Preprocessing and Coating on the Skin Surface of General Aircraft

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Abstract: Aircraft coating is the highest requirement for aeronautical coatings. The electrochemical oxidation, chemical oxidation and phosphating primer used for aircraft skin pretreatment are described. The aluminum alloy coating system and composite skin system are also discussed.

1 INTRODUCTION

The aircraft skin preprocessing and coating is an important part of the aviation industry. Aerospace coatings comprise only a small share of the market in the coating industry, but it is highly demanded dedication, because Aerospace coatings has been under severe load external environment, compared with other varieties of paint, the technical requirement is very special, this is because it must meet the extreme conditions of use. Aerospace coatings must withstand temperature, air pressure change, to withstand different air turbulence. No matter how the flight conditions, aerospace coatings need to withstand the temperature fluctuation of high intensity ultraviolet irradiation, humid environment, chemical invasion (such as fuel, hydraulic oil, cleaning chemicals) and corrosion test, in addition, airlines must have the coating thickness and quality as low as possible, so as to reduce energy consumption. Therefore, the aviation coating must be a very high performance coating, light quality, high performance and environment friendly is the development direction of the aviation coatings.

2 PREPROCESSING OF THE SURFACE OF AN AIRPLANE

Because the base material of the aircraft is mainly aluminum alloy and composite material, it should be treated with proper surface before coating. Why should the airplane surface pretreatment, summed up the [1~2] for two reasons: first, the main material for aircraft Aluminum Alloy base, although its sturdy, but not in the adhesion of coating on the metal substrate on other metals so strong, pretreatment can increase the adhesion between coating and substrate second, oxygen reaction; surface to form a layer of oxide film of pure aluminum and the air, the antioxidant protection effect, but can not effectively prevent Aluminum Alloy corrosion in a changing climate and complex flight environment. During the maintenance of the skin of the aircraft, the surface of the aluminum alloy plane must be pretreated artificially to increase the surface oxide film and strengthen the anticorrosion ability of the metal [3]. The compact oxide film produced by surface pretreatment not only has certain corrosion resistance, but also has uniform and porous film, and the porous structure increases the contact area with the coating, so as to improve the adhesion of the surface coating and improve the corrosion resistance of the aluminum plate. The function of substrate surface pretreatment is mainly to improve the corrosion resistance of substrate and the binding force between substrate and primer, and the quality of surface treatment will directly affect the quality and performance of coating.

2.1 Surface Treatment of Aluminum Alloy in Aircraft

Aluminum is widely used in the aviation industry. For the aircraft coating system, most of the surface of the coating is aluminum skin. The treatment of the metal surface mainly refers to the treatment of the aluminum plate, [4~5]. Electrochemical oxidation (anodizing), chemical oxidation and

phosphating primer 3 [6] are used for the surface treatment of aluminum skin on aircraft. Aluminum Alloy aircraft material has the advantages of light weight, high speed, large payload and strong corrosion resistance and other advantages, especially in the coastal sea perennial pressure

Inevitably, there are various forms of corrosion for aircraft used in the ocean environment, which may cause partial failure of aircraft, increase maintenance cost and reduce product life. Therefore, measures must be taken to reduce aircraft corrosion. Surface coating is one of the most economical and effective anticorrosion methods, and the construction of coating is simple and easy to maintain. Because of its strong plasticity, negative potential and easy oxidation, aluminum alloy has special requirements for surface treatment, coating and coating, [8]. □

The surface treatment of aircraft aluminum alloy has its special requirements. The quality of surface treatment is strict, which has an important influence on the quality of subsequent coating. The surface of aluminum alloy has special requirements for coating. Choosing the right coating and making the proper matching is very important for the anticorrosion effect of aircraft. With the continuous development of material science and corrosion science, the new surface treatment methods and antiseptic antifouling coatings will continue to mature, and more convenient, economic, efficient and environmentally friendly technologies and products will be applied to this field.

In recent years, water-based technology has been applied to the surface protection of aluminum alloys. The waterborne epoxy functional anticorrosive coatings with pre emulsification or post emulsification have been developing rapidly, but there are still many problems, such as the contradiction between convenience and performance. The emulsion or water soluble resin coating for emulsifier, average relative molecular mass distribution and molecular structure, water resistance etc. it is difficult to fully meet the needs of performance, resistance of special medium is also a lack of practical use and the use of data to support; after the emulsion process can satisfy the using performance the requirements, but the process is needed before mechanical emulsification construction is not easy to be accepted by the user, and the future aircraft repair inconvenience. Waterborne coatings also have certain requirements for the construction environment, such as the change of ambient temperature and humidity will seriously affect the curing cycle, the effect and final performance of coatings. Therefore, the large-scale promotion of waterborne coatings in aviation field also needs the attention of manufacturers and the necessary transformation of the construction environment, otherwise, it will eventually affect the promotion of coating Waterborne in the aviation field.

