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# *Anticorrosive Coating of the Vertical Vibrating Lifting Pipe in Deep Sea Mining under the Microscope*

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***Abstract:*** To explore the observation of the anticorrosive coating of the vertical vibration lifting pipe in deep sea mining under the microscope and the comparative analysis of the anticorrosive coating. Methods: the corrosion resistance of three kinds of common coatings on the market were tested. The hardness, dry time, gel time, solid content and water absorption rate of polyurea coating, polyurethane coating and epoxy iron coating were measured. The advantages and disadvantages of polyurea coating, polyurethane coating and epoxy micaceous iron coating are compared through the experimental data, and they are observed under the microscope, and analyzed quantitatively and qualitatively. Results: the elongation at break of polyurea coating, polyurethane coating and epoxy micaceous iron coatings were 48.83%, 9.41% and 42.27% respectively. The tensile strength of polyurea coating is nearly 8 times that of epoxy micaceous iron and 2 times that of polyurethane. In time, the gel time and drying time of polyurea coating were very short, the gel time was only 9s, and the drying time was only 46s. The solid content of polyurethane coating is 66.8%. Compared with polyurea coating and epoxy micaceous iron coating, the volatile content of polyurethane coating is much higher than the other two coatings. In terms of water absorption, the maximum water absorption of epoxy micaceous iron coating is about 0.76%, that of polyurea coating is about 1.16%, and that of polyurethane coating is about 3.21%. Conclusion: the corrosion time of metal under polyurethane coating is faster than that of other two coatings. Compared with polyurea coating and epoxy micaceous iron coating, the volatile content of polyurethane coating is significantly higher than the other two coatings. The hardness values of polyurea coating, polyurethane coating and epoxy micaceous iron coating are all higher, while the hardness values of polyurea coating and polyurethane coating are similar, while that of epoxy micaceous iron coating is relatively lower. The anti-corrosion coating of vertical vibration riser in deep sea mining was observed by microscope and good results were obtained.

## 1. Introduction

In the struggle for maritime rights and interests, all countries in the world have vigorously developed marine science and technology, and actively explored and utilized mineral resources, especially rare metals. Therefore, the global focus is on polar regions and oceans with rich metal resources [1]. Compared with traditional electrochemistry or corrosion medium, sea mud has many unique properties as corrosion medium. The application of anticorrosive coating in metal anticorrosion has become the main means of metal anticorrosion [2]. The hoisting hard pipe in the hoisting subsystem is composed of hoisting steel pipe, pipe joint and multi-stage electric cooker. The characteristic of current motion is that the speed and direction change slowly with time and space [3].

In the actual calculation of ocean engineering, the flow is generally regarded as a steady flow, that is, the flow is a stable plane flow with the same direction. The distribution of velocity with vertical water depth can be represented by exponential distribution or logarithmic distribution [4]. Due to the action of wind, wave and current, the mining ship produces drift motion, low frequency oscillation motion and high frequency oscillation motion on the sea surface [5]. Generally, as a rigid body, the motion of a mining ship in any space has six degrees of freedom. With the increase of wave period, i.e. the decrease of wave frequency, the maximum axial force on the top of ore lifting subsystem gradually decreases [6]. In the actual operation of mining deep-sea polymetallic nodules, because the vertical amplitude of the bottom of the lifting subsystem is too large, it often affects the service life of the lifting subsystem and the precise positioning of the collector, which will eventually lead to instability and low efficiency of the deep-sea mining system. The axial stress on the top of the lifting subsystem will seriously affect the safety of the lifting subsystem, so it is necessary to reduce the vertical amplitude and axial stress of the lifting subsystem to avoid resonance. As an auxiliary subsystem, the shock absorber can be attached to the main vibration system to distribute the energy of the vibration source to the auxiliary subsystem. The shock absorber provides the reaction force for the main system to counteract the excitation force, thus reducing the dynamic response of the main vibration system [7].

This study fully contains the three kinds of coating samples, such as oxygen cloud iron, polyurethane and polyurea, which are normally sold in the market, and carries out anticorrosive performance test. The hardness, dry time, gel time, solid content and water absorption of polyurea coating, polyurethane coating and epoxy iron layer are quantitatively and qualitatively analyzed, and the coating under microscope is observed and analyzed. The main feature of this study is to carry out the research combining with the observation of microscope. In the research, the advantages of polyurea coating, polyurethane coating and epoxy micaceous iron coating are compared through the experimental data. It is believed that through the research of this paper, China will obtain more priority exploration rights and exploitation rights in the future international seabed area, quickly keep pace with the development of deep sea resources in developed countries, meet the sustainable development of increasing China's demand for metal mineral resources in the future, and win the competition and competition of China's plan in the future international seabed resources, The design and development of deep-sea mining system has become an urgent task. In order to protect the legitimate rights and interests of China's oceans and the future demand for mineral resources, promote China to occupy a leading position in the international exploitation of marine mineral resources in the new era.

