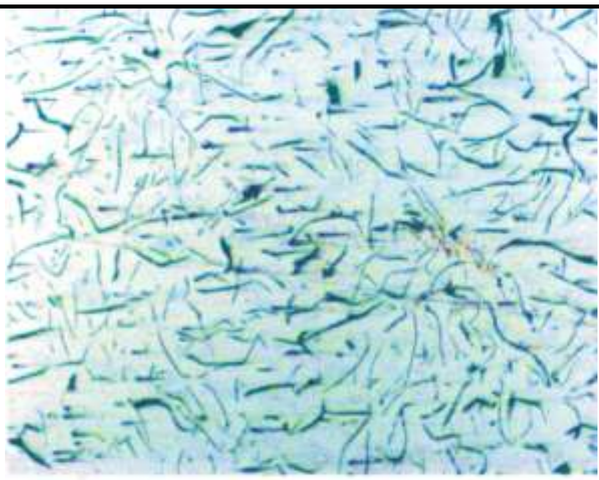
Chemical composition of liquefied cast iron of the SCh 24 – 44 brand

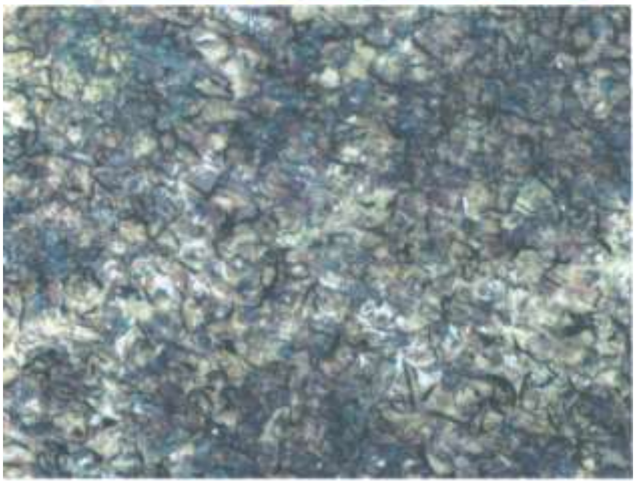
Cast iron brand	Chemical composition, %							
	C	Si	Mn	P	S	Cr	Ni	Cu
SCh 24 – 44	3,0	1,4	1,1	0,2	0,14	0,3	0,4	0,2

The samples were processed step by step using abrasive papers with a surface of 500, 1000, 1500, 2000 and 4000 microns. The surface of the samples was polished using WC (tungsten carbide) paste. After the polishing process, the samples were treated with reagents according to GOST 5639 – 82. Hydrochloric acid (HCl) and picric acid ($C_6H_2(NO_2)_3OH$) were used as reagents. The main purpose of reacting the structure of the samples is to divide the structure of the samples into phases and study them under a microscope.

As a result, it became possible to separate gray cast iron structures into clear boundaries. The structures of the samples were viewed on METAM PB – 23 brand and SEM scanning electron microscopes at x100, x3000 magnification.

Global Scientific Review
A Peer Reviewed, Open Access, International Journal
www.scienticreview.com
Volume 6, August 2022 ISSN (E): 2795-4951