After repair, assembly and pre flight work process, the surface of the aircraft is inevitably adsorbed by dust and oil stains after being overhauled. It must be cleaned before the whole machine is painted. Aluminum alloys are usually anodized to form compact oxide films of several microns to tens of microns. The surface is smooth, and the coating is not adherent. The anodic film on the aluminum surface must be removed before painting. Therefore, the purpose of aircraft surface treatment is to clean the oil, dust and anodized film, and have a certain roughness suitable for the surface of the coating. The procedures for surface treatment usually include solvent scrubbing, cleaning agent cleaning, and so on. In many surface treatment methods, at present, the widely used technology in China is anodization and chemical oxidation. The two methods are relatively mature. The oxide film produced is good for aluminum plate adhesion and corrosion resistance. However, these two methods are to use a lot of electrolytes, such as sulfate, chromate and phosphate, causing serious pollution to the environment, especially the C production has a serious harm to the human body, although in recent years have developed low chromium treatment, closed system technology, but still can not to solve the serious pollution caused by surface treatment on the environment fundamentally. Polymer membrane treatment and sol gel hybrid membrane method can replace chemical oxidation and anodization, so as to solve the problem of C pollution to environment and human body. However, the two methods need further research in terms of process control and sex.

The main coatings used in magnesium alloy kernel are organic coating, silica sol and polymer coating technology. Silica sol and polymer coating technique for the corrosion protection effect is good, but the construction of protective resin can not meet the complex conditions of the requirements for the aircraft engine magnesium alloy shell are: silica sol, silicon resin, epoxy resin, modified epoxy resin, the epoxy resin coating because of its strong adhesion and infiltration of water, high strength are widely used. In addition, there are also ten organic coatings which are treated by organic coating or chemical oxidation. A r high temperature, scour resistant and

anticorrosive coatings related research has been carried out, and some progress has been made.

2.1.1 Electrochemical Oxidation (Anodic Oxidation) Surface Treatment

Anodizing is a three oxidation two aluminum oxide film on the surface of aluminum by electrochemical oxidation. The thickness of the film is generally 5~15 u m. The chromic acid anodizing most used as an example, the membrane structure is divided into two layers; the outer layer of oxide film (Al_2O_3, H_2O) to the electrolyte side, large volume, low hardness, with loose hole, tapered capillary tube; inner film near the substrate is of high purity aluminum side, three thick two aluminum oxide. The anodized oxide film has a larger volume, better durability, good corrosion resistance and good adsorption capacity to the primer. But because of its hard, flexibility and impact resistance, the oxide film produced by Alodin is not as good as it is.

1.1.2Chemical oxidation method [7] produces a thin layer of oxide film on the surface by chemical reaction. Modern aircraft aluminum is used widely for chemical oxidation of Allodin (alodine) method, a Tu Rodin generated oxidefilm generated than anodized film, the film thickness is about 0.5 ~ 4 u m. , and the film is soft, flexibility is good, but poor resistance to abrasion, corrosion and serious when subjected to touch that film will be destroyed quickly, so it should not be used alone, and supporting the use of skin coating, can make up for deficiencies in this regard.

The general Aluminum Alloy substrate after cleaning the surface, with anoding or chromate oxide surface treatment, and titanium alloy plate and stainless steel plate material, the alkali wash oil removal, and then polished. The treated surface should be clean and pollution-free so as to ensure that the 30s water film does not bifurcate continuously. It is recommended that the bottom coat be applied within 24h, otherwise the cleaning and surface oxidation processes should be reconsidered. The quality of the surface treatment directly affects the adhesion of the coating and the quality of the coating.

2.1.2 Surface Treatment of Phosphating Primer

Phosphating primer means the phosphating primer on the surface of aluminum alloy skin is formed by phosphating at the same time, and the phosphating primer itself can not play the role of lacquer alone. It is a surface pretreatment method. The phosphating primer is sprayed on the surface of the skin aluminum plate. A part of phosphoric acid is combined with metal aluminum to make the metal surface integrated with the coating film, and it can provide a good base surface with good combination of primers in the coating system. After coating the phosphating primer, it can directly spray the primer without flushing. The phosphating primer is commonly used for the whole aircraft surface pretreatment layer with the advantages of low cost, short construction time and good environmental protection performance.