## 2. Main Contents

### 2.1. Anticorrosive Coating

(1) Anticorrosive coating of submarine pipeline

Like soil on land, sea mud is made up of solids, liquids and gases. Solid pores are filled with liquid and air. Liquid is attached to solid particles, some of which can flow in micropores. Near the surface of sea mud, due to the influence of sea water, the oxygen content is higher than that of sea soil, which is the reason for the corrosion of oxygen concentration tank [8]. It makes sea mud an electrolyte with low resistivity, usually containing bacteria and other microorganisms. The gases produced by bacterial activity are corrosive. Sulfide produced by sulfate reducing bacteria has also attracted people's attention.

However, the porous and colloidal properties of the solid phase, as well as the organic mixing with the gas phase, coupled with various combinations of water molecules and sea mud particles in the liquid phase, are quite different from many single-phase corrosion media. Second, non-fluidity: compared with the pipeline buried in the seabed, the solid phase is relatively non fluidity, without mechanical agitation and convection, while the liquid phase and gas phase can only move through the capillary gap, with poor fluidity. Therefore, the gas-liquid phase in the solid-phase capillary becomes the main way of material and energy transfer in the sea mud, and plays an important role in the process of sea mud Corrosion [9]. The third is non-uniformity: due to the formation of different polymerization structures and the control of the amount of sea water, the physical and chemical properties (especially the electrical properties) of the sea mud have a large non-uniformity in a small range or in a large range. Fourth, time seasonality: the nature of sea mud is different at different times [10]. Taking a year as a cycle, the properties of sea mud are not only different at different times of the same cycle, but also not repeated at the same time, but in different cycles. The particularity of seawater slurry as corrosion medium will affect its electrochemical corrosion process [11].

(2) Influencing factors

There are many factors that affect the corrosion of sea mud. In addition to the metal material itself, it is mainly related to the resistivity, water content, salt content, total salt content, cation, anion, sulfide, pH value, temperature and depth of the sea mud [12]. The resistivity of sea mud is directly affected by soil quality, water content and salt content, which can reflect the corrosiveness of sea mud in most cases. Generally speaking, the smaller the resistivity of sea mud, the stronger its corrosiveness. However, due to many factors affecting the corrosion of marine mud, the correlation between single resistivity and corrosion rate is not high. The sharp change of resistivity in some sections indicates that the nature of sea mud changes greatly, which may lead to the formation of strong corrosion batteries and serious corrosion. The water content of seawater slurry has a great influence on the corrosion of seawater slurry. If the humidity increases further, the salt concentration will decrease and the pores will be blocked by the expanded mud particles. When the cathode process is limited, the corrosivity of sea mud is reduced. In general, when the sea mud is wet, the corrosion of the sea mud will accelerate. One of the most influential is chloride ion, which can destroy passivated metal materials greatly, because chloride ion can easily pass through pores (passivation) film and interact with metal to form soluble compounds, or expel oxygen of protective film, which changes ionic conductivity and conductive film, and increases the oxidation rate of metal. The existence of sulfide in sea mud is closely related to the activity of sulfate reducing bacteria. The effect of organic matter on metal corrosion is often enhanced by the active process of marine mud microorganisms. The gases and acids released during the decomposition of organic matter can directly dissolve steel. In general, under the condition of high organic matter content and high humidity, microorganisms are prone to corrosion. On the other hand, with the increase of organic matter content in the sea mud, the soil colloid expands and the porosity decreases, which directly hinders the permeability of the sea mud, thus hinders the cathodic corrosion process. The change of acid and alkali in seawater mud has many effects on corrosion.

