COSMOS – GUIDE 4

Guide to Failures in Coating Systems and Industrial Paints

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I Introduction

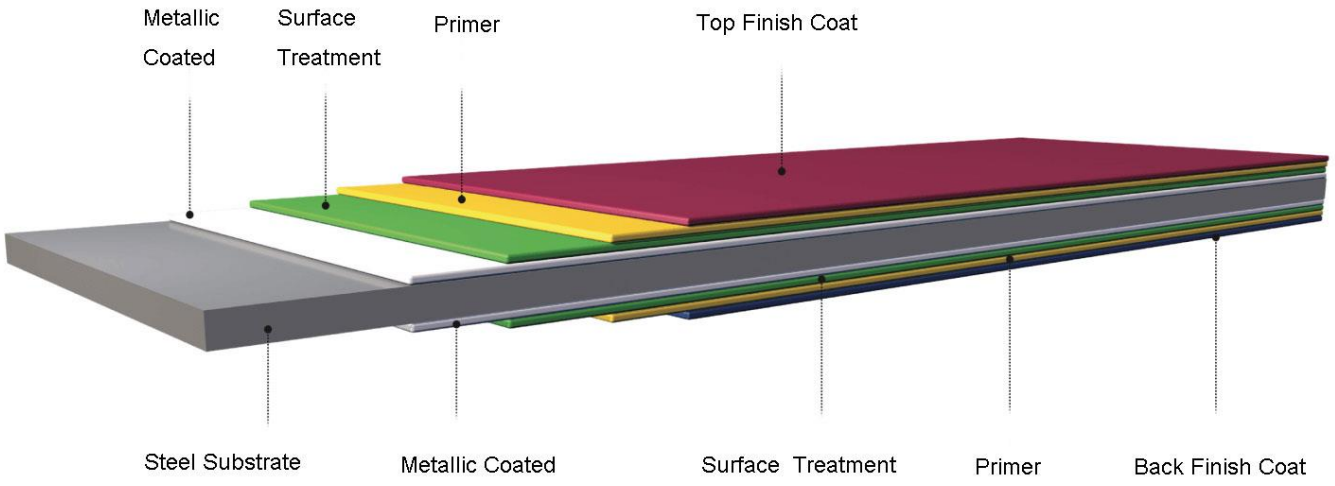
The application of coatings is imperative in material and machinery maintenance processes. These coatings protect and give new functionality to the products and materials where they are applied. An example is the facades of buildings where coatings not only act as an aesthetic element but also have an important protective function. Industrial examples are coatings for galvanized steel, metals, ships, airplanes and the construction industry, among others, which seek to protect against corrosion, isolate substrates from extreme climates and preserve the industrial value of the investments made.

Despite their benefits, the application of coatings can cause multiple adhesion failures on the various materials where they are applied. These adhesion failures can lead to other types of failures that include aesthetic failures, loss of functionality or even more serious problems such as the lack of protection of a critical area. For this reason, detecting the type of adhesion failure that has occurred is essential in order to resolve it, avoid possibly more serious problems, and thus preserve the industrial value of various projects.

Within our Research and Technical Analysis area, the identification and solution of adhesion failures is a very important topic. For this reason, in this Guide we explain the most common types of adhesion failures, the reasons why they occur and how to solve them.

II What does an adhesion problem mean in coating systems and industrial paints?

Industrial paints and coating systems are multi-component products that contain resins, solvents, plasticizers, pigments and additives, among others. All of these components, once applied and cured, form a film that adheres to the surface of the material we are trying to protect. The adhesion problem occurs at this stage, in which it is precisely essential to achieve the greatest possible adhesion between the film and the material to be coated. The adhesion problem as such is broad and we see that there are multiple different types of failures that arise for different reasons in the adhesion process. Being aware that in every industrial project the goal is to maximize investment, it is important to understand the different types of defects that can arise, determine their cause and be able to correct them as well as prevent them.



III What types of failures exist in coating systems and industrial paints?

