Dahua Technology USA Corrosion-Resistant Technology

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1. Foreword

Corrosion is the loss of metal due to a reaction with the environment, and is measured as the percentage of weight loss or as the penetration rate of the corrosion, perhaps measured in inches per year. Corrosion can develop in the presence of liquids or gases. It may occur at any temperature, although generally the rate of corrosion increases with increasing temperature. Corrosion associated with liquids is often caused by impurities or by trace elements within the liquid. Examples of that would be the presence of chlorine, which encourages formation of hydrochloric acid, or of sulfur, which forms sulfuric acid. It is important to remember that any alloy, stainless steel or otherwise, can corrode under certain circumstances. The presence of corrosion does not necessarily indicate a faulty product; it may instead indicate an improper application of that product – perhaps using a material that is not the best fit for a given environment, for example.

Metals, particularly stainless steels, form a very thin chromium oxide layer that protects the inner metal from oxygen. That is important because oxygen is needed with iron to create rust/ iron oxide. In general, no oxygen, no rust. The layer is passive – known as passivation – and self-healing; if the surface is scratched, the oxide layer regenerates itself if there is oxygen present. With the growing demands in the video surveillance field, the surveillance has gradually expanded from conventional application scenarios to coastal regions, ports, ships, wharfs and other highly corrosive environments. The corrosion resistance of the device determines its durability and has a significant impact on reliability. Conventional devices exposed to a high salt and high humidity environment, especially in coastal regions, are susceptible to corrosion and reduced service life.

Surveillance cameras with metal housings are not immune to the corrosive effects of liquids, atmosphere, or other pollutants. Cameras used in coastal areas, petrochemical plants, or coal-fired power generation stations are especially susceptible. Camera manufacturers are employing various technologies and materials to improve the corrosion-resistance of surveillance devices. Corrosion-resistant devices meet the requirements of reliable video surveillance in harsh environments offer longer service life and better mechanical properties.

2. Existing Technologies in the Industry

Security camera manufacturers have adopted various protection technologies to prolong the service life of cameras in corrosive environments. To improve corrosion-resistance for metal enclosures, manufacturers engage in the following technologies: structural change, coating protection, and electrochemical protection.

Structural change: This technology improves the nature of metals by using different materials to produce corrosion-resistant alloys specific to particular corrosive environments. For example, adding chromium and nickel to iron produces a stainless steel alloy that improves the corrosion-resistance properties as compared to regular steel. 316L steel with good plasticity, toughness, cold denaturation, and welding process performance has a low carbon content and strong resistance to atmospheric corrosion. 316L steel passes the highest level of testing for WF2 and NEMA4X, and complies with the C5-M (marine grade) international standard for corrosion protection. This solution is simple and provides strong corrosion resistance, but the resulting devices are heavy and expensive.

Coating protection: Coating a metallic surface with various protective layers to form a barrier between the metal housing and the corrosive medium is an effective method of corrosion-resistance. Common protective layers are divided into two categories: Non-metallic protective layer and metallic protective layer. This layer is applied by painting, electroplating, or spraying, or chemical application to form a dense, corrosion-resistant oxide film on the metal surface. Another method of layer application is anodic oxidation with high performance anti-corrosive powder. Applying a coating is a cost effective option but the process requires specialized equipment and strict process requirements. A protective coating is a thin layer which can be scratched or damaged, which exposes the material underneath. A damaged coating can affect the service life of the device.

Electrochemical protection: This method changes the potential of metal products by applying a current to slow or inhibit the corrosion of metal products. Specific methods include:

- Cathodic protection is a technique used to control the corrosion of a metal surface by making it a part of an electrical circuit with another metal. The simplest method to apply CP is by connecting the metal to be protected with another more easily corroded metal to act as the anode of the electrochemical cell.
- (2) Anodic protection is similar to cathodic, but the surface to be protected acts as the anode whereas, in cathodic protection, the surface to be protected acts as the cathode.

These methods require specialized equipment with strict operation requirements, contribute to environmental damage with high costs. It requires an external power supply that could fail and compromise the corrosion resistance.