The factors that affect the choice of coating are: sea water resistance; simple coating; impact resistance; long-term stability; strong adhesion with steel pipe; resistance to bacteria and marine biological erosion; wear resistance; good electrical insulation; good flexibility; cathodic stripping resistance; good heat resistance; pressure influence. Pitting is the main cause of running, drainage, dripping and oil leakage, sometimes even causing serious accidents. Groove corrosion is a special kind of crevice corrosion, which often occurs under the protective film. For steel parts requiring anti-corrosion coating, in order to prevent groove corrosion, low water permeability coating must be used, and the coating adhesion and compactness are good. Metal cracks are caused by stress corrosion, the synergistic action of crack stress and corrosion solution. The basic anticorrosion methods of submarine pipeline include primary anticorrosion or anticorrosive coating protection and secondary electrochemical cathodic protection. The combination of the two methods can achieve good protection effect. The anticorrosive coating of submarine pipeline mainly refers to the horizontal pipeline buried in the seabed silt.

(3) Coating type

Coating type: the external anti-corrosion coating for submarine pipeline mainly includes the following types: fusion bonded epoxy resin coating. The coating is suitable for pipes of various diameters. When combined with cathodic protection, only a small amount of current is required. Its disadvantage is easy to be broken by sharp and hard objects. Because of its inherent toughness and smooth surface, it is not easy to embed into the concrete counterweight layer, so it is easy to slip when laying the submarine pipeline. For counterweight coating, if the surface has not been specially treated, this anticorrosive coating is not generally used. Polyethylene coating. It is the most suitable coating material for land pipelines and sometimes used for subsea pipelines. It can be divided into high-density and low-density, and can be used by belt method, vulcanization bed method or extrusion method. The utility model has the advantages of wear resistance, impact resistance, seawater penetration resistance, etc.; the disadvantage of the utility model is that it is easy to produce environmental stress cracking, and the cathode stripping performance is poor. At the same time, we must control the selection and use of primers.As the external anticorrosion of submarine pipeline and onshore pipeline, its performance is excellent, and its anticorrosion life can sometimes be up to 60 years.This kind of coating is the most suitable when the pipeline needs to increase the weight-added layer, which can effectively prevent the slip of the thick intermediate layer in the pipeline laying process. The coating can be used with fiberglass cloth to increase the strength and toughness of the coating. Composite coating. Near the outer surface of the pipe is a thin fusion epoxy coating, and the outer layer is a thick polyethylene coating. Combine the two together with an excellent adhesive. This kind of coating has both advantages and disadvantages. Epoxy coal tar coating. The coating is suitable for onshore and subsea pipelines. It has the advantages of epoxy resin and coal tar, and overcomes the disadvantages of coal tar. It can be used with glass cloth to improve the coating strength. This kind of coating is rich in raw materials and cheap in price. However, the curing time after coating is too long to realize automatic continuous operation, the process is complex, the quality control is not good, and the production efficiency is low.

## 2.2. Metal Corrosion

(1) Form

According to the form of corrosion, metal corrosion can be divided into chemical corrosion, electrochemical corrosion and biological corrosion. The protective effect of the coating on the metal is to achieve the anti-corrosion effect by blocking one or more steps in the above process. The protective effect of the coating on the metal substrate is mainly shielding, anode and cathode protection: no matter the shielding effect is low solid content coating with 100% solid content, there will be a lot of pinholes and micro gap coating after the film-forming polymer chain structure for various reasons, they provide a channel, oxygen, water and corrosive ions. When the corrosion medium reaches the interface area of the coating metal through the coating and accumulates a certain concentration, it will cause the corrosion of the base metal. Anode action is to add pigment with corrosion inhibition or passivation effect to the coating. The ions in pigments can produce physical, chemical, ionization and other functions through the induction of water, and produce various chemical ions with corrosion inhibition. At present, it is mainly used for antirust primer. As lead and chromium compounds can ionize toxic chromium and lead ions which do great harm to human body and cause serious environmental pollution, the use of lead and chromium compounds has been banned by the state. At present, zinc series compounds and iron red series compounds with strong environmental protection are mainly used. Antirust primer is developing towards the direction of high solid content and solvent-free. Metal pigments with higher activity than the base were added to the coating. According to the electrochemical principle, the potential of the active metal is lower than that of the protected metal, so when corrosion occurs, the base metal is protected by the sacrificial anode. Zinc and aluminum rich coatings are more popular.

