Vrnjačka Banja
EMoNT 2018
Serbia

8th International Conference
"Economics and Management-Based on New Technologies"
EMoNT-2018
25-28 June 2018, Vrnjačka Banja, Serbia

Quality Management of Castings of Pipeline Armature

Tatiana Lysenko, Liubov Bovnegra, VladimirTonkonogyi, Lydmila Solonenko
Odessa National Polytechnic University (ONPU), Odessa, UKRAINE,
E-mail: tvl12odessa@gmail.com

Abstract: *The article is devoted to the study of the methods of controlling armature casting from iron alloys. It is shown how the external influence on the "casting -form" system affects the quality of the surface armature castings.*

Keywords: *control of casting processes, surface quality of castings, degassing.*

1. INTRODUCTION

Pipeline armature - a device installed on pipelines, assemblies, vessels and designed to control flows of working media by changing the area of the passage section. Characterized by two main parameters: conditional pass (nominal size) and nominal pressure. The vast majority of the designs of the armature are made with cast bodies and covers. In addition, there is a large group of fittings, which are also made in the form of castings [1].
The technology of casting of reinforcing castings should provide the possibility of obtaining castings with exact dimensions, given mechanical properties and without defects.

2. PROBLEM STATEMENT

In some cases, when manufacturing castings of armature with traditional methods of casting, it is necessary to use technological methods of controlling the processes of heat exchange and mass transfer in the system of "casting - form" for improving the quality of foundry products. Therefore, the work devoted to the quality management of armature castings due to external influence on the system "casting - the form" is relevant.

3. ANALYSIS OF THE LAST ACHIEVEMENT AND PUBLICATION

The state of the production of armature castings: armature castings - the most liquid, which allows to quickly understand the expediency of modernizing their production. For many years, valves and latches from ordinary GCI (gray cast iron) and often of the lowest quality have been used as shut-off and control valves. Today, in Europe, castings are made only with PIGG (pig iron with globular graphite) and steel. Even in Ukraine, instead of traditional latches, ballcocks are increasingly common. Ball valves with different types of connections to pipelines are increasingly being used in municipal water supply systems, heating, gas supply, on separate units of heat and power and industrial facilities. Steel ball valves with flanges are increasingly used in recent years. However, a rare foundry can

ball screws, espe
the world are ob
process. It shou
reduction in the c
The level of tech
The HWS compa
of Ukraine, as we
molds. In factorie
molding lines anc
years.
The casting of va
to manufacture o
pressing, as for
manufacture of m

Fig. 1: Arma

Choice of technol
methods of makin
casting shops, con
For the research, t
the most commor
binders are surfac
casting processes
pouring and cooli
mold.

DN25...DN200-DN250
Seyatsu process

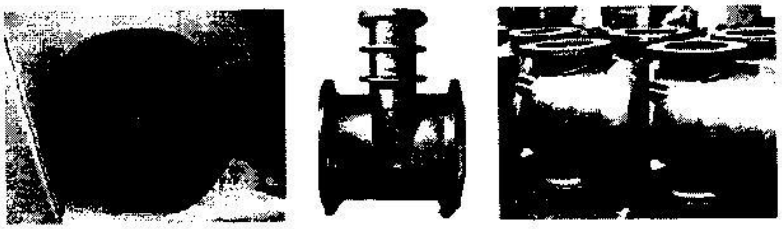
4. THE WORK P

The purpose of th
external influences
1. Determine the i
castings of arm

ball screws, especially for large ball fittings [2].The most high-quality castings of shells of armature in the world are obtained on the lines of vacuum-film formation using rods on the Cold box amine-process. It should also be noted that the environmentally friendly V-process also guarantees a reduction in the cost of castings.

The level of technological production of reinforcing castings by the V-process is presented in Fig. 1. The HWS company supplied the lines of vacuum-film forming for reinforcing castings to enterprises of Ukraine, as well as the enterprises are the Swiss lines of FDC, which make casting valves in molded molds. In factories in Europe, USA, Japan, for many years, dozens of modern vacuum forming process molding lines and Croning - process for the production of armature castings [3] work great for many years.