2.2 Surface Pretreatment of Aircraft Composite Material

The aircraft surface material in addition to all kinds of metal materials and carbon fiber, aramid fiber and ceramic non-metallic materials such as [11], including carbon fiber, aramid fiber and other advanced material consumption is an important indicator of the level of technological progress of the aircraft, but these advanced composite materials is limited to the processing of complex processes, usually appears as a large area, a single monolithic structure form. Such materials have very high tensile strength and good wave transmission properties, but there are also prominent shortcomings. For example, harsh environmental conditions will seriously affect the service life. Improper use, such as penetration of acidic medium, will destroy the mechanical properties of materials.

Advanced composite material prepreg, curing molding process has been used a lot of adhesive agent in weaving, Hector, mainly epoxy, silicone and silicon sol / gel and poly phenol imine, forming the porosity of the material is large, and the part of the material bibulous rate is higher, not only on the internal equipment later in the process of using "three" (anti heat, anti salt, anti mildew) caused by adverse effects, even if the long-term use of their own also have a negative impact, so the surface sealing and protection of the important. For different prepreg, the similar coating system is more appropriate. Choosing proper pigments and fillers can not only improve the sealing ability of the coatings, but also be beneficial to the strength of the coating itself. With the improvement of the temperature resistance of the aircraft, the improvement of the temperature resistance of the surface coating and the rubber Bob has become the key point for the next stage of development. The long-term service temperature of the coatings prepared by phosphate series gum / resin is

increased to above 650 C, and there is no carbonization residue. Compared with the traditional resin, the coating has a rare advantage.

In recent years, with the energy saving weight of aerospace materials, high-performance composite materials have been widely used in aircraft, such as radome, radio antenna cover, aileron, part of the wing, horizontal and vertical tails, and the most part of the fuselage skin is made of composite material. The surface treatment of composite materials is mainly aimed at removing all kinds of release agents on the surface when forming, and cleaning the surfaces at the same time, forming a good paint surface. It is important to clean up the release agent, especially the silicon containing release agent, which is related to the bonding strength of the coating on the surface of the composite material, and whether it is an important step to get the good coating system. The surface treatment of the composite material is to remove the demoulding agent by mechanical grinding or manual grinding, and cleaning the surface with solvent. A certain fineness of water grinding paper should be used to gently grind the surface of the composite in order to avoid the damage to the surface state of the composite. After finishing the surface of the whole composite material, it is cleaned with solvent or special cleaning agent. Water film continuous method can be used to test the degree of surface treatment. The water film is not broken in 30 s, indicating that the surface has been treated clean. Otherwise, repeated grinding and cleaning work is still needed.

3 COATING SYSTEM AND COATING OF ALUMINUM ALLOY SKIN AND COMPOSITE MATERIAL

In view of the special requirements of aircraft protection, the coatings provided must have comprehensive anticorrosive capability, strong chemical resistance, water penetration resistance, enough abrasion resistance, flexibility, weather resistance, strong adhesion, good leveling, and full color. However, only one coating or single coating is difficult to meet this requirement. Therefore, a variety of coatings need to be made to cooperate effectively to form an effective aircraft skin coating system.

3.1 Aircraft Aluminum Alloy Coating System

For aeronautical coatings, it is necessary to have high corrosion resistance to ensure the safe flight of the aircraft. The coatings for Aircraft Skins at home and abroad have gone through several developing stages: nitro / alkyd coatings to thermoplastic acrylic coatings, and then to normal temperature curing two component polyurethane coatings. With the development and replacement of air coating products, the primers and topcoat on the surface of the aircraft must meet the American military standards and Boeing standards. The primers used for aircraft outer skin coating system conform to the US military standard MIL-P-23377. Currently, the primers that meet this standard are mainly epoxy polyamide primers and polyurethane primers. Epoxy polyamide primers have good resistance to various liquid media on aircraft, and the corrosion factors of environmental conditions, such as moisture and salt fog, are also good.

