

Brightener series for zinc-nickel alloy plating

Stron Ni Zinc, High Ni Zinc, Acid Ni Zinc

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Introduction

Zinc and zinc alloy plating are widely used as anti-corrosion plating for automotive parts. About 40 years ago, the Canadian Code (1 year for exterior rust and 3 years for perforated rust, 1978) and the Nordic Code (3 years for exterior rust and 6 years for perforated rust, 1983) were issued with the goal of ensuring that the products could withstand use under severe corrosive environments where snow melting chemicals are applied in winter, such as North America and Northern Europe. In the 1990s, the U.S. automotive industry established specific rust-preventive capabilities, including a voluntary 10-year rust-preventive standard, etc. Around 1998, European manufacturers began offering a 12-year perforated rust warranty, and Japanese manufacturers followed suit. The anti-corrosion code was the catalyst for a major development in zinc alloy plating, which offers more stable corrosion resistance than zinc plating.¹

Zinc alloy plating includes zinc-iron, zinc-cobalt, zinc-nickel, and tin-zinc. Among them, zinc-nickel alloy plating is widely used for parts around automobile engines,

Table 1: Brighteners for Zinc-nickel Alloy Plating

Product name	Ni (%)	Type of plating bath	Plating method	Features
Stron Ni Zinc ZN-202	5 to 10	Alkaline	Rack, Barrel	Ideal for plating with emphasis on bending
Stron Ni Zinc ZN-208H	13 to 18		Rack	Available at high plating temperatures
Stron Ni Zinc ZN-208K			Barrel	
High Ni Zinc ZN-204J Stron Ni Zinc ZN-208J			Rack, Barrel	Iron plate can be used as anode, improved current efficiency reduction
Acid Ni Zinc AZN-6900		Acid	Rack, Barrel	High current efficiency
Acid Ni Zinc AZN-6900K			Barrel	Boron and ammonia free

Ni (%): nickel co-deposition rate in plating film

suspension parts, fuel system pipes, and other locations requiring high corrosion resistance.

Currently, the bath types of zinc-nickel alloy plating in the market are classified as shown in Figure 1, and they are used according to the bath type and the nickel co-deposition rate in the plating film.²

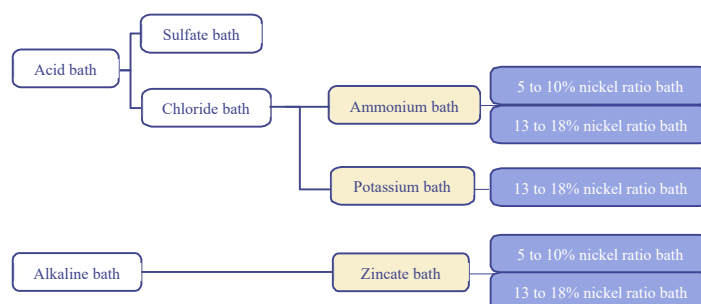


Figure 1: Type of Zinc-nickel Alloy Plating

Product Summary

The JASCO brightener series for zinc-nickel alloy plating are available in both alkaline and acidic baths, and the lineup includes products with different nickel co-deposition rates to meet a variety of quality requirements. (Table 1)

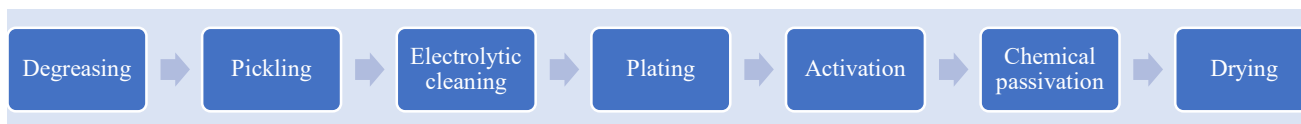


Figure 2: Zinc-nickel Alloy Plating Process (general processing process)

Features of brighteners for zinc-nickel alloy plating

- ZN-202: ideal for pipe parts that are bent after plating
- ZN-208H, ZN-208K: operation at a plating temperature of 30°C reduces cooling costs.
- ZN-204J, ZN-208J: the use of iron plate anodes reduces the amount of brightener replenishment and the loss of current efficiency.
- AZN-6900: high current efficiency, ideal for iron castings, small screws, etc.
- AZN-6900K: excellent wastewater treatability due to boron and ammonia free

All products can be analyzed for bath composition and nickel stabilizers, thereby maintaining stable plating quality.

Treatment process

The treatment process for zinc-nickel alloy plating is similar to that for zinc plating, but organic acids are generally used for activation after plating. (Figure 2)

Mechanisms

The most significant feature of zinc-nickel alloy plating is that it has three to five times higher corrosion resistance than

zinc plating while having sacrificial corrosion protection. ² It also has high heat resistance and little degradation of corrosion resistance in high temperature environments (Figure 3). For this reason, it is often applied to areas where higher corrosion resistance is required, or to areas used in high-temperature environments, such as around engines. The reasons for this are explained in terms of corrosion potential and spreading of corrosion currents.

1. Corrosion potential

Table 2: Natural Potential of Metals in Seawater (vs. SCE)

Metal	Natural potential (V)
Nickel	-0.24
Iron	-0.65
Zinc	-1.07

When two metals are brought into contact in a corrosive environment, a battery is formed due to the potential difference between the metals. The base metal (metal on the low potential side) becomes the anode and dissolves, while the noble metal (metal on the high potential side) becomes the cathode and inhibits corrosion (sacrificial corrosion prevention function).