The casting of valves up to DN250 ... DN300 in the conditions of mass production is more appropriate to manufacture on the lines of formation using the technology Seyatsu - process plus the subsequent pressing, as for small castings, the higher productivity of such lines is possible. And also the manufacture of molds for reinforcing castings with the help of the Croning process.



a b c

Fig. 1: Armaturecastingsby V – process: a–ball casting, 360 kg, steel; b–valve body DN 400; c–body of DN 200 for shipbuilding, 112 kg

Choice of technology. The first steps of domestic and multi-year world experience in choosing the methods of making foundry molds for armature castings, according to the analysis of various existing casting shops, confirm the following five best-optimized types of foundry-making factories [5].

For the research, the technology of casting into shell molds (Croning-processes) was chosen. One of the most common types of defects in the casting of black alloys in shell molds on thermosetting binders are surface sinks and burn. To eliminate such defects, a technological method for controlling casting processes in the «casting-form» system was proposed. The method consists in using, when pouring and cooling, forms of external action in the form of a system for removing gases from the mold.

Table 1: The choice of manufacturing the valve body

DN25…DN200-DN250	DN100…DN800-DN1000	DN800…DN1400-2000	DN300…DN1200	DN25…DN200
Seyatsu process	Vacuum process	Cold-hardening mixtures process (furan, alpha set)	Vacuum process	Croning – process (Shell – process) High quality casting surface.

4. THE WORK PURPOSE

The purpose of the work is to improve the quality of the surface of the armature castings due to external influences. To achieve the goal, the following tasks were solved:

1. Determine the influence of degassing system "casting - form" on the quality of the surface of the castings of armature.

2. To study heat transfer in the system of "casting-form" and its influence on the quality of armature castings.
3. To create a mathematical model of the process of heat transfer in the system of "casting - a form".
4. Determine the limits of the intensity of external action in the manufacture of castings of armature, which allow to receive high quality of the surface.

5. MAIN MATERIAL

In the study of the effect of degassing on the quality of the armature steel surface of the black alloys, the sand and resin mixture of the following composition (wt.%) was used: binding PC-104 - 4.8%, urotropin - 0.58%, calcium stearate - 0.2%, Shell sand is different. The metal for mold casting - cast iron 30B and C1035 steel melt in an electric furnace. The quality of the surface of armature casting was evaluated by the presence or absence of burnt gas or gas shells, and the surface without local defects - according to the roughness measured by the profilometer - the profile graph.
To study the influence of degassing on the quality of the castings, a container was designed and manufactured, the scheme of which is shown in Figure 2. The shell form 2 are arranged vertically in a container 1 with a cast iron charge Ø (3 – 8) · 10^{-3}m. In different zones, 12 thermocouple of type HA diameter 0,5 mm, connected to the 12 - point Potentiometer KSP - 4 were installed.

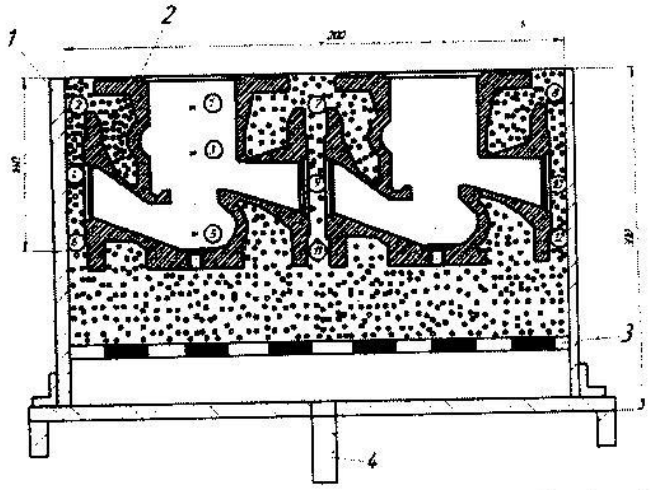


Fig. 2: Scheme of a container for filling of membrane forms in the allocation of gases from the support layer