(2) Raw materials

Alkyd resin is widely used because of its wide source of raw materials, variety, good performance and low price. Through the combination of modified alkyd resin and water alkyd resin, the comprehensive performance of the coating is improved to meet the requirements of environmental protection. Acrylic modified alkyd resin coating has high hardness, good polishing performance and good weather resistance. Epoxy resin anti-corrosion coating has a large proportion in the field of anti-corrosion due to its excellent physical and chemical properties, convenient construction and good protective performance. The traditional epoxy anticorrosive coating is abandoned because of the pollution of organic solvent to the environment. At present, the epoxy anticorrosive coating is developing towards the direction of solvent-free and weather resistant corrosion, and the water-based epoxy anticorrosive coating is the focus of its development. The epoxy micaceous iron anticorrosive coating is generally used as the intermediate coating to prevent corrosion. Micaceous iron can also eliminate the stress caused by the curing of epoxy resin, reduce the damage caused by the coating temperature or external force, and improve the weather resistance and wear resistance of the coating. Epoxy zinc rich anticorrosive coating is widely used in modern anticorrosive engineering for its excellent anticorrosive effect. From a thermodynamic point of view, most metals in nature are stable in the form of compounds.

(3) Packing

People have developed towards the environmentally friendly inorganic zinc rich direction. With the development of technology, the anti-corrosion requirements of some structures have been improved to meet the requirements of environmental protection. Therefore, the common solvent epoxy anticorrosive coating cannot meet the requirements. It is necessary to modify the epoxy resin so that it has high-efficient anticorrosion performance and good environmental protection performance. Waterborne epoxy resin is an important target of environmental protection. The modified polyurethane anticorrosive coating has excellent properties of modifier and body, and also has excellent properties. The fluorocarbon coating has low surface tension. Glass scale anti-corrosion coating is ultra-low permeability, easy to repair damaged coating, high solid content, green and environmental protection.

## 3. Simulation and Analysis of Anticorrosive Coating Experiment

### 3.1. Experimental Materials

Choose three kinds of coating samples which are often sold in the market, namely, oxy micaceous iron, polyurethane and polyurea, for corrosion resistance test. The thickness of the sample is 0.5-0.7mm. Spray polyurea for sampling according to the laboratory production standard. The sample thickness is 1.5-2.0mm. The samples were cured under standard conditions for 7 days and tested using the appropriate laboratory equipment.

### 3.2. Experimental Method

Put the clean culture dish into the oven at (120 ± 2) ℃ for 30min, take it out and put it into the dryer, cool it to room temperature, weigh it. Weigh the stirred sample of not less than 2G and place it in the culture dish, so that the coating sample is evenly distributed at the bottom of the culture dish. Then put it in the drying oven to dry it for 3h at the specified temperature, then take it out, put it in the glass dryer (standard condition) and cool it to room temperature, then weigh and repeat the above operations until the difference weight between the two does not exceed 0.01g (the most accurate weight is 0.01g). For reactive coatings, it is necessary to weigh them for the first time in a Petri dish, place them under standard conditions for 24 hours, and then carry out subsequent experiments. Epoxy micaceous iron and polyurethane shall be evenly coated on the sample plate. After the paint film is dried and formed, paraffin shall be coated around the plate. The depth of paraffin shall not be less than 5mm. After the paraffin becomes hard (35min), weigh the sample (G1) immediately. Cut 50 mm × 50 mm polyurea sample pieces, dry them in an oven at (50 ± 2) ℃ for (24 ± 1) h, move them to the oven and cool them to room temperature, take them out and weigh each sample (G1). Put the prepared sample into a glass container vertically, including distilled water, water temperature 25 ± 1 ℃, soak for 24 hours, take out the sample test plate and tweezers, quickly absorb the paint film and hanging paper on the water surface, and immediately weigh (G2). The time from removal of each test plate from water to weighing shall not exceed 2 minutes.The steel plate for the test shall be treated according to the engineering coating method and the surface dust shall be removed. Since primer is required before epoxy micaceous iron and polyurea are applied, two groups of sample pieces shall be selected and primer shall be applied. After the primer is dried, the epoxy micaceous iron, polyurethane coating and polyurea are applied to the steel plate uniformly. The sample volume is 100 mm × 200 mm × 2 mm. The thickness of three parallel sample coatings, epoxy micaceous iron and polyurethane is 120-150, and the thickness of polyurea coating is 1500-1600-hm, which is 7 days under the cure standard condition. The coating sample is immersed in a constant temperature water bath. The experiment was carried out at 23 ± 0.5 ℃, 50 ± 0.5 ℃ and 90 ± 0.5 ℃ respectively. The adhesion tests were carried out on 1d, 3d, 5d, 7d, 15d and 30d respectively. The specific operation of adhesion test is as follows: take the sample out of the water bath, absorb the water on the surface with the filter paper, select the smooth and flawless coating surface, polish the coating surface gently with the sandpaper to make the surface have a certain roughness; clean the surface of the main shaft with acetone, remove the impurities such as oil dirt and dust; use the modified acrylate adhesive for bonding; After the bonded samples are cured at room temperature for 24 hours (the wet bonding test needs to put the samples into 100% humidity and the corresponding curing temperature environment) for bonding test. Before the test, cut the coating around the spindle with a tool, apply a uniform force, observe and record the data after the coating and the substrate are separated. The interface between coating and metal was analyzed by SEM.

