International Journal of Science and Engineering Invention(IJSEI)
Volume 02 Issue 03 May 2016, page no. 1 to 8
Available online at www.isij.in

Research Article e-ISSN 2455-4286 Open Access

# INCREASE OF THE GENERAL TECHNOLOGICAL YIELDIN THE SECURING OF GRAY IRON WITH GRAPHITE SPHEROIDAL FOR THE METÓDO OF SPILLED VIBRATORY

**Rigoberto Pastor Sánchez Figueredo, MSc*[1], Asdrubal Braulio García Domínguez, PhD[2], Roberto Pérez Rodríguez, PhD. Professor[3], Fausto Hernán Oviedo Fierro Professor**

[1]Ass. Prof. University of Holguin, Mechanical Engineering Department, Cuba

[2]Prof. University of Camagüey Exploitation, Production and Recovery Equipment and Parts Study Center, Cuba

[3]University of Holguin, CAD/CAM Study Center, Cuba

[4]National Polytechnic school "Rubén Orellana "Faculty of Mechanical Engineering. Department of Materials.Quito, Ecuador

**Email** - [1]rigo@facing.uho.edu.cu, [2]asdrubal.garcia@reduim.edu.cu, [3]roberto.perez@facing.uho.edu.cu, [4]fausto.oviedo@epn.edu.ec

**Abstract** Expert in smelting of the University of Holguín, Camaguey of Cuba and the National Polytechnic School of Ecuadorhave developed research that improves the efficiency of production of articles of iron with spheroidal graphite, these products have found wide uses in the metalworking industry, due to its mechanical properties and better casting properties than steel, but the high cost of technological processes unreturning in its production, is an ongoing problem of metallurgy find alternative technologies competitive, sustainable and sustainable. With this research addresses the need to produces cast iron with spheroidal graphite at lower cost, higher quality and shorter, with less impact the environment and ensuring the stability of the technological environment. Grasp to result; it establishes an instructional technology in the production of spheroidal graphite iron applying the new method of spilled vibratory.

**Keywords**: general technological yield, graphite spheroidal, spilled vibratory, nodular iron.

## Introduction

The metal Smelting industry is fundamental for the manufacture of the necessary technological base in the development of a country, for the proper nature of the technological processes that shape it constitutes one of the industrial branches with major production cost, [1] standing out in this sense the fadings of ferrous alloys, inside which a wide industrial aftereffect has the called smeltings, between them, gray smelting, malleable smeltings, with vermicular graphite and smeltings with graphite spheroidal [2].

On the fadings production with graphite spheroidal and its application in the industry metal mechanical for the method of spilled vibratory, turns this investigation

The current fadings production with graphite spheroidal, turns out to be limited by the low metallic yield, high index of rejection and high metallic loss, which act unfavorably in the general technological yield, [11] generating a low level of modification of the gray iron to laminate [2].

Experts of the University of Holguín of Cuba and the National Polytechnic School of Ecuador they demonstrate in details all the steps that compose the technological instruction that allows to establish the method of spilled vibratory in the iron securing with graphite spheroidal, bearing in mind the vibration speed in the increase of the General Technological Yield and Technician realizes an evaluation - economic, with an analysis of the general technological yield, applying the traditional technology and comparing it with the general technological yield of the proposed technology.

## Precedents

The realized bibliographical searches and the consultations with experts, demonstrate that one of the causes of the high cost of production of graphite fadingsspheroidal is the low General Technological Yield of the Process of making because:

a) The metallic brothbegins returns to its structure of gray iron to laminate 5 seconds after being spilled in the mold and this provokes that the pieces to its initial structure of gray iron laminate [2] again.

b) The retrogressiontime to its structure of gray iron laminating is less to that of hardening of the fading, what does not allow an entire modification of the gatecrasher in the graphite securing spheroidal [3].

c) The loss of the least technological temperature to 1375ºC, it provokes a low use of the metallic broth [5].

All these unfavorable factors provoke that theGeneralTechnological Yield for the securing of 1 ton with graphite spheroidal is alone to fading of 53,41 %, [11] analyzing the efficacy and the efficiency, separately of all the factors that they determine cost of the Production of the fading, since there are the quality of the auxiliary, combustible raw and material, additives.

In addition to the determinant dependences as the skill, skill, professionalism and discipline of the man and the factor of management of direction that influences these elements of costs that are reflected in the price of sale of the completed product.