To measure the pressure in the pores of the casting mold into the latter, enter measuring t connecting with pressure sensors of various types: water or mercury pressure gauges, etc.[6].
To measure the pressure of gases in the pores of the form in this work we used strain gauges pre membrane type.
Thermal conditions of casting under external influence were investigated. Taking into acco result of the intensification of the cooling process of the casting in the shell form during the pur the supporting layer with compressed air [7] and a significant exothermic effect of the decom of the polymer binder, the heat transfer process in the casting system - the shell - the supporting we consider, taking into account two additional factors, the flow of heat through the attributio degassing and the flow of heat through the exoeffect.
The influence of the integral degassing of gases from the container after filling the shell fo steel on the temperature mode of casting, mold and fillings was studied. The result of the exper determination of temperature is shown in Fig. 3.

These data rel
the conditions
which may be
result of an inc
At the same tir
The influence
manifested by
Thus, the main
the surface of t
in two ways an
a large number
of the "hot" cas
Let's consider i
- degassing of
depending on th

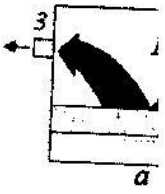


Fig. 4: Evacua
external infl

The first variant
uniform forms o
filler 3 and the m

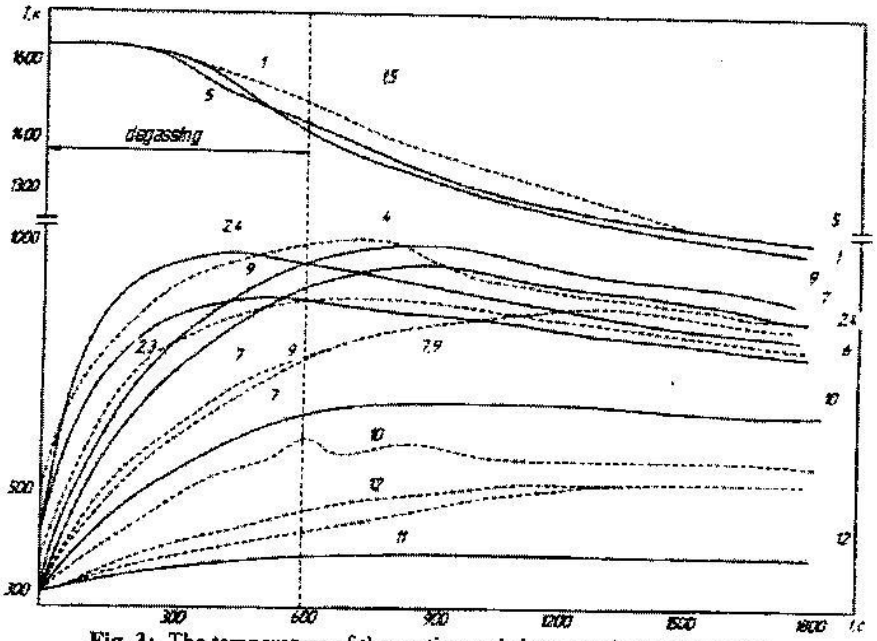


Fig. 3: The temperature of the casting and shapes at the control points (the numbers of the curves correspond to the number of points in Fig. 2)

These data relate to degassing for 360 s with a specific expense $W_{sp} = 0{,}0012 m^3/s \cdot kg$. As seen in the conditions of external influence, the rate of cooling of the casting (curves 1 and 5) decreased, which may be due to the growth of the exothermic effect of destruction of the polymer binde as a result of an increase in the oxidative potential of the gas atmosphere.

At the same time, the heating of the shells on the outer surface decreases somewhat (curves 2, 4, 6).

The influence of external gas influence on the thermal regime of the casting process is clearly manifested by the bending of curve 10 at the time of degassing stopping.

Thus, the main factor influencing the thermal conditions of molding with degassing on the quality of the surface of the castings is the deceleration of the cooling of the casting. This factor manifests itself in two ways and in opposite directions: the slowing down of the crystallization allows to pass through a large number of gases from the mold through the liquid cast, on the other hand, the longer existence of the "hot" casting contributes to the intensification of its carbonization from the gas phase.

