Development of Computer-Based Adhesive Wear-Resistant Coating in Fine Chemical Industry and Analysis of Its Wear Mechanism

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Abstract. With the emergence and development of computer technology, it has been used in many fields of production and life. Especially in the production of chemical industry, the role of computer-aided software can not be underestimated. As a research hotspot in the field of fine chemical industry in recent years, adhesive wear-resistant coating can not only make the coating stronger, but also fundamentally save resources. Therefore, it is necessary to develop its materials and analyze the wear mechanism. In this study, the basic information of adhesive wear-resistant coating, the method of developing adhesive wear-resistant coating based on computer, and the wear mechanism and influencing factors of adhesive wear-resistant coating are discussed, which provides a methodology for solving this problem.

Keywords: Fine Chemical Industry; Wear Resistant Coating; Wear Mechanism

1. Summary of adhesive wear-resistant coatings

The wear-resistant coating is a substrate coated with an anti-adhesive coating with friction resistance, and the ratio of the thickness of the coating to the longest diameter of the said ceramic particles is 0.8 to 2.0. Another kind of substrate is coated with an anti-adhesive coating with friction resistance, which includes a bottom coating and a surface coating. The ratio of the total thickness of the bottom coating to the surface coating to the longest diameter of ceramic particles is 0.8 to 2.0. It also includes a composition capable of forming an adhesion coating on a smooth substrate and displaying wear resistance. The amount of ceramic particles is sufficient to provide at least three such particles for every 1 cm long cross section of the coating formed by the composition\textsuperscript{11}.

The use of adhesive wear-resistant coating is to reduce the wear caused by material erosion on equipment parts, and a layer of wear-resistant material is coated on the surface of equipment parts to protect the substrate of equipment parts.

Wear-resistant coatings can be divided into the following types: 1) Adhesive wear resistant coating. Adhesive wear resistant coating can be divided into soft support surface coating and hard support surface coating. 2) Abrasive wear resistant coating; 3) Fatigue wear resistant coating; 4) Erosion resistant coating.
Among them, the wear-resistant coatings obtained by thermal spraying technology and chemical adhesive coating technology have excellent wear resistance. Thermal spraying process requires special equipment and skilled operation technology, the general coating is relatively thin, large area construction efficiency is high. The chemical adhesive coating process is simple, generally, you only need to match the wear-resistant coating adhesive according to the regulations and apply it evenly to the protected parts. This has no higher technical requirements for the construction personnel, convenient construction and low requirements for the site.

One of the most important properties of wear-resistant coating is wear resistance. How to effectively improve the wear resistance of the coating is a subject that R & D personnel have been doing all the time. One of the most commonly used paint chemicals is zirconium phosphate. It can be widely used in architectural coatings, canned coatings, automotive coatings, aircraft coatings, household appliance coatings, wood coatings, bridge coatings, plastic coatings, paper coatings, marine coatings, wind power coatings, nuclear power coatings, pipeline coatings, steel structure coatings, rubber coatings, aviation coatings and other special coatings. A good wear-resistant coating can play the following functions: 1) Remove harmful odor from paint; 2) Enhance the ability of reducing friction and anti-wear; 3) Increase service life; 4) High temperature resistance, acid and alkali resistance; 5) Strong stability; 6) Increase adhesion, leveling and other functions; 7) Antibacterial activity[2].

2. Development of adhesive wear-resistant coating based on computer.

The adhesive wear-resistant coating is to apply the wear-resistant adhesive to the surface of the cleaned parts, and the coating formed after the adhesive is cured is this kind of coating. The wear-resistant adhesive is composed of four parts of raw materials[3]:

1) curing agent: There is a chemical reaction with the dipping material to form a reticular three-dimensional polymer, and the user wraps the filler in the net, and finally forms three cross-linking structures.

2) adhesive: Merge the materials in the coating together and stick them firmly to the surface to form a coating.

3) Special fillers: Most of them are one or more kinds of powders or fibers with certain elimination, such as nitrides, carbides, oxides and boride, etc. The main function is to resist friction, reduce friction, increase strength and endure corrosion.

4) Auxiliary materials: Including diluent, coupling agent, antioxidant and toughening agent and so on. Its main function is to improve the various properties of the coating, including the aging resistance and toughness of the coating. In addition, auxiliary materials can also reduce the viscosity of the adhesive, thus improving the quality of the coating.

After completing the selection of materials, the study should be based on the main factors affecting the wear resistance of adhesive coatings. It includes the amount of toughening agent, powder, curing agent and powder particle size, etc. Through the relevant computer software, the effects of the amount
of various materials and the particle size of the powder on the wear resistance of the whole coating were obtained.

In addition, a computer is needed to help make the optimal design of the coating. The previous experiments can only determine the approximate range of the amount of various materials, but can not find the optimal amount. By using computer-aided software, the quantitative effects of toughening agent, powder particle size and powder addition on the wear resistance of the coating can be obtained. This provides a driving force for the improvement of coating quality\(^4\).

![Figure 2. Computer aided optimization process.](image)

### 3. Wear mechanism and influencing factors of adhesive wear-resistant coatings

Material wear is a process in which the shape, size, structure and properties of more than two friction surfaces change under the action of normal force, relative motion and the action of related medium and temperature environment. From the analysis of the characteristics and results of wear, any kind of wear occurs on the working surface of the object. However, not only the surface of the object changes macroscopically, but also the microstructure and properties of the object will change, and a certain number of wear products will be produced at the same time. Wear is one of the main reasons for the failure of mechanical parts, which has a great impact on the life and reliability of mechanical parts.