3. Dahua Corrosion-resistant Technology

3.1 Introduction

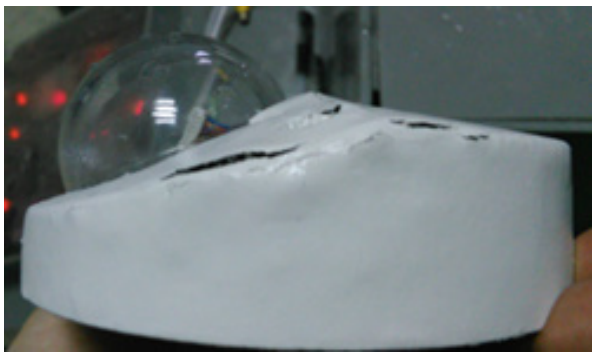
3.1.1 Corrosion-resistant Technology of high performance Anti-corrosive Aluminum and high performance Anti-corrosive Powder

Dahua provides corrosion-resistant properties to specific network cameras by using corrosion-resistant aluminum and special coating. Dahua adds rare earth elements such as cerium (Ce) to the aluminum alloys, improving the compactness of the material and the corrosion-resistant performance of the substrate metal. The structure does not corrode even if a corrosive substance, such as salt or sulfur dioxide, penetrate into the powder base. Dahua also coats the metal surface with a high-performance anti-corrosive powder that offers stronger adhesion, tighter coating, stronger impact resistance, and better toughness compared with typical powder coating. The Dahua powder coating tightly bonds to the metallic surface for an added layer of protection. Dahua devices with these types of protection are widely used in coastal areas, chemical plants, and environments with severe industrial pollution and corrosive atmospheres.

Figure 3.1, below, compares the effects of a corrosive environment test on two metallic housings:

- Sample A: Ordinary aluminum and general powder
- Sample B: Corrosion-resistant aluminum and high performance anti-corrosive powder

The test consisted of 1,000 hours of neutral salt spray test (salt spray concentration: 5%; test chamber temperature: 35°C ± 2°C). Sample A shows considerable damage from the corrosive atmosphere, while Sample B shows no corrosive damage and retains its bright surface.



SAMPLE A

SAMPLE B

Figure 3.1 Corrosion-resistant effect comparison

Compared with other corrosion-resistant processes such as powder coating or micro-arc oxidation plus powder coating, Dahua corrosion-resistant technology of high performance anti-corrosive aluminum plus high performance anti-corrosive coating has the following advantages:

(1) Compared with traditional corrosion-resistant processes, the production process of this solution is simple, and all processes can be completed in the plants of general

suppliers without the need of oxidation or electrophoresis from outsourcing plants. The method does not produce excessive wastewater or exhaust emissions, thus causing minimal environmental pollution.

(2) With sufficient raw material capacity, great product consistency, short delivery cycle, and stable product supply, the solution is suitable for stable mass production.

(3) Offers certain advantages over ADC12 in terms of mechanical properties, thermal conductivity and density.

(4) Corrosion-resistant performance increased by more than two times compared to traditional corrosion-resistant solutions such as oxidation or electrophoresis plus powder coating.

(5) Meets Dahua's surface-treatment performance requirements, including, adhesion, alcohol resistance, paper tape abrasion, and pencil hardness.

(6) Suitable for coastal areas, chemical plants, or environments with severe industrial pollution and corrosive atmospheres.

Figure 3.2, below, illustrates three different corrosion-resistant processes: The process Dahua employs, using high-performance anti-corrosive aluminum plus a high-performance anti-corrosive coating, requires six steps:

- Die casting
- Machining
- Cleaning
- Baking
- Powder coating
- Baking

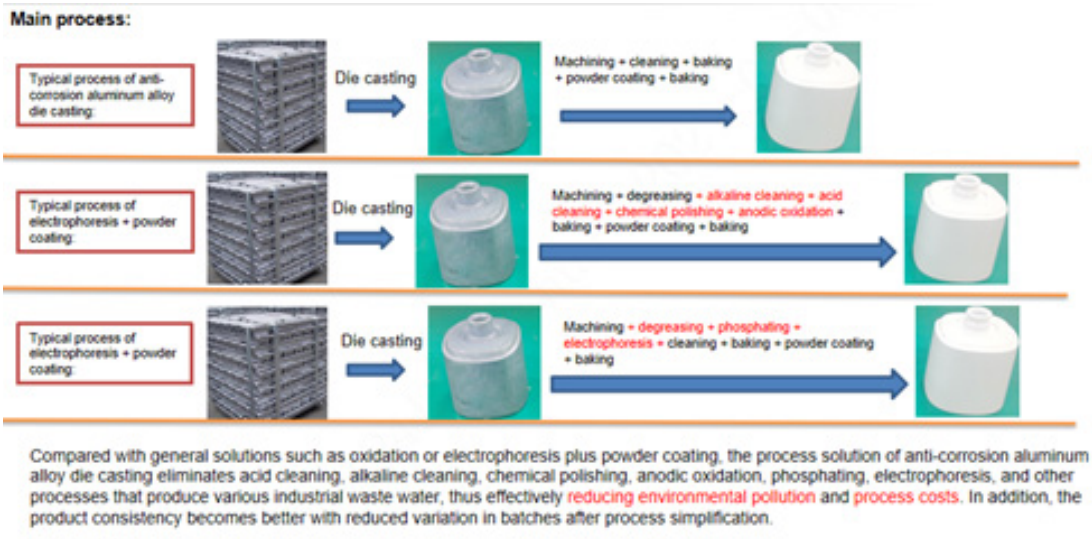


Figure 3.2 Comparison of three different corrosion-resistant solutions

Compared with general corrosion-resistant solutions, this process eliminates acid cleaning, alkaline cleaning, chemical polishing, anodic oxidation, phosphating, electrophoresis, and other processes that produce wastewater. The Dahua process effectively reduces environmental pollution and process costs. In addition, the product consistency is improved with reduced variation in batches after process simplification.

3.1.2 Stainless Steel Corrosion-resistant Technology

The iron-based alloy containing chromium of more than 12% is called stainless steel, which is a type of steel resistant to air, steam, water and other weakly corrosive media. The chromium contained in the stainless steel forms a thin chromium film, which prevents oxygen from penetrating the steel, providing corrosion protection. In addition, the corrosion resistance of stainless steel decreases as the carbon content increases. Therefore, the higher the chromium content and the lower the carbon content, the better the corrosion resistance of stainless steel.

Dahua stainless steel corrosion-resistant technology uses SUS 316L stainless steel. 316L stainless steel is a 300 series Fe-Cr-Ni alloy austenitic stainless steel. Due to its high chromium (16%–18%) and nickel content and minimal carbon content (≤ 0.03%), 316L stainless steel is one of the most corrosion resistant stainless steels with good mechanical properties. The material complies with the highest steel structure corrosion-resistant standard and passes the 28-day alternating salt spray test and 1KH neutral salt spray test without any additional processes. It is widely used in the chemical industry with the following advantages:

(1) Glossy and aesthetic product appearance.

(2) Excellent corrosion resistance, especially pitting corrosion due to the addition of Molybdenum.

(3) High strength at high temperature.

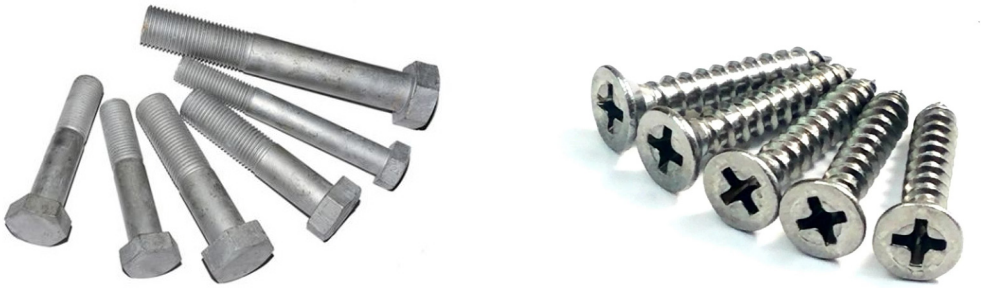
(4) Excellent processing hardening with non-magnetic properties

