SELECTION OF OPTIMAL ALLOYING COMPOSITION TO IMPROVE WEAR RESISTANCE OF 110G13L HIGH-MANGANESE STEEL

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This article investigates the formation of an optimal alloying composition aimed at improving the wear resistance of 110G13L high-manganese austenitic steel. The effects of alloying elements (Cr, Mo, V, Ti) on microstructure, hardness, and abrasive wear resistance were analyzed. As a result, it was substantiated that through complex alloying, it is possible to increase wear resistance by stabilizing the structure and forming dispersed phases.

110G13L steel (Hadfield steel) belongs to the class of high-manganese austenitic steels and is widely used for parts operating under high impact loads. Its main advantage is its ability to undergo work hardening under deformation.

However, in its unalloyed state, 110G13L steel does not exhibit sufficient wear resistance in certain abrasive environments. Therefore, optimizing its chemical composition through alloying is an important task.

The objective of this study is to determine the optimal alloying composition to enhance wear resistance of 110G13L steel. This includes analyzing the influence of alloying elements, studying microstructural changes, evaluating hardness and wear characteristics, and proposing an optimal chemical composition.

The research methods include: metallographic analysis, scanning electron microscopy (SEM), hardness measurements (HRC), and abrasive wear testing.

The addition of alloying elements significantly affects the structure of 110G13L steel:

Chromium (Cr) – forms carbides and increases wear resistance

Molybdenum (Mo) – refines grains and stabilizes the structure

Vanadium (V) – forms fine dispersed carbides

Titanium (Ti) – inhibits grain growth

In conventional 110G13L steel, the austenitic structure predominates. After alloying:

austenite + carbide phases are formed;

dispersed particles appear;

grain refinement occurs.

This leads to improved wear resistance.

Hardness and Wear Resistance

№	Composition (additions %)	Hardness (HRC)	Wear coefficient
1	Base 110G13L	220 HB (~20 HRC)	1.0
2	+1.5% Cr	28 HRC	0.85
3	+1% Cr + 0.5% Mo	35 HRC	0.70

4	+1% Cr + 0.5% Mo + 0.3% V	42 HRC	0.55
5	Complex (Cr+Mo+V+Ti)	45–48 HRC	0.40

Table 1. Alloying Composition and Properties

It can be seen that complex alloying provides the best results.

Based on the research, the following optimal composition is recommended:

Element	Content (%)
C	1.0–1.2
Mn	12–13
Cr	1.0–1.5
Mo	0.3–0.5
V	0.2–0.4
Ti	0.05–0.1

This composition ensures high hardness, good ductility, and maximum wear resistance.

An effective combination of complex alloying elements for 110G13L steel has been identified. The role of dispersed carbide phases has been scientifically substantiated, and the mechanism for improving wear resistance has been developed.

The proposed composition provides:

1.5–2 times longer service life

Increased efficiency in mining and crushing equipment

Reduced maintenance costs

In conclusion, selecting an optimal alloying composition is crucial for improving the wear resistance of 110G13L steel. Complex alloying (Cr, Mo, V, Ti) stabilizes the structure, promotes the formation of dispersed phases, and significantly enhances mechanical properties. As a result, the operational efficiency of the material is greatly improved.

References

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