The General Technological Yield (GTY) depends straight on the metallic yield (My), rejection Index to (Ri) and the metallic loss (Ml). The negative change of the general technological yield can cause economic losses raising the Costs of Production of the fadings[11].

The General Technological Yield (GTY) mathematically is calculated:

$$GTY = My(1 - IrRi)x(1 - Ml)x100 \quad (1)$$

Where: **GTY**: General Technological Yield; My: Metallic yield; Ri: Rejection Index; Ml:Metallic loss.

Knowing that the metallic yield (My) is the relation between the clear metal and the gross metal measured in per cent and depends straight on the technological design and the complexity of the piece and to a great extent he decides the magnitude of the general technological yield [11], because to major metallic yield the general technological yield increases being more effective and efficient in our productions for it it was realized:

a) An ideal calculation of the design and technology of the System of Feeding [7].

b) The use of dynamic charges, with what its volume was diminished, weighed and a more effective control of the reshape and porosities.

There was achieved the design of the systems of feeding and evacuation for the pieces melted below 10 % of the entire weight, obtaining a metallic yield superior to 90 % and with the use of dynamic charges.

Index of Rejection (Ri). There is the per cent established according to the technology and the complexity of the pieces ó the obtained real rejection, which can be major ó less than to (Ri) [11].

The Index of Rejection influences negatively the general technological yield increasing the production cost losing in efficacy and efficiency what indicates that it is necessary to do an ideal control of the quality, in addition to taking the statistics of the discarding, but trying to prepare it putting all the attention, capacity, fortitude, skill, skill, knowledge and enthusiasm on having realized the design, to make the mold, to mold the piece, to prepare the charges of the stove, to be melted the piece, to give him finished [11].

Metallic losses (Ml). It has a direct and negative influence in the general technological yield and there must be a strict control because by means of her it is where there goes away most of the economy of the process diminishing significantly the efficacy and efficiency [11] to:

a) To prepare the load materials with the whole permissible quality, applying the pertinent merger alternatives in every case [8].

b) To calculate ideally the scrap, forming of slag, refuels, rust-removers, Ferro-alloys of that it takes control in the merger [4].

c) Strict control and organization of the track of spilled by the weight and the temperature of the different codes to be melted.

d) Review, warming and ideal preparation of the casseroles and buckets of spilled according to the technology, to avoid with this the cooling of the metal in the bucket increasing the metallic loss [5].

e) To optimize the control of the gradient of heat losses of the metallic broth in the bucket, applying a diagram time - temperature that allows us to move for the whole track of spilled without I cooling the metal [9] to us.

f) In every game of the spilled one the alone bucket must contain the metal to be strained to avoid the cooling of the metallic broth.

g) Scoria carefully to avoid spilling metal in the pits, kettles, soils, etc. that must remain definitely prohibited [1].

The strict control of the general technological yield and the knowledge of the behavior of the metallic yield, index of rejection and the metallic loss allow realizing a detailed analysis of the technical-economic expediency of attacking a production and the most propitious conditions for its execution [1].

The costs of the merger depend to a great extent on the value of the components of the metallic load for this reason a composition of the same one is needed where the price of each of them to born in mind according to its quantity.

$$Pc = \frac{Cn}{GTY} \quad (2)$$

Where:**Pc:** Production Cost; **Cn**: Consumption Norm; **GTY**: General Technological Yield.

## Materials and methods

The results of the previous analysis imply that for the competitive iron production with graphite spheroidal, it is necessary to increase the General Technological Yield diminishing the index of rejection and the weight of the pushed back metal, therefore the proposed technology must diminish the hardening time, achieving a high use of the metallic broth, for the fulfillment of these targets the following technological instruction is applied.

On a metallic ramp of 6000mm X 4000 mm, constructed of angular of 45 and sheets of 3 mm of thickness, supported by 6 wharves and an electromagnetic vibrator in the center. There are placed the molds to be spilled. As it was indicated in the instruction that at the moment of the molds should spill the vibrator ignites and the spilled one

 *Corresponding Author - Rigoberto Pastor Sánchez Figueredo, MSc*[*1]

is realized, which allows to diminish the time of hardening of the piece, for the action of agitation provoked by the vibration that propitiates an increase of the loss of temperature, produced by the heat exchange between the layers of the metallic broth, that is to say increases the speed of cooling and hardening of the fadings of iron with graphite spheroidal, there being achieved the hardening of the pieces melted before the retrogression to gray iron to laminate of the metallic broth.

