INVESTIGATION OF THE TECHNOLOGY FOR PRODUCING GRAY CAST IRON (СЧ15) FROM SECONDARY METAL WASTE

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Abstract: It is well know that in the production of machine parts, gray cast iron of various grades is widely used as a raw material for manufacturing machine components. These cast iron products are cost-effective and facilitate mechanical processing. If the carbon in the alloy is primarily in the form of a chemical compound, such alloys referred to as white cast iron. If the carbon exists in the form of free graphite, the alloy called gray cast iron, malleable cast iron (КЧ), or high-strength cast iron (ВЧ), depending on the shape of the graphite.

Key words: gray cast iron, secondary metal waste, cast iron production, sch15 cast iron, induction furnace, metal recycling, high-strength cast iron, graphite structure

Introduction.

The microstructure of cast iron can be pearlitic or ferritic, depending on the iron base. The mechanical properties of cast iron depend on both the shape of the graphite and the iron base.

Manganese (0.5-1.4%) inhibits the separation of graphite but reduces the harmful effects of sulfur. Phosphorus does not affect the graphite separation process but improves the fluidity of cast iron in its liquid state by forming a eutectic mixture. However, sulfur has a detrimental effect, as it increases the size of the inclusions, raising the risk of cracking and increasing brittleness at high temperatures. Therefore, manganese is added to cast iron to reduce the harmful effects of sulfur.

The chemical composition of gray cast iron typically includes: 2.5-3.7% carbon, 1.0-2.9% silicon, 0.2-1.1% manganese, up to 0.3% phosphorus, and up to 0.12% sulfur. Carbon, silicon, and manganese enhance the mechanical properties and fluidity of cast iron [1-5]. Excessive phosphorus and sulfur increase brittleness. If the sulfur content exceeds the norm, the fluidity of the cast iron deteriorates. Therefore, phosphorus and sulfur should be present in minimal amounts in gray cast iron. Currently, the industry uses gray cast iron grades such as СЧ 12-28, СЧ 15-32, СЧ 18-36, СЧ 21-40, СЧ 28-48, СЧ 32-52, СЧ 36-56, СЧ 40-60, and the highly durable СЧ 44-64. The tensile strength of СЧ 44-64 is 44 kgf/mm², and its bending strength is 64 kgf/mm².

Low-strength cast iron grades like СЧ 12-28 are used in the construction industry for manufacturing foundation slabs and low-responsibility parts. СЧ 15-32 and СЧ 18-36 are used for producing certain parts of metal-cutting machines and agricultural machinery.

High-quality cast iron grades [6-9], from СЧ 21-40 to СЧ 36-56, are used for manufacturing critical machine components such as pumps, compressors, turbines, gears, shafts, and blocks. High-responsibility and large-volume parts used in heavy machinery and construction equipment, such as multi-chamber blocks, cylinders, crankshafts, and elbows, are produced from СЧ 40-60 and СЧ 44-64 grades.

The chemical composition of high-quality СЧ 44-64 cast iron includes: carbon = 2.5-2.7%, silicon = 2.5-2.9%, manganese = 0.2-0.4%, phosphorus = 0.02%, sulfur = 0.02%, chromium = up to 0.3%, and nickel = up to 0.5%. Its mechanical properties (HB) range from 229 to 289 units.

Result. Such cast iron is of exceptionally high quality and strength, capable of withstanding high external forces [10-13]. Therefore, it is suitable for producing cast parts with wall thicknesses of 60 mm or more, used in high-stress applications in machinery and construction. Examples include crankshafts, large gears, valves, cylinders, pump housings, and piston rings. The demand for such parts is increasing daily in our republic, especially with the growth of the construction industry. If cement production equipment components are made from this cast iron, the service life of the machinery can be increased by 1.5 to 2 times.

Currently, this grade of cast iron is not produced in our republic. We propose producing this cast iron using 80% steel waste and 20% cast iron waste. Such secondary metal waste is readily available in our country, as steel waste is generated in all industrial enterprises.

Conclusion. The proposed technology involves using induction furnaces to melt the metal and produce high-quality СЧ 44-64 cast iron with exceptional strength. This grade of cast iron has not been produced in our republic until now. By briquetting and pressing secondary steel waste and adding secondary cast iron products, the metal is melted at 1550°C, and modifiers and ferroalloys are added to achieve the desired chemical composition. The microstructure of this cast iron has been studied and is presented in the appendix. It is noted that the graphite structure consists of small, curled particles, giving it high strength comparable to ВЧ 40-50 cast iron. The use of modifiers is crucial in achieving the desired structure. We propose this technology for producing high-quality cast iron from secondary metal waste.

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