## 3.3. Experimental Results and Analysis

(1) Hardness analysis

*Table 1. Hardness analysis*

| Project | Polyurea | Polyurethane | Epoxy micaceous iron |
|---|---|---|---|
| Tensile strength / MPa | 24.65 | 11.79 | 2.72 |
| Elongation at break /% | 48.83 | 9.41 | 42.27 |
| Hardness | 92 | 89 | 50 |

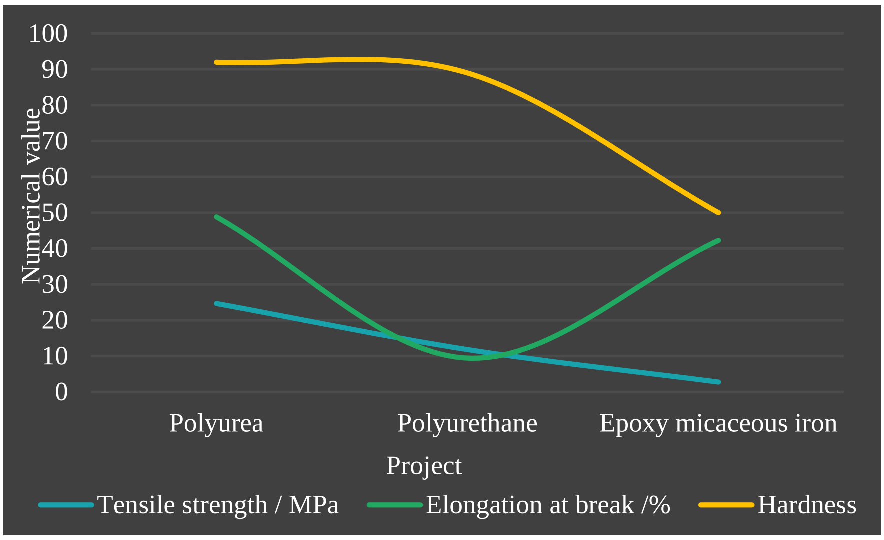

*Figure 1. Hardness analysis*

According to the statistical analysis of data, as shown in Figure 1 and Table 1, the tensile strength of polyurea coating, polyurethane coating and epoxy micaceous iron coating is 24.65mpa, 11.79mpa and 2.72mpa respectively, the elongation at break is 48.83%, 9.41% and 42.27%, and the hardness is 92, 89 and 50 respectively. The tensile strength, elongation at break and hardness of polyurea coating are higher than those of the other two coatings. The tensile strength of polyurea coating is 8 times that of epoxy micaceous iron and 2 times that of polyurethane. Polyurea is a kind of copolymer formed by alternating soft segment and hard segment. Its molecular structure is similar to that of polyurethane. The bond energy of polyurea is higher, while the nitrogen and oxygen atoms in polyurea increase the degree of internal hydrogen bonding, so its tensile strength is higher. The reason for the low tensile strength is that a certain proportion of mica flake powder of epoxy micaceous iron is added to the epoxy matrix, and mica flake powder can improve the shielding ability of the coating and the corrosion medium, thus increasing the corrosion resistance of the coating. The polyurea coating has good elasticity, can withstand the large deformation and collision of samples in engineering application, and the polyurea coating will still maintain good continuity without cracks and other defects affecting the anticorrosive performance of the coating. However, the epoxy micaceous iron coating and polyurethane coating have certain brittleness, which can not bear the deformation and collision of the samples in use. The hardness of polyurea coating, polyurethane coating and epoxy micaceous iron coating is higher than that of polyurethane coating, but the hardness of epoxy micaceous iron coating is lower. The hardness of the coating is closely related to its material structure. There are soft and hard segments in the polyurea coating and polyurethane coating, the proportion of soft and hard segments is different, the degree of crosslinking is high, the hydrogen bond is high, which makes the material show high hardness.

