# ANALYSIS OF ALLOY STEELS

**Atakhonova Sayyora Koraboyevna**
Associate Professor, Andijan State technical institute
Email: ataxonova.sayyora@mail.ru

**Abstract:** Alloy steels are types of steel with special additives introduced into their composition. This article analyzes the composition of alloy steels, the main alloying elements, their impact on microstructure, and mechanical properties. Additionally, it examines the heat and corrosion resistance, hardness, elasticity, and strength of steels. The phase transitions, heat treatment, and technological characteristics of alloy steels are also covered. Their applications in mechanical engineering, construction, and other industries are reviewed. Methods for improving steel quality are also discussed.

**Keywords:** Alloy steel, analysis, strength, composition, mechanical properties, corrosion resistance, heat resistance, alloys, structural changes, chemical elements, phase transitions, fracture, plasticity, ductility, strengthening elements, technological properties, heat treatment, hardness, elasticity, steel grade.

## 1.Introduction

Alloying elements are elements added in metallurgy to improve the mechanical, physical, and chemical properties of alloys. They are introduced into steel, aluminum, titanium, and other alloys to enhance hardness, corrosion resistance, heat resistance, and other characteristics. Alloying elements affect the base metal in various ways:

Modify the crystal lattice structure (forming ferrite or austenite in steel).

Change diffusion processes (improving heat treatment processes).

Enhance mechanical properties (strength, hardness, flexibility).

Increase corrosion resistance (providing protection against rust).

Improve heat resistance (allowing operation at high temperatures).

## 2.Research methodology

Main alloying elements and their effects.

| Element | Symbol | Effect on Steel |
|---|---|---|
| Chromium | Cr | Increases corrosion resistance, creates stainless steel. |
| Nickel | Ni | Improves impact resistance, stabilizes the austenitic phase. |
| Molybdenum | Mo | Enhances hardness, improves high-temperature resistance. |
| Tungsten | W | Provides heat resistance and hardness. |
| Vanadium | V | Refines grain structure, increases hardness and strength. |
| Cobalt | Co | Enhances magnetic properties, improves heat resistance. |
| Aluminum | Al | Produces lightweight alloys, protects against oxidation. |
| Copper | Cu | Improves rust resistance. |
| Manganese | Mn | Increases strength, reduces sulfur's harmful effects. |
| Titanium | Ti | Improves grain structure, increases corrosion resistance. |
| Silicon | Si | Enhances elasticity and strength. |
| Boron | B | Improves steel hardness, adapts to heat treatment. |
| Nitrogen | N | Increases steel hardness and rust resistance. |

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|---|---|---|
| Phosphorus | P | Improves strength but may cause brittleness. |
| Sulfur | S | Enhances machinability but may cause brittleness in excess. |

## 3.Results and analysis

Low-alloy steel – alloying elements ≤ 5% (easy to process, used in construction and the automotive industry). Medium-alloy steel – alloying elements 5-10% (heat-resistant and strong). High-alloy steel – alloying elements ≥ 10% (stainless, refractory, and special properties). Stainless steels (with chromium, nickel, molybdenum) are used in medicine, the food industry, and the chemical industry. Heat-resistant steels (with tungsten, molybdenum, vanadium) are used in energy, aviation, and automotive manufacturing. Superalloys (with cobalt, titanium, aluminum) are used in rocket and space technologies. Alloying elements are added to improve the mechanical, chemical, and thermal properties of alloys.

Each alloying element has a specific effect, and their proper selection helps enhance the working characteristics of alloys.Stainless steels, heat-resistant materials, and high-strength structural alloys are created through alloying. The correct selection of alloying elements increases the strength, durability, and quality of alloys.

**Effects of key alloying elements**

| Element | Effect on Alloy |
|---|---|
| Chromium (Cr) | Increases corrosion resistance, hardness, and strength. |
| Nickel (Ni) | Improves elasticity and impact resistance, creates stainless steel. |
| Molybdenum | Enhances high-temperature resistance and hardness. |

| | |
|---|---|
| (Mo) | |
| Tungsten (W) | Improves heat resistance, strength, and hardness. |
| Vanadium (V) | Refines grain structure, increases hardness and wear resistance. |
| Cobalt (Co) | Improves heat and magnetic properties. |
| Aluminum (Al) | Produces lightweight alloys, resists oxidation. |
| Copper (Cu) | Enhances rust resistance. |
| Titanium (Ti) | Refines grain structure, improves corrosion resistance. |
| Silicon (Si) | Increases hardness and elasticity. |

## 4.Conclusion

Alloying elements make steel and alloys strong, elastic, corrosion-resistant, and heat-resistant. Alloying elements play a crucial role in producing high-quality materials in various industries. Alloyed alloys are widely used in metallurgy, automotive, aerospace, and electronics industries. Alloying technologies play an essential role in developing new materials. When alloying elements are added to alloys, they significantly alter their mechanical, physical, and chemical properties. These changes depend on operating conditions and are applied to improve corrosion resistance, hardness, strength, heat resistance, and other characteristics.

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