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ANALYSIS OF CAST IRON MELTING TECHNOLOGY IN ELECTRIC ARC FURNACE

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Abstract: This article examines the problems that occur when liquefying cast iron in electric arc furnaces and how to overcome them. With the widespread use of electric arc furnaces in foundries, the search for solutions to its problems is urgent today.

Keywords: cast iron, gray cast iron, liquefaction, foundry, lifting roof, caolin, DSP – 0.5, electric arc furnace, ladle, model, sand – clay, mold, ferrosilicon, GOST 1412 – 85, alloys.

Introduction. One of the important tasks in the world today is to obtain high-quality, inexpensive thin-walled cast products based on improving the strength, quality, and mechanical and operational properties of parts used in the engineering and production industry obtained by the casting method. Also, in order to reduce energy and fuel consumption, the need for lightweight products with high strength is increasing. By using gray cast iron alloys or by reducing its thickness while maintaining its strength, casting parts obtained in the automotive industry reduce the cost per vehicle by almost 15% compared to parts made from steel or aluminum alloys. As a result of the increased demand for thin-walled cast products in the world, many techniques and technologies have been developed, which require the production of high-quality, cheap and competitive parts. For reference, gray cast iron accounted for the largest market share of 37% in the global steel and cast iron manufacturing market in 2021. Currently, as a result of the increased demand for cast products, many techniques and technologies have been developed, which require the production of high-quality and cheap, competitive parts. One of the urgent problems facing the whole world is the step-by-step development of the technical and economic development of many branches of the engineering and national economy industries. Because the development of all sectors of the world's population depends on the level of development of mechanical engineering is an undeniable reason [1 – 3]

Main part. Before loading solid materials, it was checked whether the oven was suitable for work, whether there were any cracks or cracks in the

lining part. 450 kg of secondary gray cast iron slag was used as solid material for the furnace, and ferromanganese FeMn17 GOST 4755 – 91, ferrosilicon FeSi75 GOST 1415 – 93, and copper phosphite CuP₂ GOST 4515 alloys were used as modifiers. After loading secondary cast iron slag into the furnace and applying 170 voltage and 50 – 75 A current to the graphite electrodes through copper cables, coke was loaded according to GOST 3340 – 88 in order to create a stable electric arc in the furnace

The mold material presented in the table below is obtained from kaolinite binder Al₂O₃, 2SiO₂, 2H₂O minerals, which is used as mold clay in many foundry enterprises, its density is 2.58 – 2.60 g/cm³ and the melting temperature is 1750 - 1790 °C and kaolin clay when heated to 100 – 140 °C, hygroscopic and 350 – 580 °C clay loses its moisture and turns into metakaolinite (Al₂O₃ * 2SiO₂), in which the process of losing the binding properties of clay is called “liamotization of clay”. At 900 – 1050 °C, metakaolinite separates into amorphous components Al₂O₃ and SiO₂ – 3Al₂O₃ 2SiO₂ (mullite) is formed between 1280 °C. This component has no binding properties and is more of a refractory material, on the basis of the composition presented in the table 1, the mold material for the lifting roof detail was prepared in the foundry mechanics workshop [4 – 6].

SCH 24 - 44 gray cast iron GOST 1412 - 85, which is used in the casting of lifting window parts at the O'zmetkombinat enterprise, and in the samples with the proposed new composition, the amount of elements is given in table 1 below.

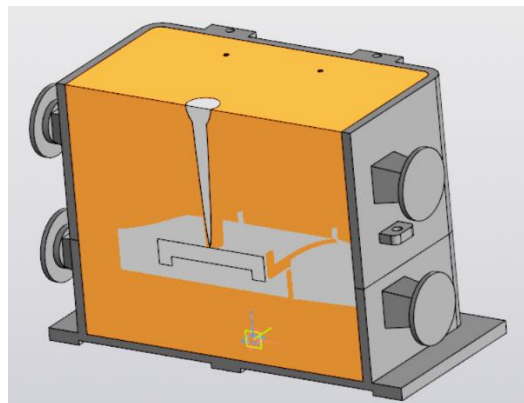
Table 1

Cast iron mark	C	Si	Mn	P	S	Cr	Cu	Ni
CЧ24 – 44	2,9 – 3,2	1,2 – 1,6	0,8 – 1,2	0,7 – 1,0	0,1 – 0,2	0,2 – 0,3		0,03 – 0,04
N – 1	2,9 – 3,4	1,2 – 1,6	0,8 – 1,2	0,7 – 1,0	0,1 – 0,2	0,2 – 0,3	0,1 – 0,2	0,03 – 0,04
N – 2	2,9 – 3,6	1,2 – 1,6	0,8 – 1,2	0,7 – 1,0	0,1 – 0,2	0,2 – 0,3	0,3 – 0,5	0,03 – 0,04

