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The Structural Modifications of Welded Grey Cast Irons

The welding of grey irons (lamellar graphite iron) for the reshuffling of casting faults is a technical problem and a scientifical one, caused by the existence of free carbon in the structure - graphite - but also by the notching effect of the of the lamellar graphite on the matrix. This paper studies the structural modifications induced by such an operation in the structure of the experimental sample, casted from grey iron, in the adding material and, also highlights, the possibility of welding the casted pieces from grey irons.

Keywords*: welding the casted pieces; oxiacetilenic cutting.*

1. Introduction

The casting faults of the pieces were considered a special problem of cast pieces from the beginning of their manufacture.

Excepting the extreme situation of the scraping of cast pieces resulted from the piece manufacturers made researches and managed to finalize reshuffling technologies for the casting faults. This implies lower costs than the ones realized as a result of recasting the pieces.

Leaving aside the latest technologies of reshuffling the casting faults - impregnation and puttiness - which need special materials (many times very expensive) and which do not ensure the high quality of the fissured and cracked cast pieces from grey cast irons-lamellar graphite cast irons, the welding of grey irons-lamellar graphite irons, the welding of grey irons may be considered a solution for reshuffling.

It is also well known the fact that, the welding of cast pieces from lamellar graphite irons is not a suitable technical operation because the structure of these cast irons is not the proper one for the application of such a reshuffling operation, unlike the one for steel cast pieces (mainly, unalloyed carbon steel). It is known that from a metallurgical point of view, lamellar graphite irons contain, in their structure, free carbon in the shape of graphite lamellas, which act in a negative way on the compactness of the matrix, by ”the notch effect”. The effect of the tip of the graphite lamellas combined with the heating process from the welding operation may have as result the initiation of cracks in the matrix and even the propagation of these cracks, and for the existing cracks, their development. Thus, the issue of reshuffling through the welding of cast pieces from grey irons needs special attention.

On the other hand, during the reshuffling process through the welding of cast pieces from lamellar graphite irons, a series of modifications in their chemical composition may appear and in the structure of the adjacent reshuffled area of the cast piece passed through the welding operation (in the basic metallic mass-cast piece and also in the added material-welded electrode which will form the welding belt). During the welding operation and during the cooling process of the casted piece, internal tensions appear in the structure of adjacent area.

2. Experimental studies and results

The reshuffling of hot welding of cast pieces from cast irons is realized with the help of a gas burner specific for the oxiacetilenic cutting - welding operation, using as adding material rods of grey iron with a chemical composition corresponding elements: high fluidity, low content of pearlitic accompanying elements (Table 1). The grey iron from which the welded rod electrodes are casted is obtained through elaboration in coreless induction furnace of medium frequency (5000 Hz), with a basic lining, with a capacity of 250 kilos and from a metallic charge composed of synthetic iron (100%).

The heating temperature of the sample (Figure 1) is of 800^{0}C.

The sample is heated in a closed experimental furnace and which has a detachable roof, the heating of the sample is uniform on the entire section. The access of the welding operator and the welding devices is made easily. The construction of the furnace is conceived in such way so it may maintain a temperature of 500…550^{0}C for the sample, during the welding operation.

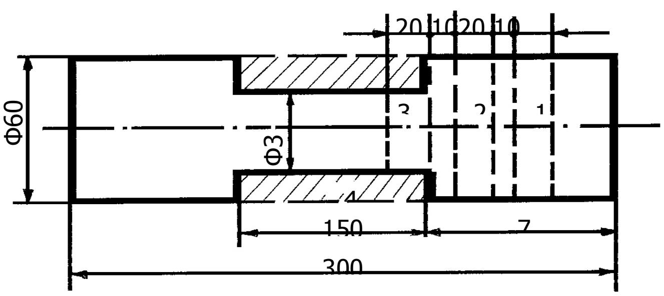


Figure 1. Experimental sample from lamellar graphite grey iron: 1, 2, 3, 4, 5 - sample detached for the metallographic analysis; 4 - adding material.

Table 1

The chemical composition of the welding electrodes [%].