Figure 3.3 Dahua SUS 316L stainless steel corrosion-resistant product

3.2 Special Corrosion-resistant Fasteners

Dahua corrosion-resistant technology not only ensures corrosion-resistant enclosures but also uses screws with a layer of Dacromet® for additional corrosion protection. Dacromet® is a cold-dip/spray process that results in a thin coating of zinc similar to that of plating. The components are dipped and spun in a cold zinc solution before they are baked at 300° Celsius. The Dacromet® coating has the following protective effects on the metal substrate:

- Four-way Corrosion Resistance: Dacromet® coating protects metals from corrosion via barrier protection, galvanic action, passivation, and self-repairing of damaged areas.
- Solvent Resistant: Dacromet® becomes inorganic once cured, offering resistance to solvents and other corrosive liquids.
- Free of Hydrogen Embrittlement: The absence of acids or electrolysis in the coating process ensures the part is free from hydrogen embrittlement



(a) Dacromet screws (b) Stainless steel screws

Figure 3.4 Two screw types

3.3 Bracket Adapter Process

Applying corrosion-resistance to camera housings and fasteners are an important step for long-life operation in corrosive applications. The life of the camera, however, is limited by the life of all components, including mounting brackets. Bullet-style cameras use a three-axis rotation bracket adapter that requires sufficient strength and wear resistance. The strength and corrosion resistance of common aluminum alloys, such as grade 7075, 6061, 6063 and ADC12, cannot meet the application conditions for these bracket adapters. Although the strength and corrosion resistance of stainless steel materials meet the application conditions, their cost is too high. Therefore, Dahua introduced a new material that incorporates Scandium into aluminum alloys to strengthen the overall mechanical properties of these brackets.

Many precipitation-strengthened aluminum alloys undergoes recrystallization due to the hot and cold applications resulting in a loss of strength. Adding scandium into aluminum inhibits or completely prevents recrystallization by increasing the heat treatment temperature, avoiding recrystallization and producing a higher-strength aluminum alloy material. In a corrosive environment, the surface of scandium aluminum alloys produces a protection film of bayerite or boehmite, improving corrosion resistance of the materials.

Dahua corrosion-resistant bracket adapters use a solution of scandium aluminum plus five layers of plating Cu + (SBr-Ni) + (Br-Ni) + (MP-Ni) + trivalent chromium.

Figure 3.5, below, compares the yield strength, tensile strength, and the elongation of scandium aluminum, stainless steel and a Zinc alloy. Zinc alloys have poor corrosion-resistant protections, but offer strength that meets the bracket adapter requirements. Scandium aluminum materials have similar benefits to stainless steel in this application, with lower cost.