Let's consider in more detail the physical model of cooling process of casting under external influence - degassing of gases from a container with filling (Fig. 4) and select it three alternative variants, depending on the intensity of degassing (Fig. 4).

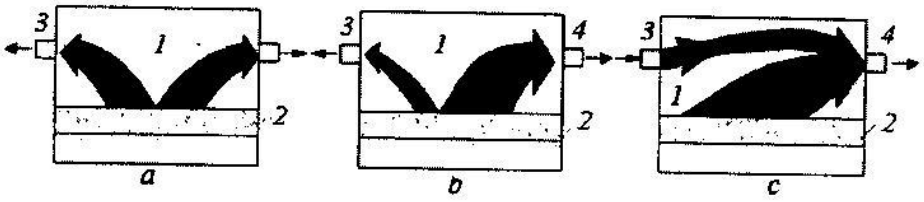


Fig. 4: Evacuation schemes of gases from a container with filling (1) and form (2) in the absence of external influence (a), relatively little intense degassing (b) and highly intensive degassing (c).

The first variant (Fig. 4.a) is characterized by the absence of external influence on the casting system - uniform forms of evacuation of gases emitted from the mold through the upper outer surface of the filler 3 and the mesh bottom of the container 4.

The second option is implemented in degassing through the bottom with a low intensity, which leads to some redistribution of power flow of evacuation of gases in directions 3 and 4 in the direction of the latest.

Finally, in the third variant, the intensity of degassing is so high that it exceeds the integral gas evolution from the mold, due to which in the container (the time of filling) a depression is created, and air from the surrounding space enters through the upper boundary of the filling 3.

The balance of gas flows in the container looks like:

$$q_ф = q_в + q_д + q_к, \quad (1)$$

where q_f–flow of gases from the form;

$q_в$–flow of gases through the upper section of the filler;

$q_д$– flow of gases through the bottom grid;

$q_к$–flow of gases, going to change the pressure in the container.

In the first and second variants there is a ratio:

$$q_д + q_к < q_f; \quad (2)$$

and $q_в > 0$ –gases are separated through the top of the form; at the third option:

$$q_д + q_к > q_f; \quad (3)$$

and $q_к < 0$ – gases are pumped out of the atmosphere.

As, as it follows from the analysis of literature, the main factor that leads to the appearance of the surface of steel castings of shells of chemical shrinkage origin, is the partial pressure of CO in the gas atmosphere of the boundary with the casting of the mold, consider the kinetics of carbon monoxide formation.

The transfer of carbon oxide from casting through the mold to the container and further into the environment consists of two stages: the movement of CO inside the mold and the movement of CO in the container. The determining factor here is the first stage, the transfer of gases through the form meets much greater resistance.

The intensity of the first stage is determined by the gradient of pressure, the difference of partial pressures. CO near casting and at the border is a fill-up form. Degasing from a bucket container, we increase this difference, and hence the intensity of evacuation of CO from the mold. The schematic model allows quantifying this process (Fig. 5).

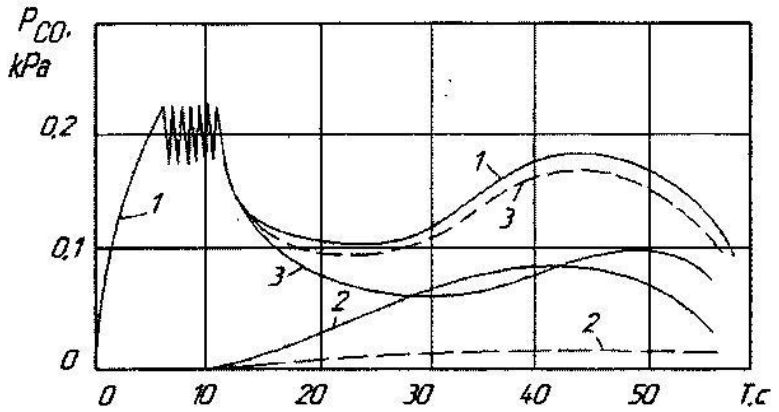


Fig. 5: Effect of degassing on the difference of partial pressure of CO on the boundaries of the form: 1-casting-form; 2-note-form; 3-difference; 4-line non-degassing line; 5-stroke with degassing

The presence of counter flows CO_2 i O_2leads to the fact that due to the evacuation of one part of CO and oxidation of the other part, the content of the latter in the expelled gas is rapidly falling, replaced by high content CO_2.