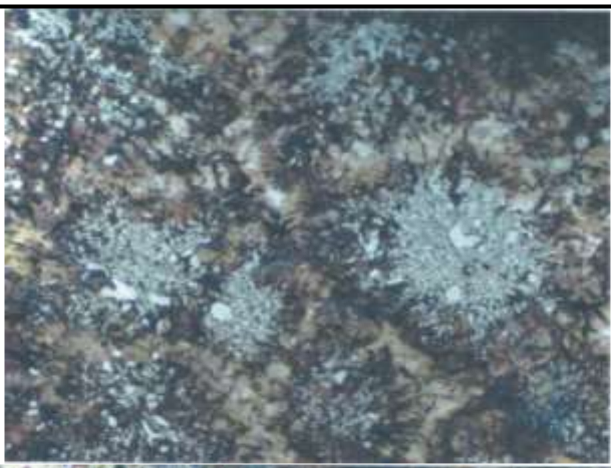


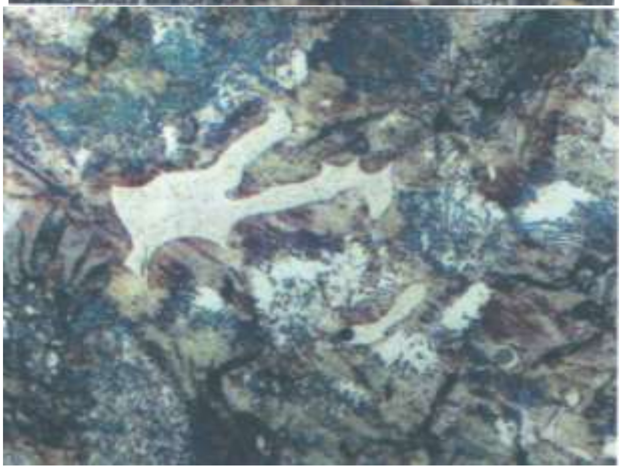


9 – a – picture. METAM PB – 23 microscope image of the specimen at x100 magnification

9 - b - picture. METAM PB – 23 microscope image of the specimen at x100 magnification

Figure 9 – a shows that the sample is composed of plate graphite, and Figure 9 – b shows the structure of plate pearlite, ferrite and graphite.

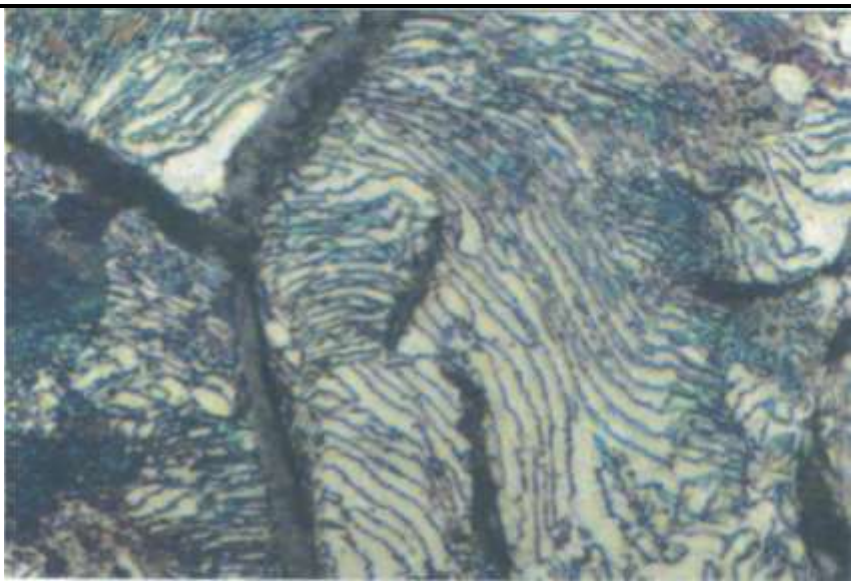




10 – v – picture. METAM PB – 23 microscope image of the specimen at x100 magnification

