HOW TO SELECT COATINGS TO OPTIMISE COMPONENT PERFORMANCE

Overview

When choosing a surface coating for a specific application there will undoubtedly be a primary motivation or reason behind the selection, for example to provide resistance to corrosion, wear, friction or release. This is often followed by a series of factors that also influence the choice just as much as the initial need, such as the surface properties of the material to be coated, the required appearance, product cost targets, required service life and the conditions the materials will face in the field.

The right surface coating on a component can increase overall service life, drive down product costs, reduce expensive downtime or improve operational performance. With such a potentially business-critical decision-making process, working with a partner who can provide the right application engineering advice will ensure the customer selects the appropriate surface coating for the application.

Coating for Corrosion Resistance

Corrosion poses a major threat to several industries, potentially causing critical component failure, disruption, expensive downtime and even loss of life. In the oil and gas equipment industry for example there are vast potential corrosion problems ranging from fixed structures, risers, drilling tools, pipelines, gas turbine generators and compressors, various valves and flow control components, down to nuts and bolts. To cope with this, there is a large range of material choices, applied electrical corrosion protection methods and hundreds of coatings to choose from. However, how does a designer or engineer know which method and coating is best for the requirement?

The initial decision to be made is whether a barrier coating to prevent the corrosive media from reaching the substrate, or a sacrificial coating that is preferentially attacked leaving the component relatively unaffected, is more appropriate. A sacrificial coating corrodes in preference to the steel or substrate, examples include galvanizing and zinc nickel. There are also coatings that

can combine both attributes and multi-layer coatings that achieve similar results. In the face of so many options, it is best to work with an expert application engineering partner to ensure the optimum surface coating solution is selected.

The range of different coatings needed to meet the operating and performance requirements for a subsea flow control device is an example of the surface coating specification decisions that need to be made at design stage to optimise performance. In the oil and gas industry, many flow control valves operate in environments that are extremely hostile to the valve component materials. To offer protection from corrosion their external surfaces can be coated in relatively thick epoxy paint systems that would allow repair to any surface damage. It may be decided to use a relatively thin sacrificial metal, like zinc nickel or zinc alloy plating, containing heat cured coating or even apply a thermally sprayed aluminium coating. A thick powder coating as an off-the-shelf manufacturing finish might also be acceptable.

We have more than 200 different coatings available for corrosion, wear, release and porosity challenges

When it comes to the moving internal parts, however, the valve design and performance requirements would demand the coating to be thinner with a tight thickness tolerance, and often to be harder so that the mating surfaces will contain the pressurised gas or liquid. The coating may also be required to provide a low friction property to ensure reliable operation.

The key to a successful project is the selection of the right coatings, an area in which Surface Technology specialises in advising their customers. Surface Technology coats many types of valves and control gear and uses multiple paint systems, heat cured sacrificial resins, thermally sprayed aluminium, electroless and electrolytic plating applications, deposited nickel and nickel/polytetrafluoroethylene (PTFE) and a wide range of polymer coatings. These materials provide precision low friction and corrosion protection, and Surface Technology has over 60 years of experience in which coating is most appropriate for which surface and application combination.

For example, electroless plating is more accurate in thickness control and so can plate more complicated systems, however there are fewer options without applied current from a chemical bath. This is commonly used in automotive, aerospace, electronics and offshore, and differs from the electrolytic process which involves using electricity to plate a cathode or anode. Benefits include cost effectiveness as well as providing a wider selection of coatings and so it is common for, and applicable to, many industries.

Complex Commissions

Larger components with threaded connections such as risers and tethers for tension leg platforms present a coating challenge to the surface finishing industry due to their size and complex handling and resultant health and safety issues. The coatings used on these types of long components are normally sacrificial heat cured or thermally sprayed aluminium on the external surfaces with anti-galling or low friction treatments on the connecting surfaces. Large oven capacity and preparation equipment is necessary for this type of work. Surface Technology has developed a specialism in managing this type of component, particularly for the oil and gas industry, and has a facility in Renfrew, Scotland specifically for handling larger and more complex work pieces.

We have been protecting and enhancing the performance of metal surfaces since 1946

Coating to Reduce Friction and Wear

The surface characteristics of engineering materials have a significant effect on the serviceability and life of a component and should not be overlooked in design. Engineering environments are normally complex, combining loading with chemical and physical degradation to the surface of the component.
Friction and wear occur where two surfaces undergo sliding or rolling under load. Friction is a serious cause of energy dissipation and wear through abrasion, erosion, adhesion, corrosion and surface fatigue is the main cause of material

wastage and has a major impact on a components service life. Lubrication in tribological applications reduces friction and wear, however liquid lubricants can fail under extreme conditions such as low pressure, oxidative or corrosive environments, high speeds or high loads – and in some environmental conditions regular lubrication may be difficult to perform.

Surface coatings can play a key role in providing surface protection to reduce wear or friction, minimising the use of liquid lubricants, and the wear that naturally results from two surfaces moving in contact, reducing heat generation, running costs, maintenance costs, machine downtime and operational limitations.

Dry film lubricants are used in arduous applications where the use of liquid lubricants (oils, greases etc) has proven unsuccessful. Dry film bonded lubricants remain in place and are effective in extreme and adverse conditions. They are based on molybdenum disulphide, graphite, fluorocarbons and fluoropolymers combined with high performance resins and binders which are tailored to suit a wide range of performance requirements.

Molybdenum disulphide-based coatings are used for friction reduction and control, particularly where high loads and low speed are a factor. The reduction in friction and consistency of lubrication improves resistance to wear that naturally results from two surfaces moving in contact with one another.

