Engine Cylinder Head Pre-Painting Research Exploration

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Abstract: To solve the problem of inaccurate coating thickness and low adhesion of metal sheet coating in existing technology, this paper has studied and explored the pre-spray of engine cylinder head, providing treatment of metal sheet material, engine head treatment, and an engine cylinder head. Plasma treatment allows plasma to be produced on the surface of metal materials to alter surface characteristics and improve the appearance of metal surfaces; using ultrasonic spraying technology to atomize the paint to form small droplets and be evenly sprayed onto the surface of the material, improving the spray efficiency of the coating solving the problem of inaccurate paint spraying.

Keywords: Engine Cylinder Head; Sheet Metal; Plasma Treatment; Ultrasonic Coating

1. Introduction

The engine cylinder head is a critical component within the engine [1, 2], which seals the combustion chamber to ensure that fuel and air do not leak during combustion, while allowing exhaust gases to escape. The cylinder head is usually metal[3] and can easily rust in wet or corrosive environments.

Apply an even coating to the engine cylinder head[4]. To form a thin film that isolates media from metal contact in an environment, the cylinder head sealing, combustion efficiency, power loss and increased fuel consumption can be avoided due to rust corrosion, Emissions are not up to standard, resulting in longer cylinder head life and reduced replacement and repair costs. Coating the engine cylinder head also improves heat management and maintains the appearance of the cylinder head. However, the painting process is currently inefficient and takes longer to Takt[5]. This paper has developed an efficient and environmentally friendly process for painting the engine cylinder head, and has also provided an engine cylinder head. It is vital to increase productivity and protect the environment.

2. Metal Sheet and Engine Head Treatment

2.1Metal Sheet Handling Method

2.1.1 Ultrasonic Cleaning

Before you treat metal sheets, clean the surface of the panels. Ultrasonic cleaning removes oil, dust, rust and other impurities from the cylinder head surface and hard-to-reach areas, and is far superior to conventional cleaning methods. The cleaning principle is that the small air bubbles produced by ultrasonic vibration produce a small shock wave when they burst, they can penetrate into small porosity and complex structures, thoroughly clean the surface, provide the best starting conditions for the subsequent plasma surface treatment and spraying process, and increase the adhesion of the paint. While ensuring cleanliness, damage to metal sheets is minimal.

Since the cleaning solution keeps dissolved and dispersed contaminants suspended and prevents them from being redeposited onto the workpiece surface, adding the cleaning solution to the water further increases the cleaning efficiency. Cleaning solutions include chemical components such as surfactants, alkaline or acidic compounds, chelating agents and additives, which enable cleaning solutions to play chemical and physical roles not only as a medium for the transmission of ultrasonic energy. The chemical components are effective in dissolving and dispersing oils, grime, metal oxides, and other contaminants, and alkaline compounds are particularly effective in dissolving oils and fats, while acid compounds help to remove rust corrosion and mineral deposits. The chelating agent captures and stabilizes hardness ions in water to prevent scale formation, and the additive protects the cylinder head material from chemical attack during cleaning.

The process of ultrasonic cleaning of metal plates is: According to the type of plate, determine the optimal cleaning parameters corresponding to the plate, such as cleaning time, temperature and frequency, and batch clamp the workpiece to the ultrasonic cleaning tank using the mechanical arm. Rinse and clean with clean, flowing water, remove oil, dust, and other contaminants, and bake them dry.

2.1.2 Plasma Processing

Turn the cleaned workpiece through the transfer equipment to the plasma processing station to determine the optimal cleaning parameters for plasma processing corresponding to the workpiece, such as cleaning time, temperature, and frequency, according to the type of cylinder head. The cleaned workpiece surface is then plasma treated, and the processed workpiece is cooled and dried to gradually cool the surface to room temperature to avoid abnormal internal stresses caused by rapid cooling. In surface treatment, by creating plasma on the surface of the material, the surface properties of the material are altered, the surface adhesion of the material is improved, and the plasma can be used to further clean the surface and to activate or alter the chemical and physical properties of the material surface. This enhances the adhesion of paints and coatings.

