How to Conduct a Coating-related Corrosion Failure Analysis (12 Key Steps)

Corrosion is the deterioration of a metal structure through its reaction with the environment. Conducting a *root cause* analysis to identify the exact cause of a coating failure leading to corrosion, and to determine appropriate remedies, requires a detailed and thorough analysis.

Failure analysis experts such as ExcelPlas Labs can be involved at any point of a coating's life cycle including the design, manufacturing, application, and ultimately, when coating fails leading to corrosion of the steel substrate. The following article gives a brief outline of the coating failure analysis process.

The types of corrosion damage that are encountered in service after coating failure often include under-film surface corrosion, rust bleed, and localised corrosion. Environment-related corrosion problems that occur after coating failure can be quite dangerous to a structure (e.g. frames/supports) or components (e.g. piping and tanks) particularly in marine or coastal areas as in the case of oil & gas and LNG plants, leading to stress corrosion cracking, intergranular corrosion, selective leaching corrosion, and erosion corrosion (see examples below).

12 key steps in a corrosion failure analysis:

The steps that are often involved in a coating failure analysis include:

- Information gathering, often at the site of a coating failure – an important initial stage of the failure investigation.
- Preliminary visual examination, microscopic examination, and documentation of all results.
- *In situ* testing of coating samples both failed and intact is required (for DFT, hardness and profile microscopy).

- Selection of appropriate coating samples for subsequent examination and analysis – a key part of any corrosion failure investigation.
- Macroscopic examination of fracture surfaces, secondary cracking, and surface condition of coating samples
- Laboratory characterisation of the coating's properties through study of the chemical and DSC thermal behaviour of the failed coating material.
- The samples may also require Scanning Electron Microscopy (SEM) and EDAX (X-ray elemental analysis) studies.
- Selection, preparation, and microscopic examination of embedded and polished coating microsections of a failed coating and good (reference) coating.
- Identification of the coating failure mechanism. Sometimes several failure mechanisms may be occurring simultaneously.
- A critical and comprehensive forensic review of the Paint Inspection Reports (PIR) which captures application conditions and DFTs.
- Data and results review, formulation of conclusions and reporting.
- The report should include recommendations on how to avoid a similar coating failure occurring in the future.

The coating failure analysis outlined briefly above can be very time consuming to carry out, as it may require analysis and testing of many representative samples to complete.

The failure analysis will also likely be expensive, with the cost depending upon the purpose and scope of the failure investigation. However, a coating failure analysis carried out professionally and exhaustively can become the basis for a successful product liability or insurance claim.

A failure analysis report may also become part of the chain of expert evidence presented by lawyers in a civil or criminal court case.

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