Failures in the adhesion of coating systems and industrial paints occur in different forms. Characterizing the defect and then determining the type of failure that has occurred is imperative to determine its cause and be able to solve it. Common examples of these failures include:

.1. Spider webs

The appearance of threads that resemble those of a spider web is one of the most common adhesion defects during the application of coating systems. Generally, this failure is caused by very rapid drying of the coating during its application or by drying of the coating prior to its application.
To prevent this defect in our projects we must try different solutions, such as: (i) Reduce the amount of air, (ii) change the diluent/thinner of the coating system for one that takes longer to dry, (iii) reduce the viscosity of the mixture.

.2. Blisters (“blistering”)

When small blisters form all over the surface of the coating used, there are several possible causes. Among these causes may be: (i) Trapped solvent, (ii) a surface contaminated with salt, (iii) oil, (iv) humidity, (v) excess cathodic protection current, (vi) the use of a coating with excess viscosity, (vii) too rapid of an evaporation of the diluent/thinner that can be caused by very high temperatures in the curing process or by high volatility of the diluent/thinner in the paint.

To correct this problem there are several possible actions, among them: (i) Ensure that the surface is completely dry and free of contaminants prior to any painting, (ii) modify the dissolution ratio between the paint and its diluent/thinner, (iii) reduce the curing temperature, (iv) replace the paint or rectify the selected coating system, (v) respect or increase its flash time prior to subjecting the substrate to any increase in temperature.

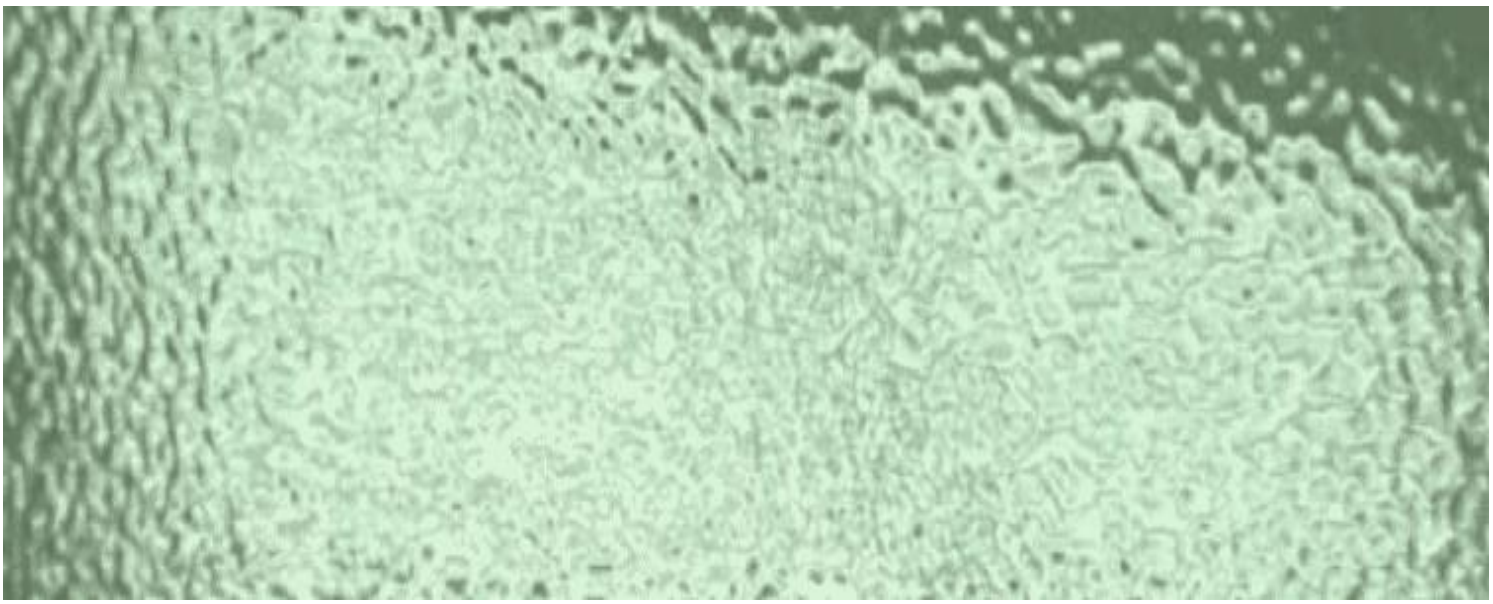
.3. Bubbles or holes

When small holes or bubbles form in specific points of the coating, it is due to different possible errors, including: (i) Excessive agitation in the paint, which in turn leads to the appearance of foam, (ii) too fast pumping of the paint, (iii) too fast evaporation of the diluent/thinner.