When the hardness of the coating is higher, the young's modulus of elasticity of the coating is also higher, which makes the elastic modulus of the coating closer to that of the metal matrix. Therefore, when the coating is damaged by tensile action, internal stress, temperature stress and external stress, the deformation of high hardness coating is more similar to that of metal matrix, which makes the coating not easy to be damaged by internal stress. However, the hardness of the coating can not be increased indefinitely, which is determined by the internal structure of polymer materials. The increase of the hardness of the coating will reduce other properties of the coating, and the low temperature brittleness will be very obvious.

(2) Time analysis

*Table 2. Time analysis*

| Project | Polyurea | Polyurethane | Epoxy micaceous iron |
|---|---|---|---|
| Surface dry time/s | 46 | 1.4 | 1.5 |
| Gel time/s | 9 | 3 | 6 |

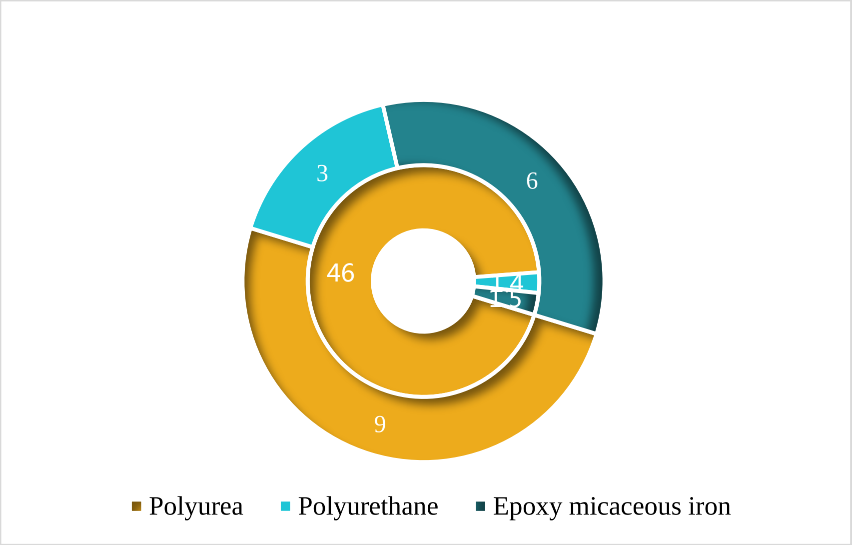

*Figure 2. Time analysis*

According to statistical analysis, as shown in Figures 2 and Table 2, polyurea gel time and drying time are very short, gel time is only 9s, and drying time is only 46s. Because the reaction between polyurea isocyanate group and amino terminal group forms urea, and the activities of the two groups are very high, a large amount of heat is emitted rapidly after the completion of the whole reaction, and the rise of reaction system problems promotes the further acceleration of the reaction. 9s gelation time allows to spray any thickness of polyurea during construction without affecting its appearance, and can be sprayed on any shape of surface. The drying time of 46s can make the second application of polyurea in a short time, which greatly shortens the construction time. However, shorter gel time and drying time also have many disadvantages. The short gelatinizing time makes the polyurea unable to penetrate into the surface of metal matrix effectively, resulting in the poor adhesion between polyurea and metal. Therefore, the polyurea primer must be used when the polyurea coating is applied on the metal substrate surface, because the engineering coating cannot be completed in one day. Therefore, the short drying time of the surface also brings about the problem of poor adhesion between layers, so it is necessary to add a film with good adhesion between layers to improve the adhesion between layers of the film. The gelation time of epoxy iron and polyurethane is very long, 6h and 3h respectively. Epoxy iron and polyurethane are two components of the coating, need to be mixed before coating. If the gelation time is short, coating is difficult. If the spraying method is adopted, it is easy to block the spraying equipment and cause equipment damage. The coating thickness is not too thick due to the long gelation time, which leads to the uneven flow and thickness. The surface drying time of epoxy micaceous iron and polyurethane is 1.5h and 1.4h respectively. Due to the requirement of gelation time, the reaction activity and reaction rate of the product are decreased. Long time surface drying time is easy to cause the reaction between amino group in polyurethane and water in air, which will cause foaming and affect the corrosion resistance and construction time. However, longer surface drying time can effectively improve the adhesion of the coating.