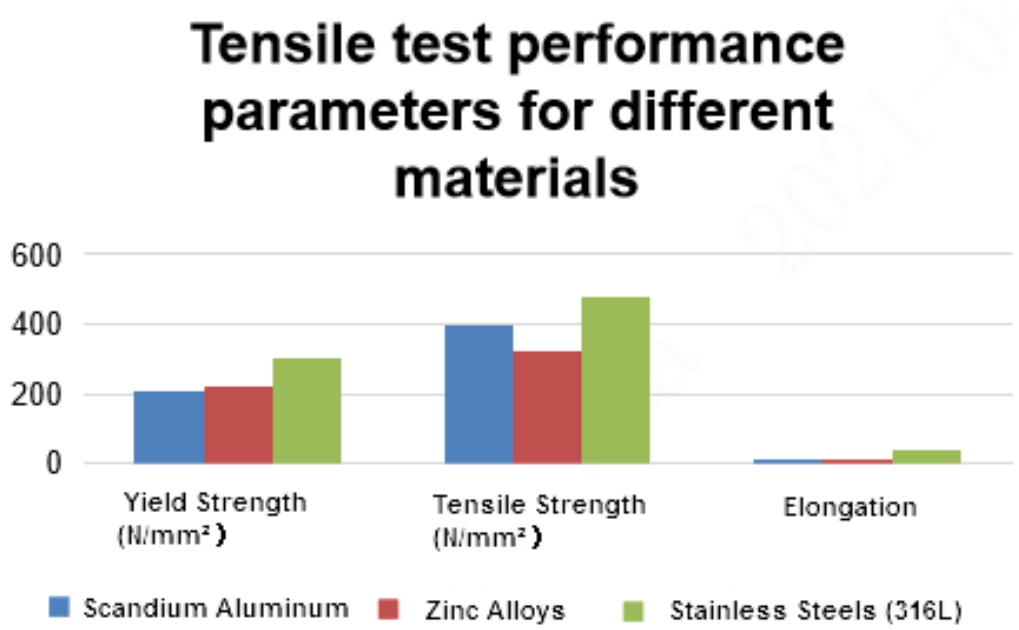


Figure 3.5 Tensile test performance parameters for different materials

Figure 3.6 shows the results of scandium aluminum samples after performing the NEMA-4X salt spray test. The samples show no sign of corrosion and are bright and clean. The overall structure passes the IP67, IK10, vibration test, drop test, and other reliability tests.

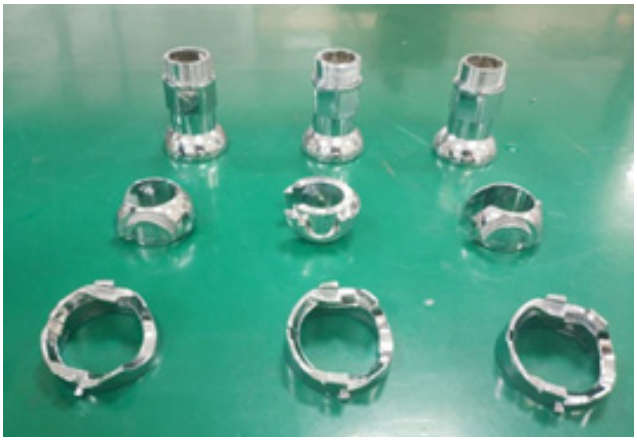


Figure 3.6 Samples after NEMA-4X salt spray test

3.4 Corrosion Protection for Accessories

Camera mounting accessories also require high corrosion-resistant performance. However, conventional corrosion-resistant solutions for accessories, such as aluminum alloy and anti-corrosive powder, cannot meet the current national and international corrosion-resistant standards, thus affecting the corrosion-resistant performance of the whole device.

Dahua provides the following corrosion-resistant brackets:

(a) Corrosion-resistant ceiling mount bracket

(b) Corrosion-resistant pole mount

(c) Corrosion-resistant wall mount bracket

(d) Corrosion-resistant junction box

Figure 3.7 Corrosion-resistant brackets

3.5 Corrosion-resistant Test Standards

3.5.1 WF2 Test Standard

The WF2 corrosion-resistant test is the highest corrosion-resistant standard of China, and a component must meet the following the test conditions:

- Sulfur dioxide gas corrosion concentration: 17.5 mg/L
- Temperature: 40 °C

- Humidity: 100% (with condensation)
- 24 hours per cycle, 10 cycles in total

In addition, the enclosure protection class should be IP54. Two test samples are required.

3.5.2 NEMA4X Test Standard

Compliance to the NEMA 4X standard ensures the device is suitable for indoor or outdoor use and provides a degree of protection against

- access to hazardous parts,
- ingress of solid foreign objects (windblown dust) into the device
- to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water)
- provides an additional level of protection against corrosion

The test requirements for steel (except for SUS304, 316 and 316L) and zinc materials: 800 h salt spray test plus 1200 h wet carbon dioxide and sulfur dioxide air test; judgment standards: No pitting, cracking or other degradations worse than similar tests.

Test requirements for metal materials 304, 316, and 316L, copper and aluminum alloy: 200 h salt spray test; judgment standards: The corrosion should not be worse than the control sample (generally 304 stainless steel).

3.5.3 UL-22 Test Standard

Exempted if aluminum alloy or stainless steel enclosures are used.

4 Summary

Dahua corrosion-resistant products provide high-performance operation and corrosion-resistant housings that improve the service life of devices. These devices are certified to IP67 effectively preventing salt spray from entering the devices and causing corrosion. Dahua products not only meet WF2, NEMA 4X and UL-22 corrosion-resistant standards, but also ensure a long-lasting bright and clean appearance. They can be widely used in chemical plants, ships, islands, ports, wharfs and other scenarios.

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