Thus, degassing acts on the maintenance of CO in two ways and in one direction - to reduce the concentration, which is essential for the elimination of the surface of shells of chemical shrinkage origin.

Summarizing the above, it can be argued that degassing affects the amount and composition of gases near casting as follows (Fig. 6, a).

The most important factor of the additional influence on the quality of the surface of steel castings during degassing is also the slowing down of the cooling rate of the latter (Fig. 6, b).

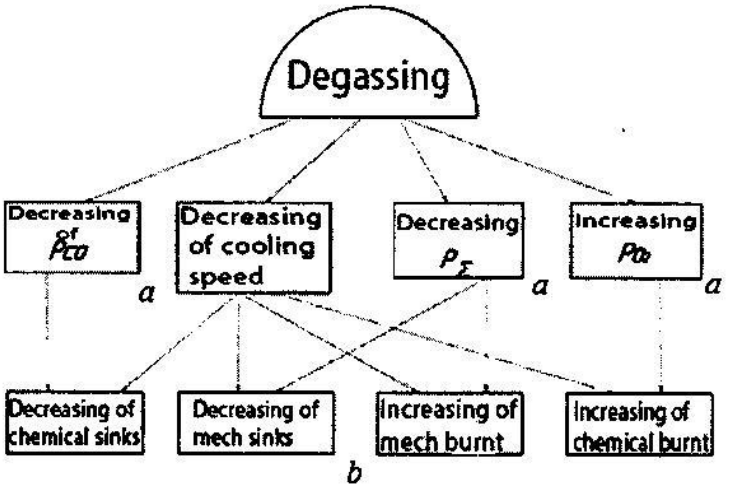


Fig. 6: Scheme of the effect of degassing on the atmosphere of the form (a), the rate of cooling of the casting (b)

At the same time, on the surface of steel castings there is a decrease in the number of (to the complete disappearance) of gas shells of chemical shrinkage and mechanical origin, but first there is a mechanical, and then - with an increase in the intensity of degassing - and a chemical fog (Fig. 7).

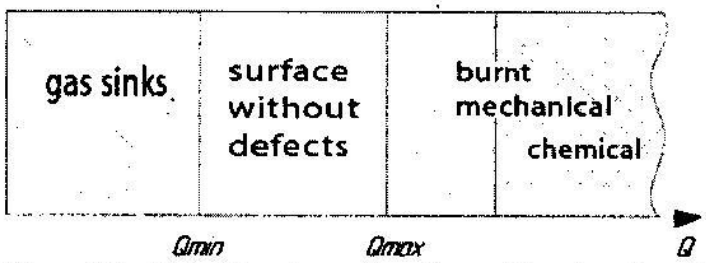


Fig. 7: Scheme of the effect of degassing on the surface qualitysteel castings of armature

The presence on the scheme of the optimal area of the surface without defects, the width and coordinates of which depend on many technological factors and may vary even within the same casting (for example, in different values of the metal-static head, etc.), poses to the researcher the task of optimizing the intensity of degassing.

Value P_{CO} and P_{Σ}, as functions of time for different molding conditions (material and form density, metal pouring temperature, size of the mold) are obtained experimentally.

The influence of these parameters on the quality of the surface of the steel castings is determined by the experimental and experimental way. For this purpose, the dependence of the quality of the surface of the steel castings on the intensity of degassing has been experimentally established for the same molding conditions.