C	Si	Mn	P	S	Cu	Ni	Cr	Mo
3.40	3.58	0.22	0.580	0,016	0.12	0.07	0.07	0.01

Table 2

The chemical composition of the experimental sample [%]

C	Si	Mn	P	S	Cu	Ni	Cr	Mo
3.20	1.35	0.70	0.095	0.045	0.15	0.09	0.05	0.12

During the melting process of the welding electrode and of the welding area of the experimental sample, its temperature reaches the value of 750…800^{0}C.

For protection, the metallic bath formed in this area will be covered with a protective layer made of a protective flux which is composed of: 70% borax, 25 % incinerated soda, 5% sodium chloride.

The cooling speed of the experimental sample, which also contains an adding material, is of 20^{0}C/h and it is obtained through its cooling in the same time with that of the heating - maintaining furnace.

The analysis of the metallographic structures on different areas of the experimental sample shows the following aspects:

- The basic material (the experimental sample - casted) (sample 1) is characterized by a mainly pearlitic matrix, by lamellar graphite separations Gl 5…6 (70…250μm) and by isolated separations of eutectic phosphorus (Figure 2).
- The basic material in the middle of sample 3 is presented almost in the same way and it is characterized by a mainly pearlitic matrix, lamellar graphite separations Gl 5…6 (70…250μm) and isolated separations of phosphide eutectic (but slightly longer) (Figure 3).
- In exchange, the adding material, noted with 4, from the exterior of sample 3, is characterized by mainly ferritic matrix and punctiform interdendritic graphite separations (similar to the welding electrodes structure). No separations of phosphide eutectic are noticed (Figure 4).
- The transition area between the basic material and the adding material (Sample 3) is characterized by a pearlitic matrix and with ferrite separations around the punctiform interdendritic graphite separations and in which we may observe little separations of free cementite (Figure 5).
- The gray iron electrodes are characterized by ferritic matrix and by punctiform interdendritic graphite separations (Figure 6).

Figure 2. The metallographic structure of the basic material (experimental sample) (Sample 1) (100X).

Figure 3. The metallographic structure of the material in the welded area – interior of the sample: the basic material (sample 3) (100X).

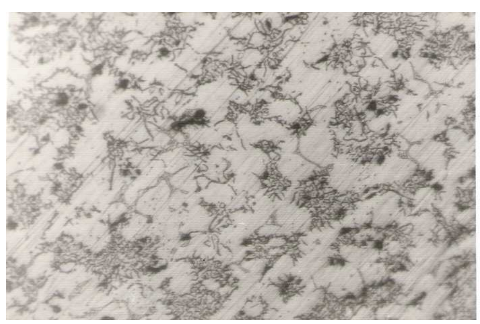
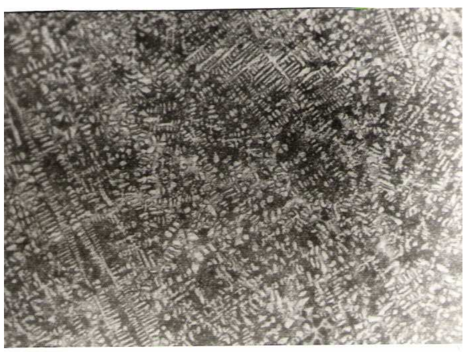


Figure 4. The metallographic structure of the material in the welded area – exterior of the sample: adding material (Sample 4) (100X).

Figure 5. The metallographic structure of the material from the transition area – adding material: (Sample 5) (100X).



a.

b.

Figure 6. The metallographic structure of the welding adding electrode material: a. 100X; b. 1000X.

3. Conclusions

In the chemical composition of the welding electrodes, from the metallurgical point of view (fluidity, melting, low tendency of cracking during solidification and cooling) it exists a lower content of pearlitic trace elements (Cr, Ni, Mo, Cu) and a higher content of silicon and phosphorus is needed.

The using of the protective flux on the surface of melting surface is needed because the flux is not a result of the welding electrodes (similar to the welding electrodes for the electric welding and to prevent formation the porosities in the melting, but also to prevent the penetration of nometallic inclusions in the melting.

Even if the welding electrodes have a high content of phosphorus, is not emphasized in the structure of the material – the nonexistence of the phosphoride eutectic.

For the structural homogenization (of the mechanical properties, the application of a head treatment is needed (normalization).

The cooling of the experimental sample once with that of the furnace is needed, after the loading of the adding material, in order to prevent the cracking of the sample as a result of structural modifications of internal tensions.

4. References

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