(3) Solid content analysis

*Table 3. Solid content analysis*

| Project | Polyurea | Polyurethane | Epoxy micaceous iron |
|---|---|---|---|
| Dish mass/g | 38.4237 | 37.5718 | 39.2868 |
| Mass after addition /g | 41.1361 | 43.597 | 41.7635 |
| Mass in one day /g | 41.0766 | 41.6564 | 41.4962 |
| Solid mass /g | 96.8 | 66.8 | 88.2 |

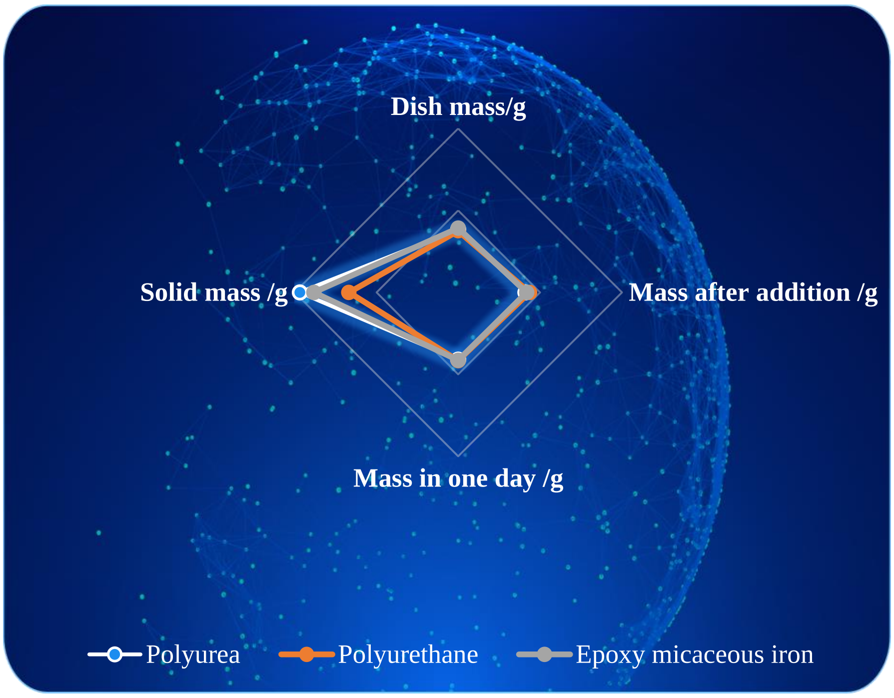

*Figure 3. Solid content analysis*

According to the statistical analysis of data, as shown in Figure 3 and Table 3, the solid content of polyurea is 96.8%. The solid content of epoxy micaceous iron is 88.2%. Flake micaceous iron filler and epoxy resin are not volatilized in the epoxy micaceous iron coating. The curing agent contains organic solvent. The solvent does not participate in the reaction of the system, but evaporates completely, which reduces the solid content. The solid content of polyurethane coating is 66.8%. Compared with polyurea coating and epoxy micaceous iron coating, the volatile content of polyurethane coating is significantly higher than the other two coatings. Generally speaking, materials with a solid content of more than 60% are considered to have a high solid content. The experimental polyurea coating, polyurethane coating and epoxy micaceous iron coating are all higher than 60%. Spray polyurea coating, the coating has no pollution to the environment, and the coating itself is non-toxic and tasteless.

(4) Water absorption analysis

*Table 4. Water absorption analysis*

| Time | Polyurea | Polyurethane | Epoxy micaceous iron |
|---|---|---|---|
| 1d | 0.62% | 0.07% | 0.22% |
| 3d | 0.85% | 1.25% | 0.51% |
| 5d | 0.21% | 1.94% | 0.69% |
| 7d | 0.46% | 2.61% | 0.76% |
| 15d | 0.83% | 3.17% | 0.03% |
| 30d | 1.16% | 3.21% | 0.17% |