To demonstrate the existing relation between the vibration speed and the RTG developed the practical experimentation placing 8 lots of pieces of 10 pieces each one on the vibratory ramp and they were spilled in a progressive way increasing in a speed status of 10 mm/s up to a speed of 100 mm / century final vibration In the table # 1 there appears the relation of the values obtained during the practical experimentation of the technological instruction raised in the previous epigraph. Relate it obtained in the practical experimentation between metallic speed of vibrations and losses, losses metallurgy and general technological yield and speed of vibrations and general technological yield it appears in the graphs number 1, 2, and 3 respectively.

The speed of the vibrations they were measured by a vibrometro mark Brüel&Type model WH 2258. Finally images of the cast iron appear with graphite spheroidal obtained by the technological instruction proposed in practice experimental. Only there appears the superficial structure and microstructure of the burettes obtained in the essays.

The studies metallographic were realized in the laboratory of the University of Holguín "Oscar Lucero Moya", in a microscope New mark I shape NJF-120 and the images were taken by a largeness of 200X with a camera it marks Canon.

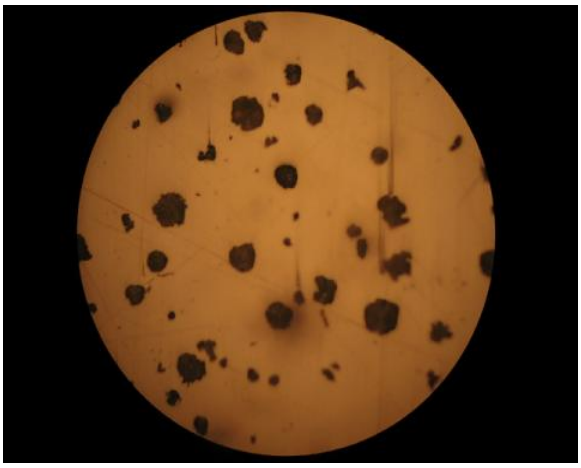

**Fig. 1, Microstructure of the burette # 5 was obtained at a speed of vibration of 40 (mm/s).**

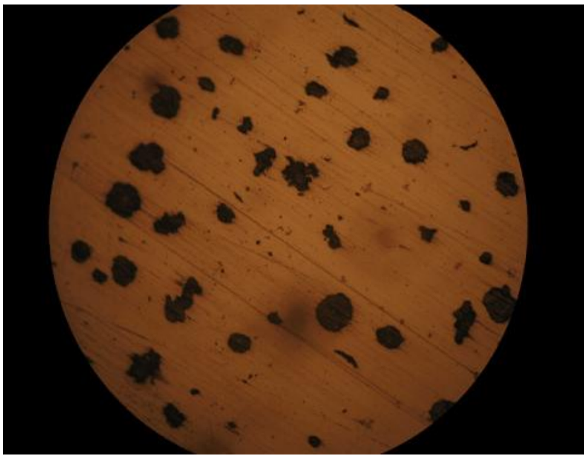

**Fig. 2, Microstructure of the burette # 6 was obtained at a speed of vibration of 50 (mm/s)**

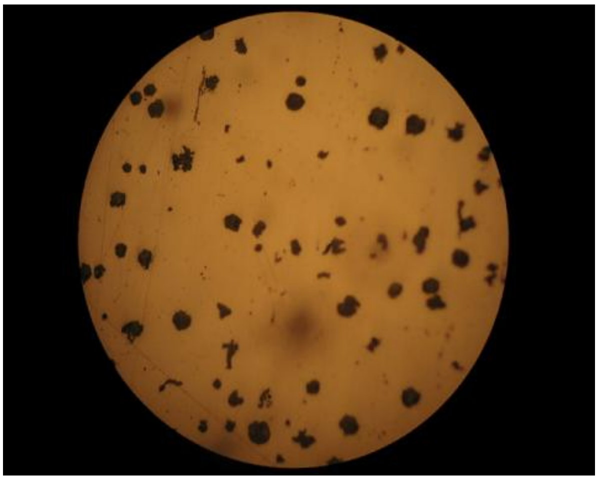

**Fig. 3. Microstructure of the burette # 7 was obtained at a speed of vibration of 60 (mm/s).**


*Corresponding Author - Rigoberto Pastor Sánchez Figueredo, MSc*[*1]