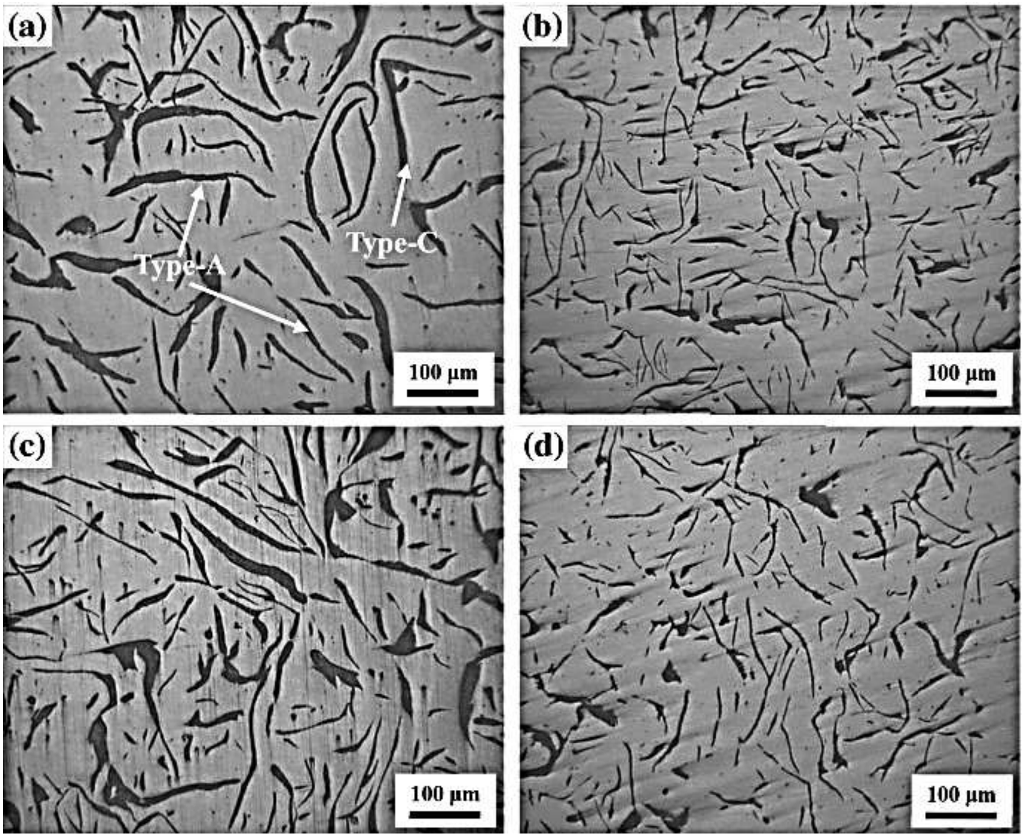
10 – g – picture. METAM PB – 23 microscope image of the specimen at x500 magnification

Figures 10 – v, g show that the samples are composed of plate pearlite, ferrite, graphite, phosphide eutectic, the upper zone of the sample is seen in figure 10 – v, and the middle zone in figure 3 – g.



11 – picture. METAM RV – 23 microscope image of the specimen at x100 magnification

Figure 11 shows a sample with plate pearlite, ferrite and free graphite.



12 – picture. SEM image of the microstructure at x3000 magnification using a scanning electron microscope

Figure 12 shows that graphite fragments have different shapes and thicknesses. In addition, free graphite separation increased due to increased silicon content in gray cast iron. As a result, the fluidity of gray cast iron increased, and a quality thin – walled cast product was obtained.

Conclusion

In order to increase the fluidity of gray cast iron for liquefaction of thin-walled casting products, MF 10 copper phosphorus was introduced into the furnace and the fluidity of gray cast iron was increased. In addition, the amount of silicon in the alloy was increased, as a result of which it was observed that free graphite was separated more. As a result, the ductility of gray cast iron increased even more. Also, due to the smallest wall thickness of the cast thin-walled cast products being 8 mm, the temperature of the alloy was increased to 1450 – 1460° C in order to better move the alloy between the thin walls and better fill the mold cavity. By raising the temperature of the alloy, the fluidity was further increased, and the mold cavity was well filled. In conclusion, casting of thin-walled cast products was achieved using the methods listed above.