To solve this problem there are several options, including: (i) Reduce the amount of agitation in the paint, (ii) use less volatile diluents/thinners, (iii) modify the dissolution ratio between the paint and its diluent/thinner, (iv) reduce the curing temperature.

.4. Orange peel

The orange peel defect is recognized by its roughness that resembles an orange peel and occurs when the coating inappropriately loses diluent/thinner during the spraying process (airless). To resolve and prevent this failure, the application distance between the airless instrument and the substrate must be reduced or the coating/air ratio increased.



.5. Drip

Dripping on a surface is due to a low viscosity of the coating, as well as the use of an incorrect diluent/thinner.

There are effective solutions to this adhesion defect such as: (i) using diluents/thinners with higher evaporation rates, (ii) applying thinner coating layers, (iii) correcting the use of the application mechanism, whether airless spraying or another.

.6. Eruptions

Random eruptions in industrial paint and coating systems is a fairly common adhesion failure. The reason for their formation is due to small holes/voids containing air that erupt during curing and give rise to the defect.

Possible solutions to this problem include: (i) Force the cavities to erupt prior to application of the last layer of the coating system, (ii) select a coating that has a low curing temperature and thus prevent eruption during curing.

.7. Fisheye

The so-called fisheye defect is an adhesion failure that appears as a hole that penetrates all the way through to the material. The cause of this problem is the presence of some contaminant in the substrate to be painted that prevents it from getting wet or achieving adhesion contact during the application of the paint. For example, oily substances prevent adhesion during application.

To avoid this defect, the part or the substrate to be treated must be perfectly cleaned, and the technical staff must avoid the existence of contaminants in the application stage.