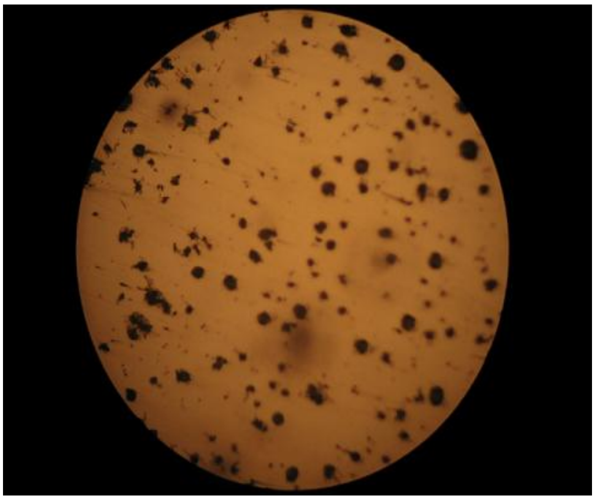

**Fig. 4 Microstructure of the burette # 8 was obtained at a speed of vibration of 70 (mm/s).**

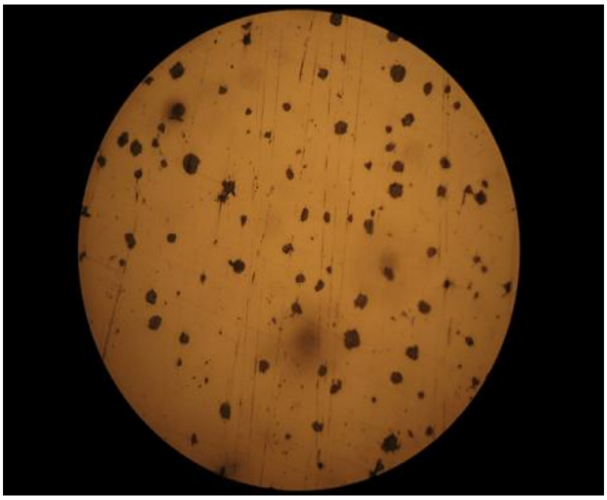

**Fig. 5 Microstructure of the burette # 9 was obtained at a speed of vibration of 80 (mm/s).**

Next in the table # 1 and 6, 7 and 8 of Graphs Represents 1, 2 and 3 the results of the experiments join graphically.

**Table1. Relation between the speed of vibrations, metallic loss and general technologicalyield.**

| | Speed of Vibration [mm/s] | Metallic loss [Kg] | Metallic loss [%] | General Technological yield [%] |
|---|---|---|---|---|
| 1 | 5 | 550 | 56,0 | 39.48 |
| 2 | 10 | 550 | 56,0 | 39.48 |
| 3 | 20 | 523,41 | 53,3 | 41.86 |
| 4 | 30 | 444,72 | 45,5 | 48.92 |
| 5 | 40 | 361,96 | 37,2 | 56.35 |
| 6 | 50 | 283,26 | 29,3 | 63.41 |
| 7 | 60 | 204,18 | 21,4 | 70.51 |
| 8 | 70 | 124,32 | 13,4 | 77.67 |
| 9 | 80 | 45 | 5,5 | 84.79 |
| 10 | 100 | 45 | 5.5 | 84.79 |

The graph demonstrates us how as they increase the vibration speed the metallic losses diminish, what means that the agitation provoked the metallic broth by the vibrations the cooling speed increases and parallel to this the hardening speed makes bigger to itself than that of desmodification and one manages to obtain a major volume of modified fadings.

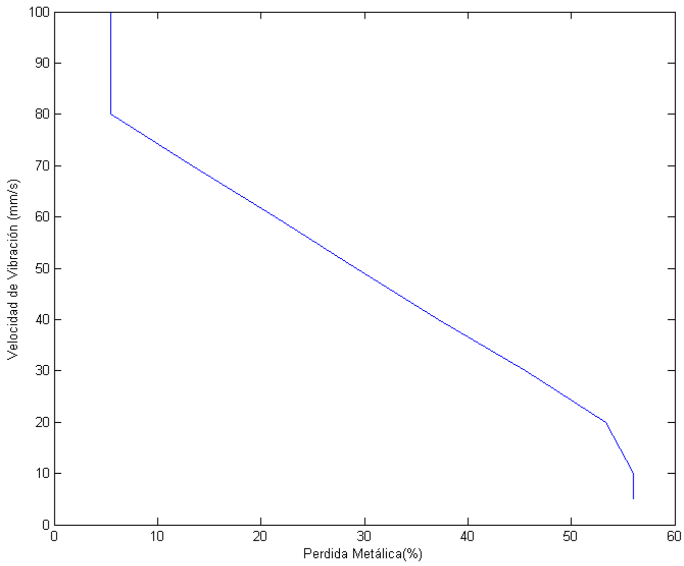


Fig.6, Graph 1 Relation between the speed of vibration and the metallic loss.