Reference

[1] Bekmirzaev, S., Saidmakhamadov, N., & Ubaydullaev, M. (2016). "Obtaining sand – clay casting". Theory and practice of modern. Russia, (4 (12)), 112.
[2] Саидмахамадов Н. и др. Технология предотвращения пор в отливах //Экономика и социум. – 2019. – №. 4. – С. 661 – 672.
[3] Саидмахамадов Н. и др. Общая технология производства порошково констукционных материалов //Экономика и социум. – 2019. – №. 4. – С. 673 – 680.
[4] Саидмахамадов Н., Хайдаров У., Эгамбердиев Б. Улучшение подготовки технологий методом специального сливания //Экономика и социум. – 2019. – №. 4. – С. 651 – 660.
[5] Turakhodjaev, N., Saidmakhamadov, N., Turakhujaeva, S., Akramov, M., Turakhujaeva, A., & Turakhodjaeva, F. (2020). Effect of metal crystallation period on product quality. Theoretical & Applied Science, (11), 23 – 31.
[6] Turakhodjaev, N. D., Saidmakhamadov, N. M., Zokirov, R. S., Odilov, F. U., & Tashkhodjaeva, K. U. (2020). Analysis of defects in white cast iron. Theoretical & Applied Science, (6), 675 – 682.
[7] Shirinkhon, T., Azizakhon, T., & Nosir, S. (2020). Methods For Reducing Metal Oxidation When Melting Aluminum Alloys. International Journal of Innovations in Engineering Research and Technology, 7(10), 77 – 82.
[8] Djahongirovich, T. N., & Muysinaliyevich, S. N. (2020). Important features of casting systems when casting alloy cast irons in sand – clay molds. ACADEMICIA: An International Multidisciplinary Research Journal, 10(5), 1573 – 1580.
[9] Nodir, T., Nosir, S., Shirinkhon, T., Erkin, K., Azizakhon, T., & Mukhammadali, A. (2021). Development Of Technology To Increase Resistance Of High Chromium Cast Iron. The American Journal of Engineering and Technology, 3(03), 85 – 92.
[10] Nodir T. et al. Development of 280X29Nl Alloy Liquefaction Technology to Increase the Hardness and Corrosion Resistance of Cast Products //International Journal of Mechatronics and Applied Mechanics. – 2021. – T. 154. – C. 2021.

[11] Turakhodjaev N. et al. Quality improvement of the steel melting technology in an electric arc furnace //ACADEMICIA: An International Multidisciplinary Research Journal. – 2021. – T. 11. – №. 7. – С. 48 – 54.
[12] Saidmakhamadov N., Abdullaev K., Khasanov J. Теория и практика современной науки //теория и практика современной науки Учредители: ООО" Институт управления и социально-экономического развития". – №. 2. – С. 3 – 8.
[13] Nosir S. et al. Development of High Chromium White Cast Iron Liquefaction Technology //Eurasian Journal of Engineering and Technology. – 2022. – Т. 4. – С. 123 – 127.
[14] Nosir S. et al. Development of technology for obtaining quality castings from steel alloys //Eurasian Journal of Engineering and Technology. – 2022. – Т. 5. – С. 135 – 138.
[15] Nosir S. et al. Technology for Obtaining High Quality Castings from Resistance White Cast Iron //Eurasian Journal of Engineering and Technology. – 2022. – Т. 5. – С. 139 – 148.
[16] Nosir S. et al. Technology to Increase the Hardness and Resistance of High–Chromium White Cast Iron //European Multidisciplinary Journal of Modern Science. – 2022. – Т. 6. – С. 665 – 670.
[17] Nosir S. et al. Development of Technology for Production of Wear – Resistant Cast Products //Middle European Scientific Bulletin. – 2022. – Т. 25. 516 – 522.
[18] Nosir S. et al. Improvement of the Technology of Obtaining High – Chromium Wear – Resistant White Cast Iron //Spanish Journal of Innovation and Integrity. – 2022. Т. 07. 498 – 504.
[19] Nosir S. et al. Study of the Effect of Copper Addition on Secondary Carbides with High Chromium Wear – Resistant White Cast Iron //International Journal of Innovative Analyses and Emerging Technology. – 2022. Т. 2. 37 – 43.
[20] Valida B. et al. Development of Technology of Liquefaction of Steel Alloys in Electric Furnaces //Spanish Journal of Innovation and Integrity. – 2022. Т. 8. 65 – 69.