Chemical Transforming Agent of Chromium （III）

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Abstract

As the ever-increasing realization of environmental protection, study on the chemical transforming agent of non-Cr and Cr (III) has become the research trend in order to decrease environmental pollution during metal surface pretreatment and meet market needs. This paper mainly elucidates the composition, mechanism of functions, advantage and the practical application of a Cr-transforming agent.

Keywords: Cr (III), chemical transformation, metal surface treatment

1. Introducation

Transforming film of chromate has been widely used in all kinds of metal surface treatment for a long time. However, Cr (VI) is toxic due to its effects of causing cancer, teratogenesis, and gene mutation induction, which has become a great burden for many surface treatment processes concerning environment safety. Regulation, management and control on it are more rigorous all over the world, therefore, to develop non-toxic or low-toxic chemicals for replacing chromate transformation is a need.

With the improvement of the standard of people's living conditions, the requirements on product's environmental protection are also inceasing. The existing non-Cr technology, including rare metals, phytic acid, silane and nano-cerammics,etc, but, the present non-Cr technology has shortcomings in low quality of film layer, complexity of process and the high cost, etc. Experiments showed that the transforming technique of Cr (III) to Cr (VI) could be achieved through certain methods, indicating the transformation processing of Cr (III) is still quite valuable.

2. Feature of the Cr (III)- transformation

1) treatment solution does not contain Cr (VI) and the film layer after the treatment also does not contain Cr (VI).
2) meet the specification of the RoHS, WEEE and ELV.
3) Cr(III) treatment solution can be used for different kinds of equipments, eg., spray, steeping, etc.
4) low temperature processing, can be used in room temperature.
5) no phosphate, nitrate, Zn, Ni, Mn and volatile organics
6) suitable for different types of metals, iron material, aluminium product, electrolytic galvanized material, and zinc alloys, etc.
7) suitable for paint, powder, and electrophoretic coating pretreatment
8) no precipitate during production
9) good binding power and corrosion resistance

The treatment could form a uniform and compact nano-level transforming layer on the metal surface, especially for the pressure casting aluminium alloy and galvanized steel, etc. For example, no white rust was found after 100 hr neutral salt corrosion test for the treated steel electrolytic zinc-coated material, and the result of salt-mist corrosion test is similar to that of Cr (VI) transformed film for aluminium materials.

2.1 Mechanism of the Cr (III) treatment agent

After metal interacts with Cr (III) treatment agent solution, metal oxidation and H^+ reduction could occur on the phase interface, causing pH increase around the interface. Cr (III) forms, the decrease in the stability of the Cr(III)-chelate in the solution, the formation of precipitates in the reaction with OH^-, Ti and Zr, and the chemical transforming film layer formation of Cr, Ti and Zr with the increase in pH.

2.2 Composition of Cr (III) treatment agent

Concentrated Cr (III) treatment agent was prepared by a certain ratio of soluble Cr (III) compound, soluble Mg compound, soluble Ti and Zr compound, fluoride and other additives. After the reaction with metal materials, chemical transforming film

layer containing Cr of 0.05~0.8 mmol/m^2 and Ti and Zr of 0.05~1 mmol/m^2 could be formed, with the thickness of 40~100 nm.

2.3 Process condition and experimental method for Cr (III) treatment agent

2.3.1 Flow chart for the processing

Degrease → water wash → water wash (pure water better) → Cr (III) Treatment → water wash→ water wash (pure water better) → dry

2.3.2 Processing condition

concentrated Cr (III) treatment agent solution	40~60 ml/L
pH	4.0~4.2 (adjusted by 1% NaOH or 5% H_2SO_4)
total acidity	3.5~8 point
temperature	room temperature~35℃
time	30~120s
spray pressure	0.8~1.2 bar

2.3.3 Experiment method

Put water (de-ionized water is better) in PVC plastic tank or stainless steel tank, add calculated amount of Cr (III)-treatment agent, stirring to homonize, solution will turn to light green, measure pH, adjust the pH range when necessary.

2.4 Maintaining management for the Cr (III) treatment agent solution

1) Newly prepared Cr (III) treatment agent solution displays a light green color.

2)Check pH every 2hr during production, in general, pH increases as the increase in time and the yield of product. Production time could be longer accordingly with the decrease in temperature.

3) During the production, analysis and addition of Cr (III) treatment agent solution should be done at a certain period of time. 30~70ml Cr (III) treatment agent solution needs to be added for a 1m^2 metal sample (different metal materials need different amounts).

4) A suppressed air is suggested to use for stirring with better effect, quartz pipe or Ti steel for the heating pipe is better when heating is needed in winter.

5) Cr (VI) and other metal contaminants are forbidden to add into the Cr (III) treatment agent, samples dropped in the solution should be taken out in time, using magnetic or screen mesh.

6) In the Cr (III) treatment agent solution, the amount of contaminated ions ≦50~300 mg/L for Fe, ≦10~30 g/L for Zn, and ≦3~8 g/L for Al. For the amount greater than the standard requirement, chemical or ion exchange methods can be use to get rid of the additional ions.

7) After chemical transformation by using Cr (III) treatment agent, temperature in the water cutting furnace is 100~140°C, drying time 15~30min, the drying temperature for Cr (VI) usually less than 80°C and cracks in film layer could occur if higher, which affect corrosion resistant property and the corresponding drying time will be longer. Crystallized water in the transformed film will be lost if the drying temperature is over 100°C, enhancing the transformed film's property in atmosphere change resistance and corrosion resistance. Cr (III) transforming film can maintain 80% of original corrosion resistance when temperature reaches 180°C.

3. Conclusion

Besides the reduction in environmental pollution and the dangers to human health, the life cycle of the Cr (III) chemical transforming treatment agent is relatively long, properties in heat resistance and corrosion resistance are quite good, which is beneficial to metal post-coating treatment or other operations. This can be a better choice for replacing Cr (VI). With the ever-increasing customers' requirement and the social development, for applying Cr (III) products, management should be strengthened with better recycle and control to decrease environmental damage to a lowest level.