In the figure 7 graphic 2 is observed as, on having diminished the metallic loss, the general technological yield increases


*Corresponding Author - Rigoberto Pastor Sánchez Figueredo, MSc*[*1]

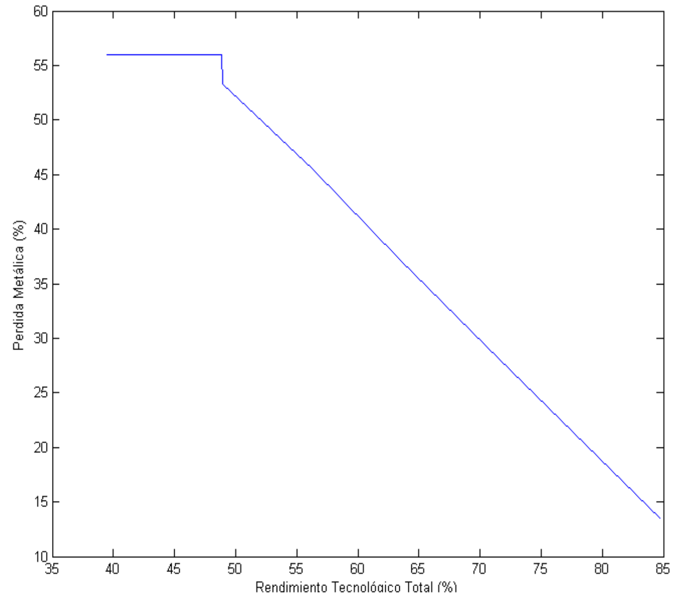


Fig.7. Graph 2 Relations between the metallic loss and the general technological yield.

The graph demonstrates that the decrease of the metallic losses they affect in a positive way in the continuous increase of the General Technological Yield.

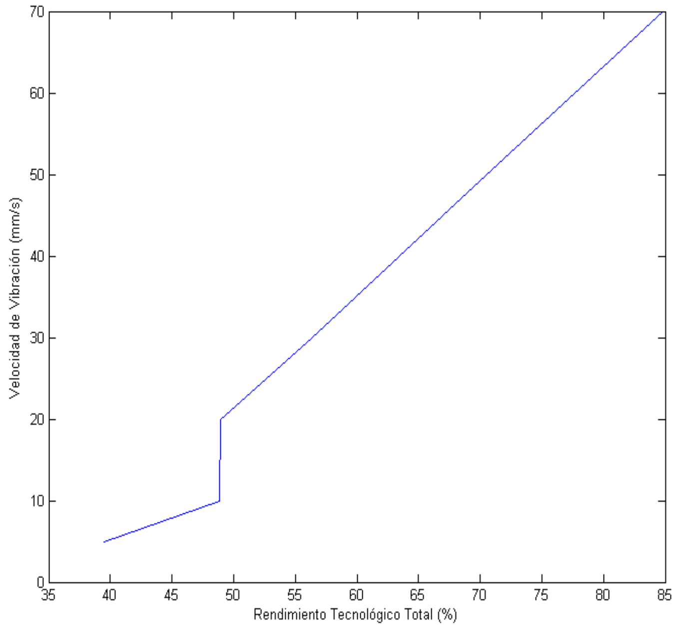


Fig.8. Graph 3 Relations between the speed of vibration and the general technological yield.

Graphically there is demonstrated the fulfillment of the targets of this investigation on having increased the RTG with the increase of the speed of vibration.

Of previous analyses we conclude that:

1. At major speed of major vibration cooling speed.
2. At major speed of major cooling slodidificacion speed.
3. At major speed of major hardening volume of modified metal.
4. To major volume of less modified metal metallic loss.
5. To less major metallic loss General Technological Yield.
6. At major vibration speed, major per cent for area and less diameter of the graphite spheres.

**Analysis of the relation of the RTG with the proposed technological instruction**

The application of the technological instruction in the iron production with graphite spheroidal allows the increase of the general technological yield, diminishing the production cost for one ton of iron with graphite spheroidal in a competitive, sustainable way and sustainable.