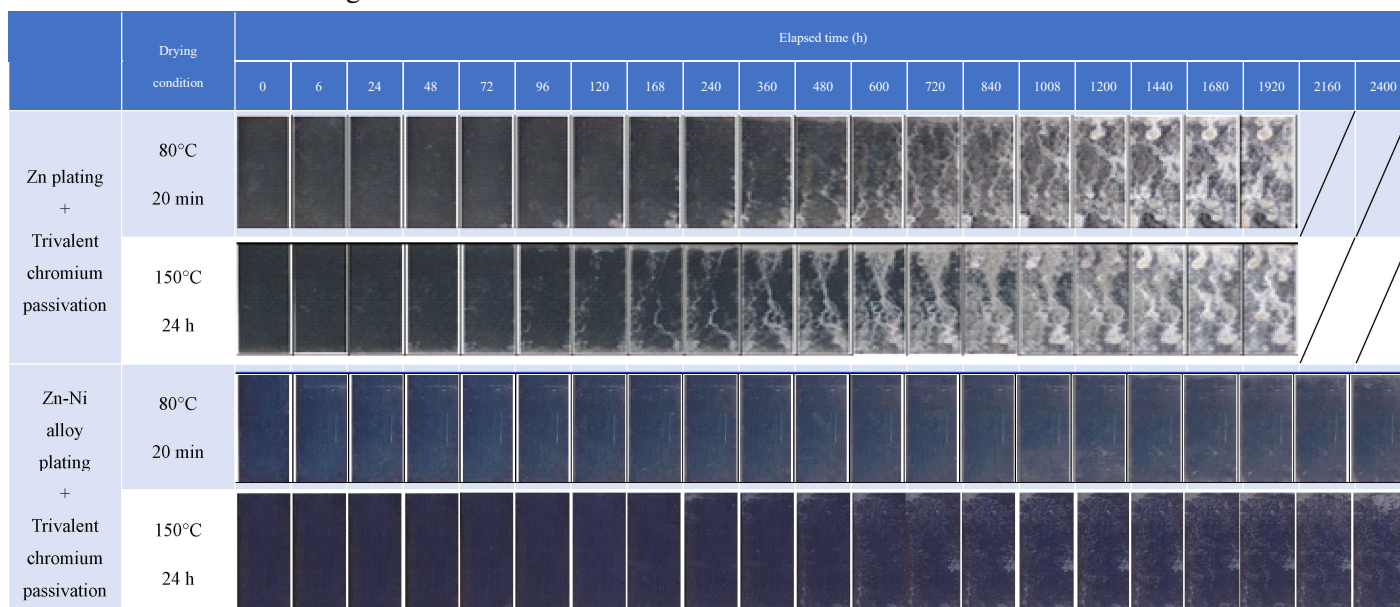


Figure 3: Comparison of Zinc plating and Zinc-nickel Alloy Plating by Salt Spray Test

When galvanized iron is present in seawater, the natural potential of zinc is -1.07 V (vs. SCE), while iron is -0.65 V (vs. SCE), so zinc becomes the anode and dissolves, while iron becomes the cathode and inhibits corrosion. On the other hand, in nickel plating, the sacrificial corrosion protection function does not work because the natural potential of nickel is -0.24 V (vs. SCE) while that of iron is -0.65 V (vs. SCE). (Table 2)

The large potential difference between zinc and iron (0.42 V) has a high sacrificial corrosion protection effect on iron. However, due to the high dissolution rate of zinc, the zinc disappears early, and the sacrificial corrosion protection effect also decreases. If the potential difference can be reduced by making the potential of the plating film closer to that of the steel material, the dissolution rate of the plating film itself will be reduced and the duration of the sacrificial corrosion protection effect can be extended.³

In the case of zinc-nickel alloy plating, the natural potential of the plating film itself approaches iron due to the co-deposition of nickel in the plating film, and the difference in electrode potential between the plating film and the material metal becomes small. In this case, by controlling the electrode potential so that it does not become more noble than iron, a long-term sacrificial corrosion protection effect can be obtained.

2. Spreading of corrosion currents

Under the corrosive environment of salt spray test, zinc electrochemically dissolves preferentially compared to nickel. This causes stress in the plating film, resulting in the formation of micro cracks on the plated surface (Figure 4). The micro cracks become finer as the corrosion progresses, resulting in spreading of the corrosion current and a reduction in the corrosion rate. At this time, a non-conductive $ZnCl_2/4Zn(OH)_2$ layer is formed, which acts as a protective film and suppresses the progress of corrosion.⁴

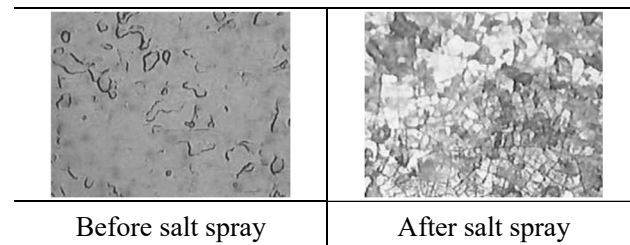


Figure 4: Zinc-nickel Alloy Plated Surface Before and After Salt Spray

Plating type: alkaline zincate bath (Ni: 13 w%)

Test condition: salt spray JIS Z2371, 48 h

In closing

Zinc-nickel alloy plating is an indispensable technology for automotive parts and other steel industry products and is particularly suitable for areas subjected to heat or requiring high corrosion protection. JASCO's zinc-nickel alloy plating brightener series can be used for a wide range of applications thanks to its long track record in the field and extensive lineup.

References

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