The parameters for plasma processing can be adjusted according to the characteristics of paints and plates. When painting the cylinder head, due to the large area and complexity of the cylinder head, more processing time is required to ensure uniformity of treatment and surface activation, which can result in unnecessary energy consumption and increased production time. Plasma processing time is 30 to 120s, which can achieve plasma processing without waste of energy, and to avoid thermal damage to the substrate or coating, the plasma treatment temperature is 25 to 100°C. In addition, the power of the plasma processing process is low, which reduces the stability of plasma processing, and if power is too high, the plasma generates excessive heat and reduces processing efficiency. Too much power can also cause damage to metal plates, which can affect the adhesion of the paint. Thus, plasma processing power in this article is 10W~15kW, which not only ensures the production and intensity of the plasma, but also enhances the adhesion of the layer by effectively activating the surface of the metal plate, while also reducing processing time. For efficient production.

2.1.3 Ultrasonic Spraying

Ultrasonic spraying technology has significant advantages in improving spray efficiency, saving material and improving coating quality, mainly by using ultrasonic vibration to atomize the paint. During the spraying process, the ultrasonic generator produces high frequency vibrations transmitted through a special nozzle to the paint, which causes the paint to form small droplets, which are then sprayed evenly on the target surface.

In terms of paint selection, the most common paints currently include high temperature heat resistant paints, rust resistant primers, epoxy paints, polyurethane paints, one or more ceramic based paints, self-lubricating paints, aqueous paints, and UV-cured paints, which act to form a protective film on metal plates to isolate media from metal in the environment. Forms protection for metal sheets. High temperature heat resistant paint can withstand high temperatures ranging from 150°C to 350°C and can contain special heat resistant additives such as silicone, epoxy resins or polyamide. To ensure that no decomposition or loss of adhesion is present at high temperatures. A rust-resistant primer can be applied before the hot heat-resistant paint to protect the metal surface from rust, which can be an epoxy primer containing zinc, aluminum or other rust-resistant ingredients. The epoxy paint is a two-component paint consisting of resin and hardener, which forms a very strong coating after curing, resulting in good chemical stability and wear resistance of the epoxy paint. Polyurethane lacquers are weatherproof and wear resistant, as well as good adhesion and flexibility. Ceramic-based coatings contain ceramic components to provide additional insulation and wear resistance. Self-lubricating paints reduce friction between the engine head and other components and may use self-lubricating paints, which contain lubricating ingredients such as graphite and molybdenum disulfide. The aqueous paint uses water as a solvent, reducing VOC emissions and meeting the requirements of green manufacturing. UV curable paints cure rapidly under UV rays, reducing the use of solvents, improving productivity, improving hardness and chemical resistance, and making them more environmentally friendly.

The treatment method is: Transfer the cooled and dry workpiece to the ultrasonic spray station via the transmission device, adjust the distance between the nozzle and the workpiece according to the workpiece batch, determine the power of the ultrasound generator, etc. The ultrasonic generator produces ultrasonic vibration. The spray solution forms a small droplet and is sprayed on the workpiece surface. During the ultrasonic spraying process, the paint is sprayed on the first surface by means of a nozzle, which is connected to the ultrasonic generator, which produces high frequency vibration when spraying. Vibration is transmitted into the paint inside the nozzle, vibrations from the nozzle and the paint cause the paint to form small droplets, the droplets are sprayed evenly on the first surface to form an even film, and the droplet-like coating reduces paint waste. Reduce costs. The ultrasonic power is 500W~2000W, which helps the paint form even droplets, improves spray efficiency, saves material and improves coating quality, and also prevents excessive heat from being generated by excessive power. Damage to the surface of the board can also avoid the problem of insufficient atomization and uneven application due to low power.

To further ensure uniform film thickness is formed when spraying, During ultrasonic spraying, the nozzles spray the coating on metal plates after atomizing it. Because the distance between the nozzle and the surface of the metal plate affects the coverage and deposit of the paint spray, setting a minimum distance of 5 to 20mm helps to ensure an even distribution of the coating on the surface of the workpiece. Avoid uneven coating thickness, local accumulation, or thin coating caused by too close or too far, and the above distances increase the efficiency of coating transfer and reduce paint waste during atomization. By adjusting the nozzle-to-surface distance, the thickness of the membrane can be precisely controlled, and the problem of uneven application can be avoided by being too close or too far away.