Where additional wear resistance is required, Surface Technology can provide our proprietary Armourcote® reinforced coating systems or a range of thermal spray coatings, such as the high velocity oxygen fuel (HVOF) process, that provide a hard face and are particularly suited to providing protection against erosive or abrasive wear, corrosion, fatigue, oxidation and high temperatures.

Enhanced Material Performance and Protection:

Corrosion

- HVOF
- Wire Arc Spray
- TriCem 3800®
- SIFCO Process®
- Zinc Nickel

Wear

- Fluoropolymer
- Armourcote®
- Dry Film Lubrication
- Electroless Nickel PTFE
- Silver Plating
- SIFCO Process®

Release

- Fluoropolymer
- Armourcote®
- Electroless Nickel PTFE

Porosity

- Ultraseal MX2
- Ultraseal PC504/66

Multi-Function Coating Applications

The automotive industry has an ever-increasing need for coatings which almost always requires several functions to be provided by the coating. A primary requirement for this industry is to increase the service life of the component, but this might be achieved by improving corrosion resistance, wear resistance, or lower friction and, of course, in one of the world`s most competitive industries it has to be cost-effective.

Brake assemblies were traditionally very heavy and sturdy, with most originally made from cast iron. Being largely hidden from sight meant that corrosion resistance was not a key requirement, protective coating was minimal and conventional zinc plating normally sufficed. However, as weight reduction became a major issue for fuel efficiency, designers reduced the casting sizes so the use of aluminium brake assemblies increased and the automotive industry now uses corrosion resistant coatings. Following on from this there was a rise in alloy wheels which meant greater visibility of the brakes so substantial improvements in corrosion and abrasion resistance of coatings were needed. Subsequently the move to zinc alloy plating improved performance and now manufacturers tend to apply a paint coat over the top of this. In the automotive industry, it’s not just the method and materials that are important, it’s also the aesthetics of the finished product.

Similarly, aluminium brakes that require hard anodising are also progressively being coated in paint and powder coating to enhance performance and appearance, particularly on the more expensive models. The moving pistons, similar to valves in the oil industry, require precise coating thickness through spray coating or electroless, coupled with wear resistance and low friction to ensure that the seals do not wear. This particularly applies to high performance cars where the temperature of the brake can become high enough to cause the more conventional polymers to soften and react with the brake fluid. In the most extreme examples, ceramic coatings are applied to reduce heat transfer to the brake fluid. The use of composite

discs also adds to the possible increase in temperature of the callipers which again necessitates the selection of higher temperature resistant coatings.

Surface Technology carries out a wide range of coatings on brake assemblies used across the spectrum from high volume production cars to Formula One, with the coatings being dependent on the vehicle operating environment.

External coatings are another important application within the automotive industry. Surface Technology has previously worked with a manufacturer of off-road and defence vehicles to change the selection of coatings used in vehicle bumpers. Previously the bumpers were e-coated (electro painting) followed by a powder top coat. However, this meant they were at risk of chipping through the coating allowing rust to spread and causing delamination of the thicker top coat. The customer needed to resolve this issue, and Surface Technology proposed a zinc nickel alloy initial deposit to provide a tough, sacrificial base for the subsequent powder top coat, thus eliminating the problem.

This zinc nickel solution is also being employed for fluid transfer tubes used extensively in the automotive industry. Surface Technology has the plant and expertise to deal with the often complex tasks of these types of components, known as ‘combination coatings’.

The Non-Stick Revolution

The original stainless steel reinforced PTFE from Armourcote, part of Surface Technology, revolutionised the non-stick saucepan business more than 45 years ago. Today, the same principle of enhancing the performance of the basic polymers is used by Surface Technology to solve problems in the manufacturing industry.

Surface Technology is a leader in the field of applying Fluoropolymer based (non-stick) coatings for release to equipment used in the food processing industry as well as for plastics, polymer and applications in industries such as aerospace, automotive and medical equipment.

Many foodstuffs contain sticky ingredients such as egg, fats and sugars while hot polymers and rubbers are also extremely adhesive. The choice of the coating type relies on the properties of primary fluoropolymers such as PTFE, FEP and PFA but these need to be modified to withstand abrasion and to aid adhesion to the equipment that is to be coated which is typically rollers, chutes, guides and moulds. The process, usually associated with the food processing industry is also applied to the coating of mould tools used in the manufacture of superconducting magnets for MRI body scanners. The Surface Technology site in Leeds specialises in the process of coating the wires that makes up the magnet coils in epoxy resin so that is does not move, and liquid helium is used a coolant for superconductivity.

This process is echoed throughout the aerospace industry in coating moulds for tyres to leave the tread pattern intact. It is also used on jigs in automotive plants where components are hung, making it easier to remove paint overspray and reduce plant maintenance and downtime.

Coating for Conductivity

In the field of electronics, the function of conductivity of a coating is employed to coat the internal surfaces of plastic enclosures to ensure that the RFI shielding meets regulations for electronic equipment. The options are to use coatings containing the required level of copper, nickel or silver and to be formulated to avoid damage to the life of the type of plastic used.

Electrically resistant coatings can range from sprayed conformal paints and polymers to thermally sprayed ceramics. The choice

will vary with the substrate choice, the voltage resistance required and the dimension and surface finish required.

In Summary

In summary, approaching and considering the selection of an appropriate coating can be a somewhat daunting and complex task. Having more than 60 years' experience serving a broad range of industries globally, providing a complete range of engineered surface coatings combined with extensive technical knowledge and application advice, Surface Technology is well placed to help customers select coatings to optimise performance.

Contact us now to discuss your coating challenges

T: 0845 450 0870

E: info@surfacetechnology.co.uk