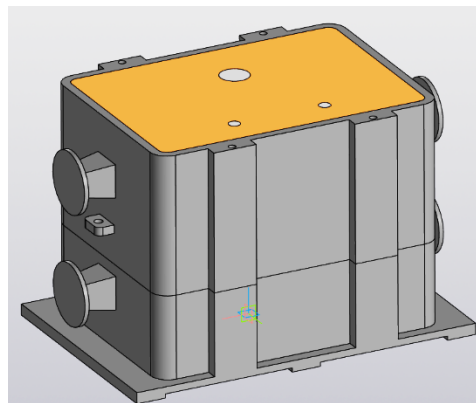
In order to improve castability and mechanical properties, modifiers were added to cast iron in order to create additional crystallization centers of graphite. Due to its high ductility, gray cast iron is also called cast iron. CuP₂ 0.3 - 0.5% copper

phosphite was added in the furnace to increase the flowability and hardness of the cast raised roof part. According to GOST 4515, it is known that copper phosphite CuP₂ contains up to 10% phosphorus, and phosphorus is a harmful element of cast iron and

increases hardness and corrosion resistance. In order to increase castability and mechanical properties, modifiers were added to cast iron in order to create additional crystallization centers of graphite. In order to increase the fluidity and hardness of the raised roof part being cast, modifiers ferromolybdenum (FeMo70) were loaded in the furnace and copper phosphite (CuP_2) in the furnace. 45 kg of secondary cast iron was used for one part



a)



b)

Picture 1. A figure of the placement of the mold of the lifting roof detail a) a cropped image of the placement of the models in the mold b) flasks layout of models

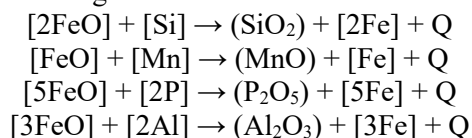
Solid materials were loaded into the furnace, and the openings for loading and pouring liquid alloy into the furnace were closed by mixing quartz sand and water as plugs. DSP – 0.5 electric arc furnace lining used for liquidizing the lifting window detail, this furnace covered with magnesite brick and steel sheet on the surface is shown in picture 2. The walls of the prepared molds are checked for cleanliness, the composition is 9 – 12% aluminum oxide fireclay, 5 – 6% electrocorundum, zirconium 2.9 – 4.2%, 1.5 – 2.5% refractory clay, 1,5 – 2.9% caolin, 4.5 – 5% liquid glass and 1-2 mm anti – scald paint is applied and heated in CH_4 natural gas at a temperature of 300 °C every hour when the temperature rises from 100 °C. after the watch was held, it was cooled along with the furnace. If the humidity in the mold exceeds the specified amount, it will cause the liquid alloy to boil when it is poured into the mold [7-9].



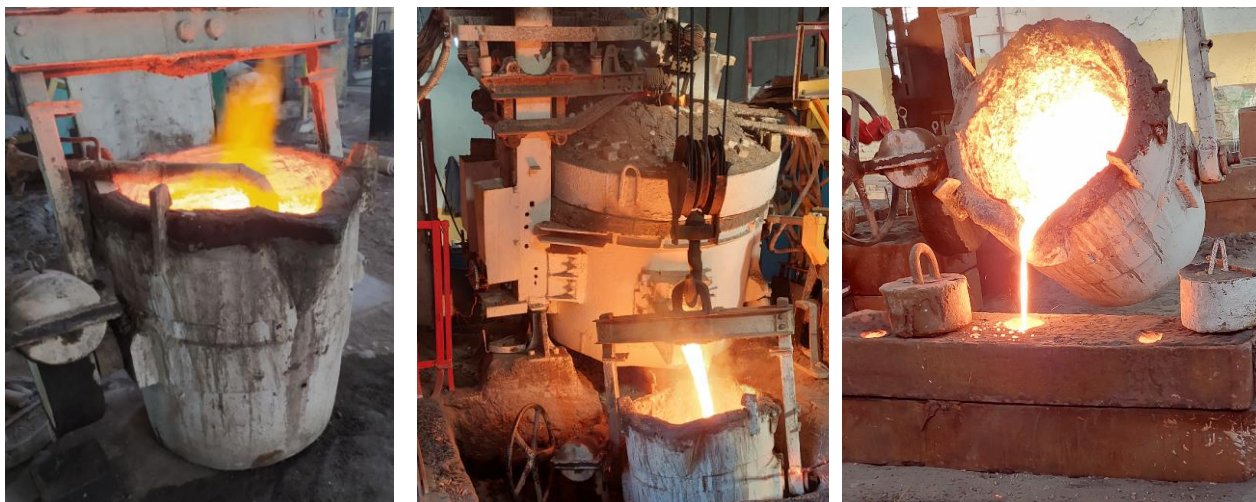
Pic. 2. An electric arc furnace used to liquefy gray cast iron for a lifting roof detail