2.2 Engine Cylinder Head Treatment

The process flow for the engine head treatment method is shown in Figure 1. First place the cylinder head in a cleaning tank with washer fluid according to the first engine cylinder head provided, and perform an ultrasonic cleaning of the cylinder head, which contains multiple ultrasonic generators and oscillators, as shown in Figure 1 (a). Cleaning the engine head and removing surface oil and dust, etc., provides the best starting conditions for the subsequent plasma surface treatment and painting process, and enhances the adhesion of the paint.

After cleaning the first engine cylinder head, the second engine cylinder head is obtained, and the second engine head is transferred through the first conveyor into the plasma treatment chamber to plasma the outer surface of the second engine head, as shown in Figure 1 (b). Using the plasma surface treatment process, the cylinder head surface can be further cleaned to remove grease, dirt, organic matter, and other impurities from the surface of the material. Provides a clean substrate for the coating and improves mechanical anchoring between the coating and the substrate.

After the second engine cylinder head has been plasma treated, the third engine cylinder head is obtained, the third engine cylinder head is transferred to the ultrasonic spray table via the second conveyor, and the outer surface of the third engine head is painted through the nozzles, where The nozzles are connected to the fuel supply pump, the ultrasonic generator, and the air supply lines, which supply the spray nozzles with paint when ultrasonic spraying, which can cause the paint to form small droplets, and the air supply lines supply the nozzles. Increase the pressure inside the nozzle as shown in Figure 1 (c). Using ultrasonic coating technology, the cylinder head can be accurately painted, the rear lake of the paint is controlled, the spray is even, and the problem of paint spray is not precise is solved.

Surface UV curing technology refers to exposing paints or coatings containing photoinitiator to high-intensity ultraviolet radiation, which absorbs light energy and triggers chemical reactions, resulting in the rapid cross-linking of monomers or prepolymers in the coating to form a rigid solid coating. Ultraviolet curing is therefore an efficient, environmentally friendly method of curing paint that provides high quality coatings, and is suitable for industrial applications where productivity and coating quality are required.

So, after the third engine cylinder head has completed plasma treatment, the first membrane is formed on the surface of the cylinder head, the fourth engine cylinder head is obtained, the fourth engine cylinder head is transferred to the ultraviolet curing chamber via the third belt, and the third engine cylinder head is exposed to ultraviolet light. Cure the first membrane to the second membrane, as shown in Figure 1 (d). After painting the cylinder head, use UV light curing technology to reduce the curing and drying time of surface paint and improve the efficiency of the work, and the cured membrane can withstand temperatures of 150℃ for a long time.

The engine head treatment proposed in this paper can be completely automated, enabling a black-light factory, eliminating the need for manual operation, reducing costs, and achieving uniform performance of the cylinder head effect.