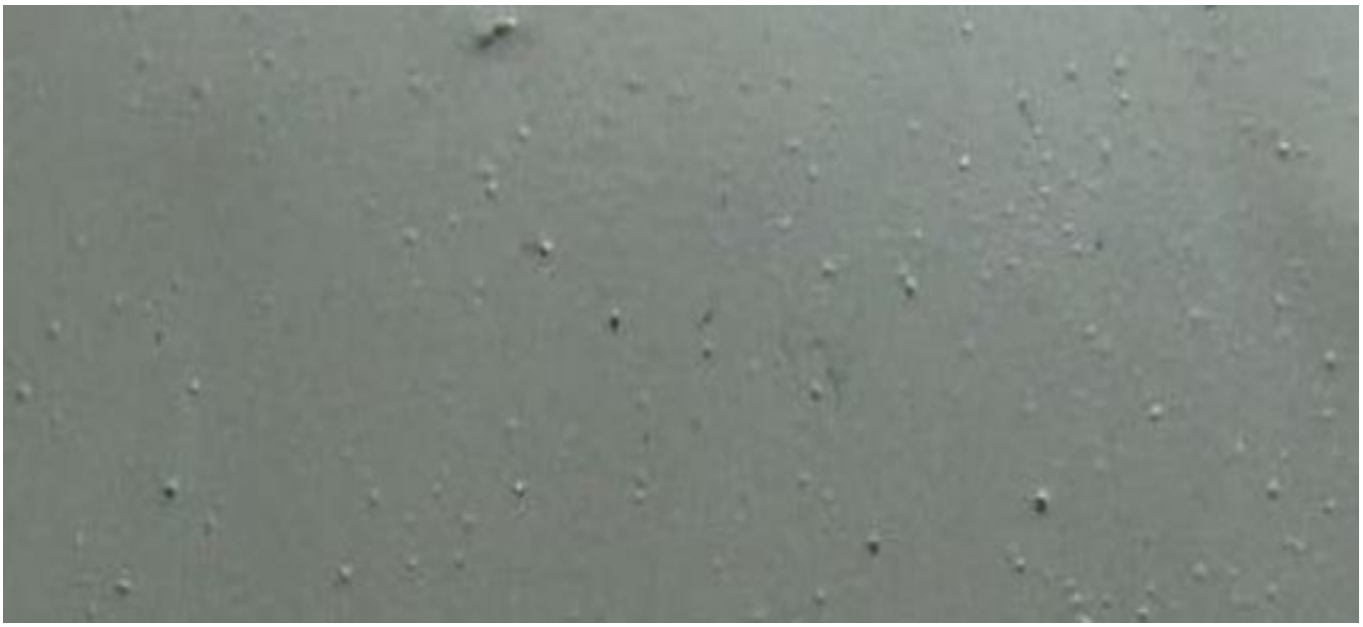
.8. Cracks

When small cracks form, similar to those of dry mud, these indicate that the coating used has been too thick, especially if it was water-based. A distinction must be made between this failure in the application of coating systems and that of large cracks that occur after several years in which temperature and humidity are the main causes. Our focus being the small cracks that arise as defects in the application process, we must resolve this adhesion failure by reducing the viscosity of the coating or applying thinner layers/films.

.9. Particulate pollution

Particulate pollution can be the cause of quite serious adhesion failures and occurs when particles are present in the work environment within shared spaces or inside a curing oven.

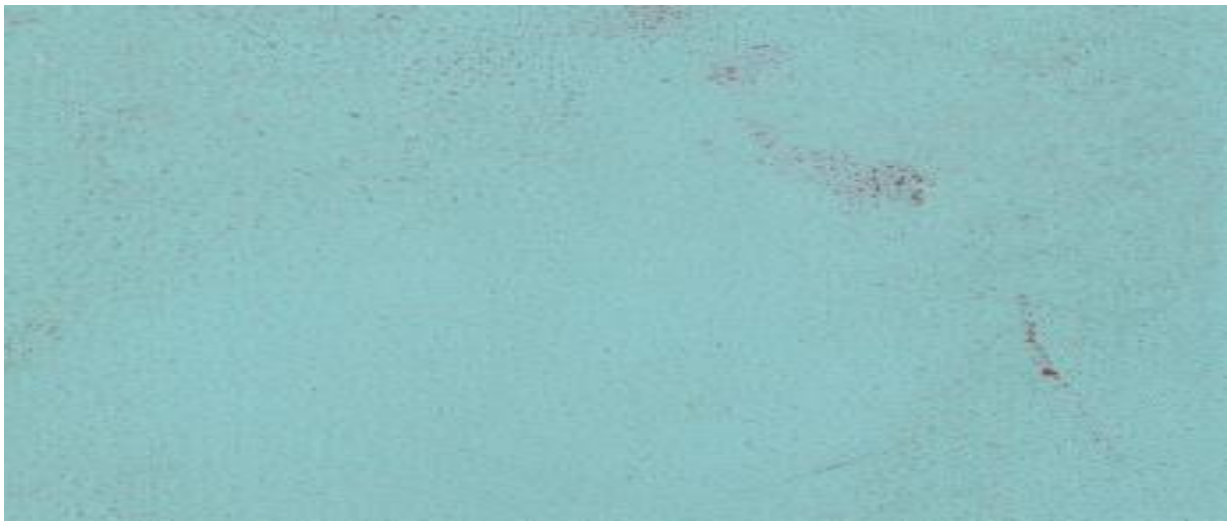
We can resolve this defect in the following ways: (i) Ensure that the cleaning of the surfaces prior to applying coatings is truly impeccable and in accordance with the requirements of the industrial project, (ii) isolate and strategically protect the application areas of the coating as well as the areas where curing will occur. Strategic planning of our projects will always bring us success and we will avoid costly mistakes.



.10. Loss of shine

The loss of shine manifests itself in the form of areas with a lower sheen, or a whitish appearance in colored paints. The loss of shine of a coating is due to the presence of moisture during the curing process, as it leaves the surface slightly rough until it loses its gloss. Opacity can also be the result of fouling of the curing oven or the use of too little film thickness.

We can solve this problem by accelerating the cooling, increasing the temperature / time ratio.



Summary of types of failures in coating systems and industrial paints: We have given a brief summary of certain adhesion defects that usually appear in industrial projects. There are other types of defects, and certainly, the project's technical team together with our Research and Technical Analysis area must analyze each defect in order to find the root cause of the problem and provide the best solutions.

