IMPROVING THE TECHNOLOGY OF ENHANCING THE MECHANICAL PROPERTIES OF STEELS USING FERROMANGANESE

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Ferromanganese is a primary alloying and deoxidizing additive widely used in steel production. Its composition typically consists of Fe–Mn as the main components, with manganese (Mn) content ranging around 70–85%. This element actively reacts with oxygen and sulfur in steel, enhancing the processes of deoxidation (binding oxygen) and desulfurization (reducing sulfur content).

In steel production, ferromanganese is used for the following purposes:

- removing oxides from the molten metal composition;
- qurifying by binding sulfur into the slag;
- improving impact toughness, strength, hardness, and wear resistance as an alloying element.

Manganese combines with oxygen to form MnO. This compound readily bonds with slag and separates from the metal phase. Therefore, the efficiency of the deoxidation process is increased by introducing ferromanganese inside the furnace or at the ladle stage.

The process of adding ferromanganese to molten steel is based on the principles of mass transfer, melting kinetics, and heat exchange. The efficiency of this process is directly related to the geometric size (d) and density (ρ) of the ferromanganese particles, the temperature (T) of the liquid, and the stirring rate (v). If the particle size is small, its surface area relative to its mass increases, meaning the melting rate rises. However, very fine particles can rapidly form an oxide layer on their surface, which may prevent complete melting or cause agglomeration. Therefore, the optimal size is selected depending on the temperature of the molten steel [1].

A new method for introducing ferromanganese into high-manganese steel has been developed. In this method, ferromanganese is first sorted according to lump size, and then one portion is added in the steelmaking furnace and the second portion in the ladle. As a result, the ferromanganese is distributed more uniformly in the cast steel, and observation of the steel microstructure shows a reduction in grain size.

Samples obtained by traditional and new technological methods were tested for tensile strength, impact toughness, hardness, and wear resistance after undergoing the same heat treatment regime. In all tests, the properties of the sample cast using the new method were confirmed to be superior.

References

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