of the raised shingle, and taking into account the addition of 0.225 kg of copper phosphite to this concrete material, the amount of phosphorus in it was 0.05%, even if it was calculated at a maximum of 10%. That is, it was ensured that the amount of phosphorus does not exceed the requirements of GOST 1412-85 for the liquefied gray cast iron alloy, the scheme of placement of the mold is shown in picture 1.

After the gray cast iron alloy was completely liquefied in the furnace, the temperature of the liquid alloy was determined to be 1440 – 1457 °C using a thermocouple Positherm. Before pouring it into the mold, the mold was heated to 750 – 800 °C in a gas burner for 45 – 55 minutes (pic 2). The main purpose of heating is that the inner part of the crucible is filled with quartz sand (85%) and liquid glass (15%), and if liquid alloy is poured into the crucible in a cold state due to the humidity of the crucible, due to the high temperature of the liquefied alloy, the alloy will be oxidized due to splashing around. A certain amount of FeSi 75 and Al was added to the molten alloy in the furnace, and the recovery of Fe in FeO was carried out based on the following reaction:



Ferromanganese FeMn17 0.56 kg of ferrosilicon FeSi75 1.7 kg of liquid alloy was loaded into the furnace 10 minutes before the casting. The temperature of liquid gray cast iron alloy was checked using a thermocouple Positherm device and poured into a crucible at a temperature of 1447 °C, and SiO_2 quartz sand was loaded for slag separation and the separated slag was removed from the crucible (slag mass 15.7 kg), these processes are shown below in pic 3.



The process of heating the ladle at a temperature of 700 – 800 °C

Ladle casting of liquefied gray cast iron alloy

The process of casting a liquid alloy into a mold

Picture 3. The process of pouring liquefied gray cast iron alloy into a mold in an electric arc furnace

Results. The process of liquefaction of gray cast iron alloy lasted for 1:10 hours, and the separated slag was taken out of the furnace (slag mass was 6.6 kg, metal burning in the furnace was 4 – 5 percent, i.e. 11 – 15 kg) and poured into a sand-clay mold. The total weight of the liquid alloy was 450 kg, of which an average of 8 – 10%, i.e. from 36 to 45.0 kg of slag was separated (slag density 2.5 gr/cm³, slag composition SiO₂, MnO, FeO, P₂O₅ consisting of non-metallic inclusions) and metal burning averaged 3-4 percent and amounted to 12 – 18 kg.

Conclusions. When samples of DSP – 0.5 liquefied in an electric arc furnace were poured into

a sand-clay mold, the release of free graphite from carbon depended on the amount of silicon included in the alloy and the cooling rate. The influence of elements on the mechanical, physical, and technological properties of gray cast iron alloy samples was considered. The technology of out-of-furnace processing of liquid alloy has been developed for obtaining thin-walled castings from gray cast iron. This makes it possible to increase the fluidity of the liquid alloy by 9-11%. The technology of in-furnace processing of liquid alloy has been developed for obtaining thin-walled castings from gray cast iron.