Based on the calculations and experiments on the influence of degassing on the surface of the casting, the following dependences were obtained for the values of the limits of the optimal interval of intensity (Qmin + Qmax), which ensure the absence of surface defects such as sinks and burnt:

$$Q_{min} = 0{,}18d_p + 0{,}3 \cdot 10^{-3}\rho + 0{,}53x_2 - 0{,}8 \cdot 10^{-2};$$
$$Q_{max} = 0{,}15 - 0{,}8d_p - 1{,}7 \cdot 10^{-3}\rho - 2{,}2x_2; \quad (4)$$

where: d_c –concentration of binder, ρ –shape density i x_2 –the thickness of the shape can be given within the limits given in Table 2.

Taking into account the equations (3) and the data of the table 2 constructed monograms for calculating the intervals of the interval of the desired external action - Q_{min} i Q_{max}. When substituting specific values a_c, ρ i x_2 can get the following relationships:

Table2: Limit values of sink shape parameters

Name and designation	Unitmeasurement	Value	
		Max.	Min.
Concentration of the binding, α_c	mass	0,01	0,05
Form density, ρ	kg/m^3	1400	1700
Thickness of the form, x_2	m	0,005	0,025

A nomogram has been developed for calculating the lower and upper limits of intensity (Q_{min}) and (Q_{max})external action The results of the research allow obtaining technological recommendations for the improvement of the quality of reinforcing castings from iron-carbon alloys due to external action for industrial use.

6. CONCLUSIONS

1. The thermal conditions of steel armature castings in shell forms during external degassing h... been studied. It was established that the main factor influencing the thermal conditions of cas... with degassing on the quality of the surface of reinforcing castings is to slow down their coo... This factor manifests itself in two ways and in opposite directions: promotes evacuation of g... through liquid casting, but on the other hand, leads to intensification of carbonization of ha... casting.
2. The mechanism of gas influence of integrated degassing on the system of "casting - fo... revealed. It is established that degassing of insignificant intensity leads to decrease of ... concentration in the form near the casting. With increasing degassing intensity from the co... to this factor is added oxidation of CO in the form of oxygen in the air, which is added t... container. Both of these factors operate in the same direction - to reduce the partial pressure o... and hence to reduce the coagulation of the casting.
4. It is established that on the degassing intensity scale there is an area of obtaining non-de... castings, limited by smaller values of the defect type of shrinkage sinks, and on the part of ... mechanical, and then a chemical burn. The calculated relations are derived and the nomog... constructed to determine the limits of the optimal zone, depending on the technologi... constructive parameters.
5. The mathematical model of the heat transfer process in the "casting - form" system was c... the adequacy of the model was experimentally confirmed.

REFERI
[1] Budz... http://u...
[2] Yasyuk... on the c...
[3] Sokolov...
[4] Theoret...
[5] L.I.: Mc...
[6] Control ... April, 2009...
[7] Lysenko... mold / F...
[8] Casting ...
[9] O.I .: Mc...

REFERENCES

[1] Budanov E. Reinforcing castings and analysis of the state of their production - http://www.ruscastings.ru/work/168/2130/2132/6198

[2] Yasyukov V.V., Lysenko T.V., Solonenko L.I., Cherednik V.A. Analysis and synthesis of chemical effects on the operational reliability of olives / Metal and casting in Ukraine. -2016. – № 8-9 . – pp. 279-283.

[3] Sokolov N.A. Casting into shell molds. - M .: Mechanical engineering, 1978. – 462p.

[4] Theoretical Foundations of Formation / Lysenko T.V., Ponomarenko O.I., Dotsenko V.P., Solonenko

[5] L.I.: Monograph. - Kharkiv: Textbook of NTU "KhPI ", 2014. – 192 p.

[6] Control processes in the mold / LysenkoT. , Malakhov V., Stanovsky A.: Monograph. - Odessa: April, 2009. – 475 p .

[7] LysenkoT.V., Stanovskiy A.L., Zheldubovskii D.A., Bibik T.V. Synchronization of composite events in a mold / Foundry – 2011. – № 12. – p. 25 – 29.

[8] Casting systems and processes control / Ponomarenko O.I., Lysenko T.V., Stanovsky A.L., Shinskiy.

[9] O.I .: Monograph. - Kharkov: Pidruchnik NTU "KPI", 2012. – 368 p.