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Technology for Cleaning Non-Metallic Inclusions and Gaseous Pores in the Process of Liquefaction of Steels

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ABSTRACT: In this paper, the technology of liquefaction of high-quality castings in sand-clay moulds by cleaning 110Г13Л and 35ХГСЛ steels from non-metallic inclusions and gaseous pores has been developed.

KEYWORDS: Inclusions, non-metallic inclusions, endogenous, exogenous, oxides, sulphides, nitrides, carbides, phosphides, oxy-sulphides, carbonitrides.

I. INTRODUCTION

The demand for cleaner steels increases every year. Industrially melted steel contains non-metallic inclusions. The quality, quantity and size of inclusions can be controlled, but such impurities cannot be eliminated in their entirety because they are natural components of the phases present in alloys. Although steel has a relatively small number of non-metallic inclusions, those impurities have a considerable impact on the material's technological and strength parameters, in particular fatigue strength and life. During processing, the shape and distribution of microparticles change, and impurities undergo anisotropic deformation. Non-metallic inclusions play a special role in the process of steel hardening. Due to differences in the physical properties of steel and inclusion-forming phases, structural stresses are formed along inclusion boundaries. Fatigue cracking is caused by local discontinuities which are transformed into micro-cracks and cause material decohesion. Fatigue occurs and develops gradually due to cyclic service load that causes stress. Initial stages are marked by the incubation of slips whose number increases in individual grains. When critical values are exceeded, the material cracks and becomes fit for scrap. Steel of various purity grades is manufactured for the production of elements that operate under different conditions. Expensive high-grade steel is not used in common applications. Steel used in structures which are exposed to low loads may contain significant amounts of impurities that do not compromise the functional parameters of steel. Some applications require high-grade and high-purity steel that guarantees structural reliability and safety. The allowable impurity content of steel, the morphology of impurities and their influence on steel strength (mainly under variable loads) have been analyzed by numerous authors. Despite years of research and analyses, our knowledge of the impact of non-metallic inclusions on the properties of steel elements is still ambiguous and limited. The aim of this study was to determine the influences of large non-metallic inclusions on bending fatigue strength hardened and tempered performed on industrially manufactured high-grade, carbon structural steel of high purity.

II. MAIN PART

Professor teachers and researchers of the Department of "Casting technologies" of Tashkent State Technical University studied the problems of production of the plant "Casting mechanics" of JSC "UzMetkombinat". During the casting of 110Г13Л and 35ХГСЛ steels, which are cast in sand-clay moulds in this plant, there are problems with non-metallic inclusions, gaseous pores and cracks. The castings are manufactured with high surface roughness, the presence

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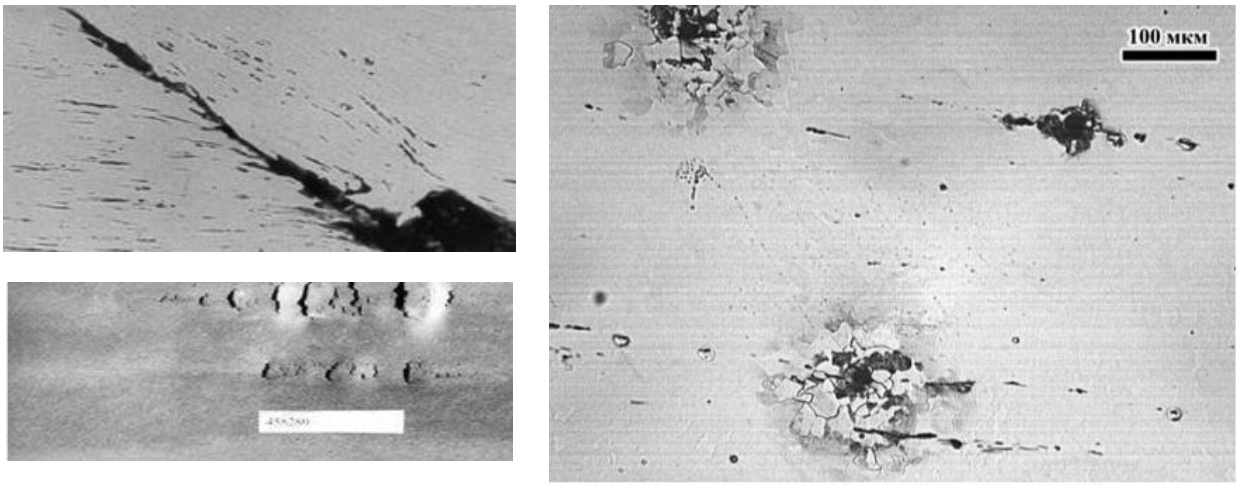
of non-metallic alloys and pores, the large size of the cast parts for machining, due to the lack of modern casting technology. many parts have problems with casting during casting.

Defective parts with non-metallic inclusions and holes.



100X magnified image of a defective part using the SPEKTROLAB-10M device.

Depending on the source of origin, non-metallic inclusions are classified into two groups namely endogenous and exogenous inclusions.