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СОДЕРЖАНИЕ

1. Химия и физикохимия композиционных материалов и нанокomпозитов

Улугова М.М., Панжиев О.Х., Негматов С.С., Талипов Н.Х., Бозорбоев Ш.А. Исследование физико-химических процессов формирования структуры водостойких композиционных материалов на основе модифицированных гипсовых вяжущих	3
Негматова К.С., Ходжаева Д.Н., Рузиева Б.Ю., Абед Н.С., Шамсиева С.С., Жалилов Ш.Н., Пирматов Р.Х. Исследование механизма взаимодействия в процессе модификации мочевиноформальдегидных смол с выбранными модифицирующими минеральными наполнителями путем применения современных физико-химических методов	8
Sayitova N.N., Ibragimova K.S., Tangyarikov N.S. Piro-, Rodo-, mezoporfirin va ularning komplekslarini 3D-metallar bilan suvsiz erituvchilarda erishi va erish jarayonlarini qiyosiy o'rganish	10
Исаева Н.Ф. Цеолитные адсорбенты: экологически безопасные решения для очистки природного газа и воды	13
Кулдеев Е.И., Негматов С.С., Тастанов Е.А. Изучение физико-химических характеристик руд диатомитовых месторождений Казахстана	15
Xushvaqto'v S.Y., Jurayev M.M., Bekchanov D.J., Muxamediev M.G. Tarkibida azot va oltingugurt tutgan funksional ion almashinuvchi materiallarga Pb (II) ionlarining sorbsiyasi	19
Xusenov A.Sh., Ashurov M.M., Abdullaev X.O., Raxmanberdiev G. Plyonkaning gidrofilligi va mexanik mustahkamligiga inulin va uning hosilalari ta'sirini aniqlash	22
Mirzoyeva G.A., Fayziyev J.B., Nazarov N.I. Rux oksidi asosida ftalotsianin birikmasining sintezida katalizatorning ta'siri va fizik-kimyoviy tahlili	25
Islomova Yu.O'., Abdushukurov A.K. N-akriloloksokarbazolni polipropilen bilan modifikatsiyalash reaksiyasi	29
Qurbanova L.M., Eshmamatova N.B., Akbarov H.I., Bekmurodova M.E., Ismoilova M.D. Po'lat korroziyasida anilinning fosfatli birikmasi asosidagi ingibitorlarning fizik-kimyoviy xususiyatlari.....	31
Ibragimov T.E., Nurullaev Sh.P. Clay adsorbents Cr ⁶⁺ adsorption ionization	35

2. Физико-механика и трибология композиционных материалов

Xasanov J.N., Turaev A.N., Davulov Sh.B. Analysis of cast iron melting technology in electric arc furnace	39
Abdulhaqova Sh.B., Rasulov A.X. Kompozitsion materiallarni yaratishda ishlatiladigan talk turlarining xususiyatlarini o'rganish usullari	42
Ризаева Н.М., Сайдумаров Б.М. Исследование состояния поверхности стали на границе раздела металла и околонины при нагреве	43
Tursunbayev S.A., To'raxodjayev N.D., Nurdinov Z.B., Mardonaqulov Sh.O'., Hudayqulov Sh.O'., To'rayev A.N. Alyuminiy qotishmalarining korroziyabardoshliligiga germaniy elementini ta'siri	45
Каримов Ш.А., Шакиров Ш.М., Абдумаликова М. Кукун материаллари босим остида электроконтакти пиширишда зичланувчилиги ва электрокаршилиги	48
Khasanov J.N., Saidkhodjaeva Sh.N., Turaev A.N. Microstructure of gray cast iron and its effect on mechanical properties	52
Искандарова М, Атабаев Ф.Б., Турсунова Г.Р., Абдуллаев М.Ч. Влияние керамического кирпича физико-механические свойства портландцемента	55
Норхужаев Ф.Р., Аралова К.Б., Маматкулов Р.Ш., Аширов А.А. Технологические возможности способов упрочнения деталей машин и инструментов	57

3. Разработка и технология получения композиционных материалов

Улугова М.М., Панжиев О.Х., Негматов С.С., Талипов Н.Х., Бозорбоев Ш.А. Исследование физико-механических свойств и разработка технологии получения водостойких модифицированных композиционных материалов с применением модифицирующих добавок	60
Рахматова Н.Ф., Шахакимова А.А., Рахматуллаева Н.Т., Абдуллаева Д.К. Получение энергоносителей из нефтешлама и других вторичных ресурсов методом пиролиза	62
Xidirova M., Abdugapporova G., Mahkamov M., Shaxidova D. Epoksid smolasi, polietilen-poliamin va mahalliy bentonit gilmovalari asosida polimer kompozitsiyalar olish va ularning sorbsion xossalarini o'rganish..	68
Жуманиязов А.Б., Тураходжаев Н.Д., Тухтамуродов Б.Т., Сабиров М.З. Получения качественных литейных изделий применяя правильные термобарьеры на 3D принтерах	72
Махкамова Л.К., Абдукаримова С.А., Ботиров А.М., Атакузиева Д.Р. Волокнообразующие сополимеры акрилонитрила с N-морфолин-2-хлорпропилакрилатом	74
Шакиров Ш.М., Каримов Ш.А., Даминов Л.О. Темир кукуни асосли композицияларни пресслашда ён девор босими ва уни аниқлаш	77