It has good mechanical properties and good adhesion to different treated oxide films. Two component polyurethane primer on liquid medium machine has good resistance; has good resistance to corrosion factors under atmospheric conditions; good mechanical properties; good adhesion on the surface treated by various Aluminum Alloy; polyurethane paint and surface adhesion between the layers is better than that of epoxy polyamide primer. High gloss double component polyurethane used at present for civil aviation aircraft

The top coat is cured by aliphatic isocyanate, and the top coat for military aircraft is based on thermoplastic acrylic resin single component system, but it is being replaced by polyurethane finish. Two component aliphatic polyurethane coatings are usually used in the surface coating of the outer surface coating system of the outer surface of the aircraft. The performance of this polyurethane coating needs to meet the requirements of US military standard MIL-PRF-85285 and the standard BMS10-72 of Boeing company in the United States. Although the products produced by many aviation coatings suppliers at home and abroad can meet the above two criteria, there are slight differences in the type of curing agents and the selection of hydroxyl resins. The choice of curing agents is mainly HDI (six methylene diisocyanate) trimer and HDI two urea. Most of them are polyester resin and hydroxyl containing acrylic resin. With the development and application of domestic and foreign fluorocarbon resin, fluorocarbon resin super weather ability,

corrosion resistance, oxidation resistance, high temperature resistance and wear resistance has aroused great concern of the people, and through the introduction of fluorine resin modified acrylic resin, fluorine resin coating is introduced into the air in the paint. Aircraft manufacturing companies from all over the world choose the coating system on the outer surface of the aircraft according to their own experience and design requirements.

Outside the aircraft with paint for dope, the primer (corresponding to the middle of the primer) the main varieties of epoxy ester primer, epoxy primer, epoxy primer, polyurethane silicone amine adduct zinc chromate primer and topcoat, is acrylic, alkyd modified silicone, silicone polyurethane, aliphatic polyurethane (polyester polyurethane, acrylic polyurethane etc.). But for some aircraft parts, such as the wing, and the level below stable region and under repair is not easy, need high requirements of corrosion protection, adopts polysulfide with aliphatic polyurethane topcoat is still; and some military aircraft such as the seaplane carrier aircraft and the surface also has excellent resistance to water and salt fog resistance the needs of coatings, corrosion resistant high like epoxy polyamide epoxy and ammonia adduct primer and acrylic polyurethane topcoat, in body shape material and non metal (glass steel, carbon fiber composite materials), used for aircraft wing skin structure and the front fuselage skeleton, flap dome etc., in order to prevent these non metal material surface water and resin aging, and prevent the occurrence of electrostatic interaction, so the use of polyamide epoxy varnish and primer primer, and supplemented by epoxy polyamide or polyester putty The external use polyurethane topcoat, which contains anti - static conductive pigment, such as carbon black, conductive oxide, etc.

In order to reduce the overall weight of the aircraft, increase the distance, the aircraft skin coating system of thin film, lightweight has become more and more important, to meet the premise of constant protection performance of aircraft skin coating under the requirements of the coating thickness decreased by 20%~ 30%. The new lacquer system developed by PPG company, compared with the traditional coating system, can greatly reduce the weight of the coating without losing the protective performance of the coating. Today, with the increasing international fuel prices, the promotion and successful application of the technology will greatly reduce the fuel cost of aircraft and create objective economic benefits for airlines. In high performance aircraft coating, the internationally renowned aviation paint manufacturers to carry out the research and application of the work in the last century in 80s, mainly analyze and study the aircraft during the flight system of the coating corrosion resistance and service life, because the flight environment of the complex diversity, improve the performance of tW coating skin the plane in extreme conditions of coating, such as heat resistance, oil resistance, scratch resistance, character painting, impact resistance [9], 90s launched related products and applications, such as PPG Polyure company, anePrimer 8WKD89, Polyurethane Primer PAC33, Conventional Solods Primer823's etc. the film series products, high and low temperature resistance, impact resistance, soft performance, excellent adhesion and anti vibration performance and the metal substrate, can ensure the process of flying violent In this case, the coating and substrate of the skin will not cause cracking due to the change of stress. Aeroflex series coating product development Akzo Nobel company in the aircraft skin protection has been in use for more than 10 years of P01, in the process of using Months and years pass by. flight, the film still can keep the excellent performance, the film gloss decreased no more than 20%, especially in the erosion tolerance of hydraulic oil flow containing vinegar, cash very good. With the development of science and technology, aircraft flying faster and the heat resistance of external skin Aerospace coatings products also put forward higher technical requirements, modern aircraft flying at high speed in the process of production and the air friction heat can reach 220 CW, which can resist high temperature dope requirements and performance changes do not occur P1'221. However, the traditional aircraft skin coating temperature can not exceed 15 (TC), during the accelerated aging process of hot air, it will greatly affect the service life of coatings, and seriously affect the safety of flight. The new high temperature skin coating developed by the Aeronautical Materials Laboratory has been successfully applied to XB-70 aircraft, which solves the defect of the traditional aircraft skin coating with insufficient temperature resistance. PPG and The Nobel company product Akzo Aerospace coatings with excellent corrosion resistance, salt fog resistance and its product performance can reach 300 ^ heat, outer surface of skin coating is widely used in large aircraft manufacturers, but due to the characteristics of the marine environment of high humidity, high salinity, Xu Cengnai skin salt fog performance index used in the the U.S. aircraft carriers is as high as 5000h.