In order to solve the problem of wear, the main methods that can be used include\(^5\):

1. Improvement of wear resistance of main materials (metal materials, ceramic materials, polymer materials, etc.). The main factors affecting the wear resistance of adhesive coating are the type, particle size and content of filler, the type and ratio of resin matrix and so on. The hardness and wear resistance of the pure adhesive layer are very low, and the adhesive coating mainly depends on the addition of hard wear-resistant fillers or antifriction materials to improve the wear resistance of the coating. The requirements of the coating for fillers are mainly as follows:
   a) It should be neutral or weakly alkaline, it has good affinity with adhesive, and has no adsorption or little adsorption to liquid and gas.
   b) The particle density is small, the dispersion is good, the particle is uniform, and the sedimentation in the clay is small. The hard wear-resistant fillers that can meet the above requirements mainly include metal oxides, carbides, boride, synthetic diamond, cubic boron nitride and so on. The materials for reducing friction are usually all kinds of self-lubricating materials, which play a lubricating role in the coating and reduce the friction coefficient of the coating to achieve the purpose of reducing friction.
   c) Have sufficient wear resistance and purity. The difference of wear caused by different fillers is directly related to the mechanical properties of fillers, which affects the breakability of fillers. Among them, alumina has fracture toughness in several fillers. Therefore, it is not easy to break, followed by ceramic materials. Hardness is also a factor affecting wear. The shape of the filler also has a certain influence on the wear. When the shape of the filler is mostly sharp corner or flake, it is easy to be broken under the action of sand grinding. When the shape of the filler is fillet or spherical, it is more difficult to break. In a word, the factors such as crushing resistance, hardness and shape of fillers essentially determine the difference of wear resistance of different kinds of fillers.

2. Lubrication
   Lubrication is an effective means to reduce wear. There are not many wear-resistant materials involved, mainly solid self-lubricating materials.

3. Surface strengthening of materials
   Because the wear often occurs on the surface and part of the part, it is an effective way to improve the wear resistance of the material by using the method of surface local strengthening. Surface strengthening technology is the use of a variety of physical, chemical or mechanical processes to
obtain special composition and structure of the material surface to improve its wear resistance and prolong its service life. For example, surface quenching, surface deformation strengthening, surface element diffusion heat treatment, chemical and physical vapor deposition and other technologies have been widely used in many fields\textsuperscript{[6]}.

Among them, surface deformation strengthening refers to a kind of methods to form a hardened layer by mechanical means of plastic deformation on the surface at room temperature, including shot peening, rolling, extrusion and so on. Several kinds of deformation treatment can improve the surface hardness, and the strengthening effect of different methods is different. It directly affects the hardness and depth of the strengthening layer and the residual compressive stress of the surface layer.

Surface quenching is an effective method to improve the surface hardness of materials, including flame induction quenching, heating quenching, high frequency heating quenching and so on.

There are many methods of surface element diffusion heat treatment. Including Carburizing, nitriding, carbonitriding, carbide covering, sulfurizing, sulfur-nitriding, sulfur-nitrocarburizing and multi-element carburizing.

Thermal spraying is the use of high-speed air flow to atomize molten or semi-melted metal, ceramic or polymer materials into particles. After accelerated spraying to the surface of the pretreated substrate, the surface strengthening technology with some characteristics has become an important means of anti-wear and anti-wear construction.

(4) Surface lining protection and repair

The use of amorphous wear-resistant materials to protect and repair the surface lining of the working interface is the most commonly used method at present.

Take the composite wear-resistant material as an example. Inorganic wear-resistant materials have poor chemical corrosion resistance and permeability.

Because of its poor bonding performance to the surface of the substrate, welded steel mesh and tortoise shell net are often needed as supporting materials. On the other hand, inorganic wear-resistant materials are not suitable for the parts with higher wear resistance, unweldable substrate surface, high chemical corrosion resistance and small construction thickness. In this case, people often use composite wear-resistant materials. In the composite wear-resistant materials, the bonding base materials include epoxy resin and its modifiers, phenolic resin, polyurethane and so on. Wear-resistant aggregates are often made of inorganic high-hard materials, such as silicon nitride, corundum, ceramics, silicon carbide and so on.

(5) Process design optimization.

For example, the variable diameter method is used to control the flow rate on the coal pipeline to reduce the wear of pulverized coal to the pipe wall, and rolling transmission is used instead of sliding transmission and so on.

4. Conclusion

Adhesive wear-resistant coating, as the name implies, its most concerned part is its wear resistance. With the help of computer-aided software, the optimal design scheme of coating can be easily made. Ordinary experiments can only determine the defects in the approximate range of the amount of various materials, which provides a basis for the improvement of coating quality. In addition, in solving the wear situation, the methods of improving the wear resistance of the main material and strengthening the protection and repair of the lining on the surface of the material have a good performance, which is worthy of further study. Strengthening the research on the wear of coating can reduce the industrial loss to a certain extent and bring economic significance to the society, which is in line with the slogan of resource saving.

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