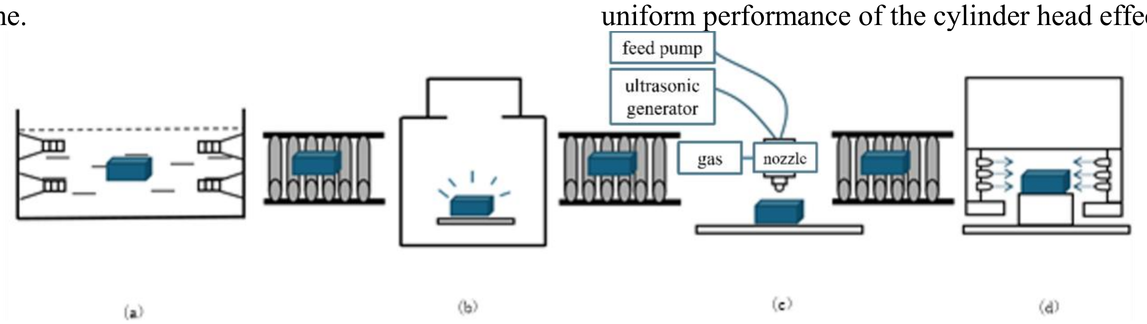

Figure 1. Engine Cylinder Head Treatment Process Flow Diagram

3. Engine Cylinder Head

This document provides an engine cylinder head, as shown in Figure 2, where 7 is the third surface of the engine cylinder head. The third surface of the engine head was obtained using the above-mentioned treatment of the engine head. After plasma treatment and ultrasonic coating, the coating was sprayed on the surface of the cylinder head using the ultrasonic spray application process, which produces high frequency vibrations, which cause the paint to form small droplets. Drip-like paint can be sprayed evenly on the target surface to obtain a first layer of uniform thickness and adhesion requirements.

Controlling the first layer thickness below 20 μm ensures optimum contact between the first layer and the face of the cylinder head, thereby increasing adhesion. A thick film may cause increased stress within the first membrane and affect its integration with the substrate, and a moderate thickness avoids this problem, improves the stability and durability of the first membrane, and accurate film thickness control helps to achieve an even distribution of the first membrane on the face of the cylinder head. Avoid local thicknesses or thinness to ensure the entire surface is of the same protection and appearance quality.

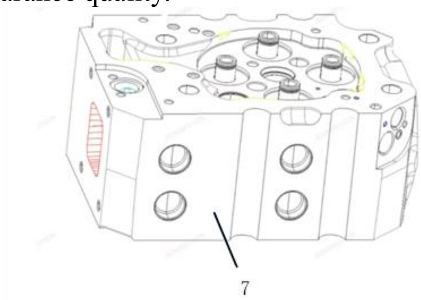

Figure 2. Engine Cylinder Head Structure Schematic

4. Handling Methodology Advantages

To compare the advantages of the processing methods presented in this paper, According to the metal sheet materials provided, the surface of the metal sheet materials shall be cleaned using ultrasonic cleaning according to the design scheme of Table 1, the surface of the metal sheet materials shall be plasma treated, and the surface of the metal sheet materials shall then be treated with high temperature heat-resistant paint using ultrasonic spray. The first membrane is formed at a thickness of 15 μm, and the first membrane is cured using the UV curing technique, resulting in a second membrane layer.

Table 1. Design Table for Metal Sheet Handling Solutions

Program Number	Ultrasonic cleaning			Plasma processing			Ultrasonic spray	
	Time /S	Temperature /℃	Frequency /KHz	Time /S	Temperature /℃	Power /KW	Power /W	Distance /Mm
1	150	30	30	70	60	13	1000	15
2	100	20	20	30	25	10	500	5
3	300	40	40	120	100	15	2000	20
4	500	70	10	70	60	13	1000	15
5	150	30	30	170	130	20	1000	15
6	150	30	30	70	60	13	200	20
7	150	30	30	70	60	13	200	30

8	500	70	10	170	130	20	200	30

The design comparison scheme is to clean the supplied sheet metal with a cleaning time of 150s and a cleaning temperature of 30°C, and then spray the high temperature heat-resistant paint on the surface of the sheet metal. The first membrane is formed at a thickness of 15 μm, and the first membrane is cured using the UV curing technique, resulting in a second membrane layer. The results are shown in Table 2, comparing the adhesion of each protocol.

Table 2. The Adhesion Results Tables for Each Protocol

Scenario number	1	2	3	4	5	6	7	8	Comparison scenarios
Adhesion	Level 0	Level 0	Level 0	Level 0	Level 0	Level 0	Level 0	Level 0	1

After plasma treatment and ultrasonic coating of metal sheet materials during surface treatment, the adhesion of the membrane layer is level 0, and the adhesion of the conventional spraying method is less than level 0. Explain that plasma and ultrasonic coating of metal sheet materials can solve the problem of low adhesion of coating coating of metal sheet coating.

The first membrane thickness test was performed on scenarios 1-8 and the thickness test results are shown in Figure 3. Options 1-8 can be found to be less than 10 μm thick film, which can solve the problem of thick metal coating on sheet materials and more than 20 μm thick in existing technology.