IV Main reasons why failures occur in coating systems and industrial paints

Adhesion failures may appear shortly after applying the paint or coating system. The origin of these failures can be due to different causes and below we indicate some important examples:

.1. Improper selection of paint or coating system

One reason for failures is when there isn't a good compatibility between the selected coating and the substrate or when there is an incompatibility between the coatings of the different layers of the coating system. Correct selection is crucial to avoid detachment among other defects.

.2. Improper surface cleaning

Before applying any paint or coating, it is necessary to clean the surface adequately to achieve proper adhesion of the coating film with the material. There are times when it will be necessary to use cleaning products specific to the type of project. We recommend putting a lot of emphasis on proper cleaning of the substrate.

.3. Incorrect application

The method of application of the coating or paint can be one of the most critical points when it comes to achieving good adhesion or finish. Therefore, it is very important to define the application parameters well.

.4. Pollution of different types

Despite our best efforts to clean the surface properly, some contamination of the surfaces being treated may occur. Surface contamination takes different forms and can be present in a variety of states on the surface. Common sources of contamination include machine oils and greases, hydraulic and cleaning fluids, adhesives, waxes, and human contamination. Before applying the coating system, be careful to see if any type of contamination has occurred. Likewise, just after applying the paint, you must remain vigilant to ensure that no additional contamination occurs to the newly painted substrate.

.5. Absence of primer

It happens that the importance of primers, which is the first layer of coating, is underestimated. The primer coat serves as the base for the chosen coating system and it should not be ignored. For metals, they provide corrosion protection, they help the topcoat adhere to the surface, they increase the durability of the paint and they can hide or fill in some surface defects.

.6. Insufficient resistance to external factors

The resistance of the industrial paint or coating system to external agents is important to take into consideration. During the useful life of the already coated substrate: What external factors will it face? Factors such as (i) the type of use that the material is going to be given, (ii) the traffic of people, cars, and/or heavy machinery that will have contact with the substrate, (iii) external agents such as temperature and/or or chemical agents that will inevitably impact the degradation of the coating system, among others. It is imperative to analyze the external factors that the substrate to be treated will face before investing in the coating system.

V How to be successful: We resolve defects and failures in coating systems and industrial paints to preserve and maximize industrial investments

At COSMOS Coatings we know that each defect must be analyzed by the project's technical team together with our Research and Technical Analysis area in order to find the root cause of the problem and provide the best solutions. We have experience in solving these types of failures and we follow certain guidelines:

.1. Identify the type of adhesion defect and define the root cause of the problem

As explained in this Guide, many defects tend to be similar to each other or difficult to define if they are emerging for the first time, so it can be difficult to differentiate or define them. COSMOS Coatings has practical and scientific knowledge within its Research and Technical Analysis area, which allows us to identify the type of adhesion defect that is occurring and define the cause of the problem along with possible solutions.

.2. Provide proposals for improvement

Once the technical project team together with our Research and Technical Analysis area has found the root cause of the problem of the adhesion defects, all viable improvements are proposed to resolve them. These fixes exist within a realistic execution context to improve the project execution process as well as improve the materials used. Some examples of these proposals include:

- ✓ Correct the cleaning protocol for the surfaces to be treated.
- ✓ Correct the activation method of the different components of the coating system.

- ✓ Replace the coating system and/or industrial paints with coatings and paints more appropriate to the industrial project being executed.
- ✓ Modify the use of the coating systems and industrial paints so that their dilution process and their application process give successful results.
- ✓ Map out and achieve variations in the application conditions, either in terms of temperature and/or curing time, or resolve the problem of external contaminants, among others.
- ✓ Adjust various different application parameters of the coating system (distance between airless gun and the substrate to be treated, dilution ratios, other ratios, drying times and times between repainting layers).
- ✓ Modify the use of the diluent/thinner depending on the problem that arises (amount, volatility, mixing technique).
- ✓ Correct the viscosity of the coating systems.
- ✓ Vary the thickness of the wet film to achieve a correction in the thickness of the dry film.

.3. Follow up on the implementation of the solution

Once the project's technical team, together with our Research and Technical Analysis area, has implemented the proposals to resolve adhesion failures, **COSMOS Coatings** follows up with the client and their technical team to ensure that the implementation of the solution was successful.