**Discussion of results and evaluation technological - economic**

The developed technology has allowed to come to competitive indexes of efficiency that have favored the production to industrial iron scale with graphite spheroidal under the conditions of the current iron and steel industry, which appear in the table 2 how there it are the decrease of the metallic loss to 5.5 %, increase of the weight of the modified iron, the general technological yield and the productivity for to 84.79 %.

This will allow to develop really the plans of replacement of pieces of steel for iron pieces with structure spheroidal, as for example: replacing the pieces of technologically possible steels of the combined machines sugar-cane grower, the weight of the machinery would diminish in 30 %, [12] an engine of less potency being needed, less combustible and less compression of the soils to the step of the machine, what brings as a result less production costs.

**Table 2 Comparison of the behavior of the Technological Indexes.**

| No | Parameters | Type of Technology | |
|---|---|---|---|
| | | **Traditional** | **Vibratory** |
| 1 | Hardening time **[s]** | 0,99 | 0,63 |
| 2 | Weight of the Broth of Gray iron **[kg]** | 1000 | 1000 |
| 3 | Metallicyield **[%]** | 94.44 | 94.44 |
| 4 | Index of Rejection **[%]** | 35 | 5 |
| 5 | Metallicloss **[%]** | 13 | 5.5 |
| 6 | General Technological Yield **[%]** | 53.41 | 84.79 |
| 7 | Productivity **[Kg/C]**. | 850 | 850 |

## Evaluationenvironmental way

In the information showed in the table 2 it is demonstrated that this work has a big impact on the environment, since there is diminished mostly the consumption of products and raw material that are used in the iron production with graphite spheroidal. Diminishing the gas emission to the ambience, solid garbage, ashes and slag to the environment.

## Conclusions

Doing an analysis of the investigation one arrives at the following conclusions

1. The development of the new methodology allows the saving of energy bearers in the production ofgrayiron with graphite spheroidal in a significant way with regard to the traditional methodology.

2. Is established a technological instruction that allows the increase of the general technological yield in the securing ofgray iron with graphite spheroidal of a sustainable competitive form and sustainable.

3. The investigation is novel for achieving the increase of the general technological yield, applying for the first time, a technological instruction that allows the production of gray iron with graphite of competitive form, in the Cuban industry.

## Recommendations

This investigation raises like recommendations the following ones

To generalize in all the companies that in its corporative aim have the production of ferrous fadings with the target to attack to industrial scale the production of gray iron with graphite spheroidal, like substitute of the steel in the pieces production for the mechanical industry.

## References

1) ABRAMOV. A. “Manual of the young smelter”. Publishing Alta Escuela. Moscú. 1983 203. p. ALEXANDOR. N.H. Control of the state of the Liquid metal for the HGE securing. Liteinoe Proistbostba No 3 Year 1998.
2) BAKKERUS AND GOES DER HOLST. The T-Nock Process forMaking Br. Modern Casting Tech. Not 711 july 1995.
3) BAD-TEMPERED CAMBRIC. To; PLAIN MOUNTAINS MEDINA, E. “Calculation of Mazarotas for Pieces of Steel”.Construction of maquinarias.1990.
4) GIRCHOVIB, N. G. Investigation method to determine the formation of the iron with

 *Corresponding Author - Rigoberto Pastor Sánchez Figueredo, MSc*[*1]

graphite spheroidal and its evaluation. Edit. Masgish. 1982. 45p.

5) GORSHKOB, A. A. About the formation of the graphite spheroidal in the Microscopic Bubbles during the crystallization. Edit. Bishaia Scuola. 1978. 123 p.
6) GOYOS PÉREZ, L.; MARTÍNEZ REIGNS, ELIO. “Smelting technology II”. Publishing house ISPJAE. City of Havana cigar 1991.243 p.
7) GYNSEY. J. Co CQ (Controlled Quality Inoculation). Processof High productivity. www.carpenterfortuna.com.mx/n-hierro.htm.Consult. 2013.
8) LYNX SMELTING. Database in Line, http://www.lince-fundición.com Consults.2013.
9) Metallography. Database in Line, http://www.metallography//technoters/iron.com consults. 2013.
10) SANCHEZ R.P. General technological yield as regulator of the cost and the prices of fundidos.2011.
11) SANCHEZ R.P. Saving of energy bearers in the securing of not ferrous fadings under the specific conditions of the Cuban metal industry. Memoirs of 6to. International workshop of Energy and Environment CD – ROOM-ISBN: 978 - 959 - 257 - 231 - 7[2010].