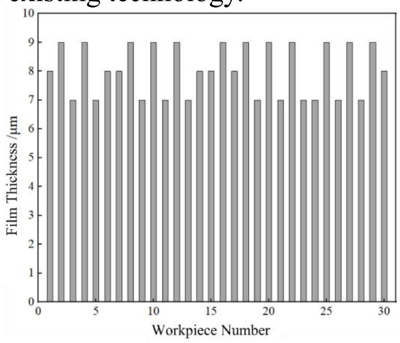

Figure 3. Test Diagram for the First Membrane Thickness

Also, to verify stability issues for scenario 1, 10 sheets of metal were prepared in accordance with the design parameters of the above-mentioned scenario 1 and the comparison scenario, and the film thickness, adhesion and salt resistance were measured against 10 sheets of metal sheet from option 1 and 10 sheets of metal sheet from the comparison scenario, respectively. The results are shown in figures 4 through 6.

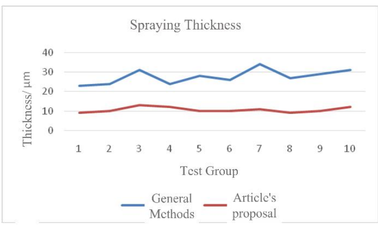

Figure 4. Film Thickness Comparison Chart

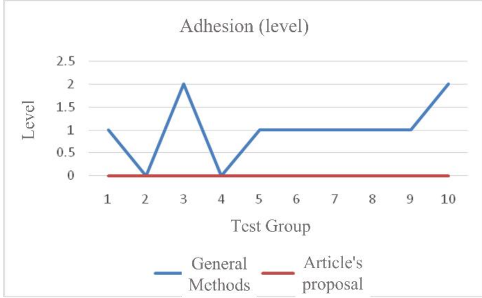

Figure 5. Film Adhesion Comparison Chart

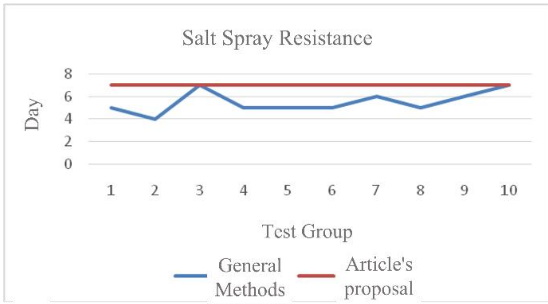

Figure 6. Salt Spray-Resistant Days Comparison Chart

As shown in Figure 4, the thickness of each sample in Protocol 1 is less than 20 μm and the adhesion is 0; as shown in Figure 5, there are two examples of comparison sample thicknesses greater than 20 μm and adhesion is 0. The other samples have an adhesion of 1 or 2; as shown in Figure 6, the sample for protocol 1 is resistant to salt spray in days greater than the proportional salt spray in days.

Based on the above analysis, it can be concluded that the film thickness after plasma and ultrasonic coating of metal plates is less than 20 μm, the adhesion is 0, and the salt spray resistance is more days than the existing technology. Explain that using the above method can solve the problem of heavy coating of sheet metal coating and low adhesion in existing technology.

5. Conclusion

(1) Plasma the surface of metal plates, which changes surface characteristics by creating

plasma on the surface of metal materials, improves metal surface adhesion, and allows the plasma to clean the metal surface, It also activated or altered the chemical and physical properties of the material surface, providing a clean substrate for the coating, thereby enhancing the adhesion of paint and paint.

(2) The first membrane is formed by applying the paint to the first surface using the ultrasonic spraying process. During the ultrasonic spraying process, the ultrasonic generator produces high frequency vibrations, which cause the paint to form small droplets, and the droplet-like coating can be applied evenly to the target surface. Resolve the issue of paint painting inaccurately.

(3) After plasma treatment and ultrasonic spray treatment of the engine cylinder head, the adhesion of the membrane is level 0, which means that the treatment proposed in this document can effectively solve the problem of low adhesion of the coating coating applied to metal sheet coating. Both layers are less than 10 μm thick, which can solve the problem of metal sheet coating thicker and thicker than 20 μm in existing technology.

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