The endogenous inclusions are formed by precipitation within the liquid phase due to the decrease of the solubility of the chemical species contained in the steels. This type of non-metallic inclusions cannot be completely eliminated from the steel but their volume fraction and the average size can be decreased by strict control in order to avoid their damaging action.

The exogenous inclusions come to the steel as a result of the trapping of non-metallic materials coming from slag, refractory fragments or from casting and covering powders used for protecting the steel and avoiding sticking during the casting. This type of non-metallic inclusions is featured by large sizes and their origin cannot be immediately recognizable, although their presence can strongly affect the micro structural soundness of the steels and the associated mechanical reliability.

Another classification of the non-metallic inclusions can be based on their chemical composition. The non-metallic inclusions can be synthetically classified as oxides (FeO, Al_2O_3, SiO_2, MnO, Cr_2O_3, $Al_2O_3.SiO_2$, $Al_2O_3.FeO$, $Cr_2O_3.FeO$, $MgO.Al_2O_3$, and MnO. SiO_2 etc.), sulphides (FeS, MnS, CaS, MgS, and Ce_2S_3 etc.), nitrides (TiN, AlN, VN, and BN etc.), carbides (Fe_3C, WC, Cr_3C_2,Mn_3C, and Fe_3W_3C etc.), phosphides (Fe_3P,Fe_2P, and Mn_5P_2 etc.), oxy-sulphides (MnS.MnO, $Al_2O_3.CaS$, and FeS.FeO etc.), and carbonitrides [Ti(CN), V(CN), and Nb(CN)] etc.

Based on the results obtained by scientific researchers, the effect of the properties of non-metallic inclusions (eg, composition, structure, etc.) on the processing of steels of different grades, the main mechanisms of breakage of cutters

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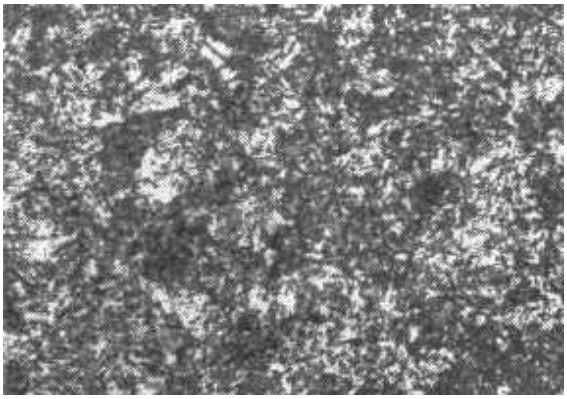
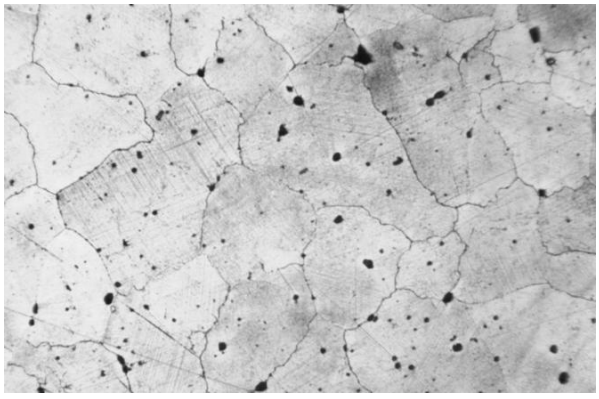
in mechanical processing, the wear resistance of the tools and various non-metallic inclusions in the cutting zone and in the alloy composition were considered. The comparative characteristics of non-metallic inclusions and their effects on various mechanical properties, such as deformation and strength, are summarized and discussed. In addition, a number of effective methods that are widely used in manufacturing today to improve the performance of parts made of different steel grades have been discussed and compared. The basis of this discussion is the choice of effective methods for controlling the number of non-metallic inclusions in liquid steel. When we clean these non-metallic inclusions using flux (chemically), until the metal is removed from the furnace to the bucket, 3-5% of the mass of the liquefied metal is added to the molten slag (55%CaO, 40%Al_2O_3 and in small quantities SiO_2, MnO, FeO) in the electric furnace. Then molten steel is poured into it. This increased the rate of reactions due to the rapid mixing of the steel with the slag and the increase of the contact surfaces, and the metal was purified to almost 65% from gaseous and non-metallic inclusions.


Detailed image of the sand-clay mold according to the results of the research. After machining.

According to the results of the research, the part cast in a sand-clay mold was magnified 100X times using the equipment "SPEKTROLAB-10M".

III. CONCLUSION

By processing outside the oven, cleaning of 110Г13Л and 35ХГСЛ steel alloys from non-metallic inclusions and gaseous pores by processing with synthetic slag. In addition, developed high-quality casting technology.

The technology of optimal liquefaction of 110Г13Л and 35ХГСЛ alloys and casting in sand-clay moulds has been developed. The technology for the production of precision castings by liquefaction of alloys 110Г13Л and 35ХГСЛ using liquefaction models has been developed. The theoretical analysis of the research is illustrated in Figure 3-4.

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