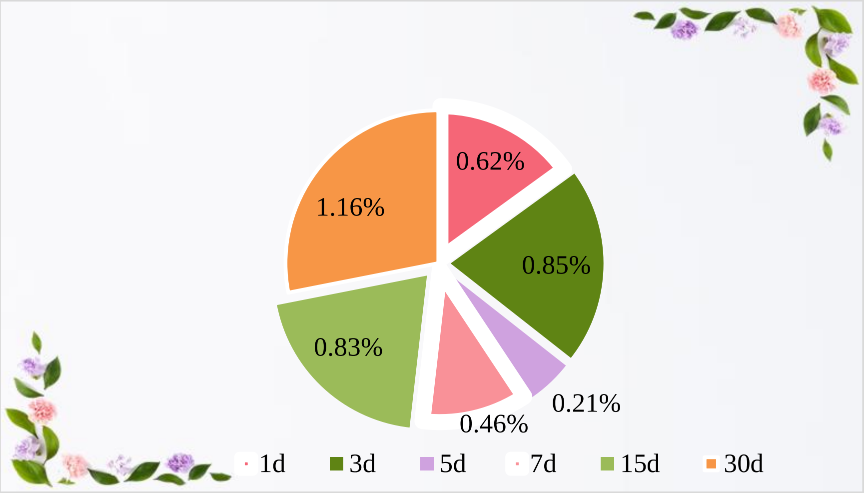

*Figure 4. Water absorption analysis*

According to the statistical analysis of data, as shown in Figure 4 and table 4, the corrosion of metals is mainly caused by the entry of water molecules. Water molecules not only bring corrosion medium to metal surface, but also oxygen dissolved in water is the catalyst of corrosion. The water absorption of epoxy micaceous iron coating is the lowest, that of polyurea coating is the second, and that of polyurethane coating is the highest. The results show that the water absorption rate of epoxy micaceous iron coating on 1d, 3d, 5d, 7d, 15d and 30d is 0.22%, 0.51%, 0.69%, 0.76%, 0.03% and 0.17% respectively; the film strength of polyurea coating on 1d, 3d, 5d, 7d, 15d and 30d is 0.62%, 0.85%, 0.21%, 0.46%, 0.83% and 1.16% respectively, One dimensional, three dimensional, 5d, 7d, 15d and 30d polyurethane coating rates were 0.07%, 1.25%, 1.94%, 2.61%, 3.17% and 3.21%, respectively. It can be seen from the figure that the maximum water absorption of epoxy micaceous iron coating is about 0.76%. Because of the compact structure of epoxy resin matrix, lamellar micaceous iron oxide can effectively fill the gap of epoxy matrix, and lamellar micaceous iron oxide can prevent the pores of the body, increase the distance of corrosive ions such as water molecules, and improve corrosion protection. The low water absorption shows that the epoxy micaceous iron has good waterproof and shielding properties, reflecting its excellent corrosion resistance. The maximum water absorption of polyurea coating is about 1.16%. After the two components of polyurea are fully mixed by collision, the material solidifies rapidly to form a continuous and dense coating. Through the analysis of the surface and cross-section of the polyurea coating, it is found that the surface structure of the polyurea coating is dense, and there are no cracks, holes and other defects; while in the case of low cross-section density, because the polyurea coating is formed by high-pressure spraying, air enters the substrate surface from the spraying gun and mixes into the material, resulting in the formation of bubbles inside the polyurea. Generally speaking, the thickness of polyurea coating is larger, which greatly reduces the penetration of internal bubbles. The maximum water absorption of polyurethane coating is about 3.21%. It can be seen from the figure that the water absorption increased rapidly in the first 7 days, reaching 86% of the maximum value. Due to the internal structure of polyurethane is not dense, there are many holes, and the initial water absorption is high; the water resistance of polyurethane coating is poor, under the action of water molecules, its internal structure changes, resulting in high water absorption. Then the water molecules continue to extend to the pores and finally reach saturation. Therefore, the results of water absorption experiment show that the corrosion time of metal under polyurethane coating is faster than that of other two coatings.

## 4. Conclusion

Through microscope observation, the corrosion time of metal under polyurethane coating is much faster than that of other two coatings and polyurethane coating, the solid content of polyurethane coating is much higher than that of polyurea coating and epoxy micaceous iron coating, the volatile component content of polyurethane coating is much higher than that of other two coatings and polyurea coating, polyurethane coating and epoxy micaceous iron coating have higher hardness value, The hardness of polyurea coating and polyurethane coating is the same, but the hardness of epoxy micaceous iron is relatively low. We should strengthen the scientific management and control of corrosion, strengthen the basic research of corrosion science, actively promote the application of various anti-corrosion methods, and develop new anti-corrosion technology to adapt to the current new situation.

The corrosion time of metal under polyurethane coating is faster than that of other two coatings. Compared with polyurea coating and epoxy micaceous iron coating, the volatile content of polyurethane coating is significantly higher than the other two coatings. The hardness values of polyurea coating, polyurethane coating and epoxy micaceous iron coating are all higher, while the hardness values of polyurea coating and polyurethane coating are similar, while that of epoxy micaceous iron coating is relatively lower. The anti-corrosion coating of vertical vibration riser in deep sea mining was observed by microscope and good results were obtained.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

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