3.1.1 Aircraft Composite Coating System

The surface protection coating system of composite materials includes surface treatment layer, primer, putty and face coat. Primer Aluminum Alloy skin surface for the general use epoxy or polyurethane primer, to prevent metal corrosion, rust primer added fillers, but not on the surface of the composite metal component, there is no problem of metal corrosion, so it does not need to add anti rust pigment of chromates. Because composite material is a water sensitive material, the strength and electrical properties of composite material will be significantly reduced after absorbing water. Therefore, the primer layer on composite surface should be highly dense, which can prevent water penetration. In addition, because the flight will be affected by solar radiation, air temperature and alternating, high-speed flight, air dust impact, therefore should be selected with weatherability, adhesion, flexibility, high and low temperature resistance, wear resistance and high corrosion resistance of the coating is excellent. When the primer is selected, the weatherability is better, and the polyurethane primer with certain elastic deformation, excellent adhesion and high crosslinking density is used. The composite surface has a porous appearance. After degreasing and grinding, the surface will still have a hole appearance. After priming, the surface pores can not be completely covered. At this time, we need to scrape the elastic polyester putty on the surface of the primer and fill the surface pores. Elastic polyester putty is made from elastic polyester resin and inorganic filler. The putty has good adhesion to polyurethane primer and topcoat, with excellent flexibility and elastic deformation, and has good filling on the surface of the composite. Lightly polish the putty layer after scraping, wipe the surface with the cleaning solvent, then spray a polyurethane primer, and the primer can be sprayed at 6 h above normal temperature, then the polyurethane finish can be sprayed.

At present, the main material for aircraft Aluminum Alloy and high performance composite materials, the pretreatment of Aluminum Alloy surface mainly by anodic oxidation, chemical oxidation and phosphating primer method, the 3 methods have their own characteristics, both at home and abroad, the aircraft manufacturing company has been applied. On the surface of composite material, the cleaning agent should be used to wipe, remove the release agent and polish it. After polishing and cleaning, continuous water film test will be carried out. The water film within 30 s will not break, indicating that the surface of the composite material has been cleaned. The surface treatment of epoxy polyamide primer or primer polyurethane and polyurethane paint is coated on the surface of Aluminum Alloy; surface treated surface composite spraying polyurethane primer, primer after drying, also need scraping elastic polyester putty, used to fill the composite surface pore elastic putty, drying after minor polishing, and again spray polyurethane primer primer sprayed polyurethane topcoat. After the surface treatment of the aircraft, the coating is not only decorative, but also has excellent weatherability, medium resistance and other protective properties.

4 CONCLUSIONS

The progress of aviation technology is an important symbol of a country's industrial system perfection, industrial technology development level and R & D capability construction. [10] is the important branch of material science. The progress of functional coatings technology even influences the development level of large aircraft. With the development of Chinese aviation industry, high speed, high altitude and far space development direction will put forward higher requirements for the paint industry, because of China's coating technical level there is a great development space, the United States Air force is the first development of the air force system, at present in the world still occupy a dominant advantage of the air force, so there is a close relationship between, to improve the performance of protective material -- Application of aerospace coatings very seriously, has formed a relatively perfect system of aviation standard paint, paint the military standard, Airlines Boeing standard, and standard application of PPG company, AKZO NOBEL company related products [11] Aerospace coatings.

Most of China's aviation coatings standards are based on foreign aviation coatings standards or conversion, and lack of a perfect standard system for aviation coatings. Widely recognized in the aviation coatings is the American Standard and Boeing standard. Besides the general enterprise standards and the military standards and industry standards of various countries, these standards are implemented within a certain range and are generally not public. The establishment of domestic aviation coating standards will promote the development of Aeronautical coatings.

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