ICorr Aberdeen Branch

ICorr Aberdeen Branch welcomes

Sherwin-Williams

Protective & Marine Coatings EMEAI
The Sherwin-Williams Company

AN OVERVIEW
The company

A global solutions provider with

Worldwide locations.
The company

GLOBAL PAINTS AND COATINGS INDUSTRY LANDSCAPE (CY2016 SALES, $ IN BILLIONS)

$16 billion

60,000+ employees

$2.7 billion

Source: Public filings and company estimates. Note: Reflects USD exchange rate average for the EUR, JPY, and NOK. (1) Excludes Non-Coatings segments.
Global finishes Group

- Protective & Marine Coatings Division
- Product Finishes Division
- Automotive Finishes Division
Protective & Marine Coatings Division
Malcolm Morris
Technical Support Manager

Sherwin-Williams
Protective & Marine Coatings
EMEAI
Biography:

JOINED COATINGS INDUSTRY 1978 (W&J LEIGH & CO)
25 YEARS EXPERIENCE IN R&D
TECHNICAL SERVICES - SITE INSPECTION
TECHNICAL SUPPORT MANAGER (SPECIFICATIONS, TRAINING, ENQUIRIES)

GRADUATE CHEMIST
NACE LEVEL 3 COATINGS INSPECTOR
PROFESSIONAL MEMBER ICorr, OCCA
UK EXPERT ON ISO STANDARDS COMMITTEES
CORROSION CONTROL USING COATINGS
Why Do we need paint?

Decoration
Protection from corrosion
Protection from fire
Communication
Speciality coatings (antifouling, non-skid etc)
Corrosion Control

Design          Fabrication
Inhibitors      Zinc Phosphate
Sacrificial     Metallic Zinc
Barrier          Glass Flake Epoxy, MIO
What is Paint?

A thin film surface coating

Variety of pigments (powders) dispersed within a film forming polymer binder

Viscosity adjusted by addition of solvents

Other additives e.g. driers, de-foamers, biocides …etc. Etc.

Paint is applied in liquid form, then dries or ‘cures’ to form a solid film
Pigment Types

Colouring pigments
Give desired shade - Carefully selected to provide optimum durability / cost balance

Functional Pigments
To give desired properties such as … corrosion resistance (zinc phosphate), moisture / chemical barrier (MIO, glassflake), intumescent properties, non skid, antifouling, etc.

Filler Pigments
Give bulk and body (opacity) to paint film & enhance properties such as weather resistance, flexibility. Also reduce raw cost of formulation
Binders (Resins)

**Polymer** which forms a protective film & binds pigments together

Often gives generic name to paint type

“Epoxy” “Alkyd” “Polyurethane” etc...
Binders (Resins)

SINGLE COMPONENT
Supplied ready for use - Dry by solvent evaporation and/or reaction with atmospheric oxygen or water vapour

TWO COMPONENT
Material supplied as separate ‘base’ and ‘curing agent’ (additive), which when mixed together, chemically react to form a solid film
Binder Type

• **Binder selection** dictates main properties of a coating

• No such thing as a ‘universal binder’

• Horses for courses depending on end use
Binder Examples

• **Epoxy** – 2 pack systems, very hard and durable polymer

• Typical epoxy uses – Corrosion protection, chemical resistance, abrasion resistance, etc

• Disadvantage of epoxies – Poor UV resistance (Chalks & discolours on exterior exposure)
UV stable binders include:

- **Polyurethanes** (good performance but isocyanate issues)

- **Acrylic epoxy, polysiloxane** (Isocyanate free alternatives)
Binder Examples

- **Alkyds** – Single pack, air drying coatings
  Not as durable as 2 pack systems but easier to use for less demanding applications

- **Acrylics** – Single pack ‘non convertible’ binder
  Not widely used due to high VOC content
  Mainly confined to thin film intumescent systems
Binder Examples

• Carbon based polymers typically used up to 200 degrees C

• Higher temperatures require inorganic binders (typically silicates / silicones)
Coating Types

Primer

• Highly pigmented coatings
• Mode of action by barrier effect, to exclude water & oxygen, with or without active anticorrosive pigment.
• Must have excellent adhesion to substrate – Minimise undercutting
• Alternative sacrificial primers (Zinc Rich)
Corrosion Equation

- Anodic reaction
  \[ 2\text{Fe} \rightarrow 2\text{Fe}^{2+} + 4\ e^- \]

- Cathodic Reaction
  \[ \text{O}_2 + 4\ e^- + 2\ \text{H}_2\text{O} \rightarrow 4\ \text{OH}^- \]

- Combined Reaction
  \[ 4\text{Fe}^{2+} + 3\text{O}_2(\text{gas}) + 6\text{H}_2\text{O}(\text{liquid}) \rightarrow 2\text{Fe}_2\text{O}_3 \cdot 6\text{H}_2\text{O}(\text{solid}) \]

RUST!
Active Anti-corrosive

Zinc Phosphate - Most common anticorrosive pigment

Mode of action of phosphate pigments.

\[ 2\text{PO}_4^{3-} + 3\text{Fe}^{2+} \rightarrow \text{Fe}_3(\text{PO}_4)_2 \]
\[ \text{PO}_4^{3-} + \text{Fe}^{3+} \rightarrow \text{FePO}_4 \]

Steel
Barrier Protection

- Coatings with a high loading of lamellar (plate like) pigments will present an effective barrier

  - Glass flakes & MIO typical examples
Barrier Pigments

Glass Flake

Micaceous Iron Oxide
Barrier Effect

- Increases the length of the pathway for the diffusion of water and oxygen to the steel substrate
Sacrificial Protection

- The majority of metal corrosion is by electrochemical process

- The more reactive a metal is the more readily it tends to form ions in solution and become anodic

- When two metals are connected together, the more anodic metal will corrode preferentially
Galvanic Series

Anodic (More Reactive)

Zinc
Aluminium 3003-(H)
Aluminium 6061-(T)
Cast Iron *
Carbon Steel
Stainless Steel Type 430, active
Stainless Steel Type 304, active
Stainless Steel Type 410, active
Naval Rolled Brass
Copper
Red Brass
Bronze, Composition G
Admiralty Brass
90CU10NI, 0.82Fe
70CU30NI, 0.47Fe
Stainless Steel Type 430, passive
Bronze Composition M
Nickel
Stainless Steel Type 410, passive

Cathodic (Less Reactive)
Sacrificial Primers

• Coatings with a high loading of zinc dust will protect steel by preferential reaction

• Zinc corrosion products will seal up small breaks in coating
Adverse Galvanic Effects

BEWARE! Bimetallic effects can cause accelerated corrosion of mild steel

ICorr Aberdeen – Corrosion Awareness Day 2017
Coatings Specifications

• Performance driven – Increase LTFMM (Life to first major maintenance)
• ISO 12944 / CIRIA / NORSOK / HA / NR
• 20 year plus systems
• Reduced solvent / increased solids content
• Solvent free / water based technologies emerging
• Ever increasing restrictions on raw materials (REACH) & product labelling (GHS)
Surface Preparation

Factors Effecting Coating ‘Life Expectancy’

- Oil, grease and soil
- Chemical Salts
- Surface Corrosion
- Mill Scale
- Anchor Pattern (too rough and too smooth)
- Fabrication Defects (weld spatter, sharp edges)
- Condensation
- Existing Coatings
Millscale

Millscale is cathodic to mild steel leading to rapid pitting
Historically **millscale** removed by allowing it to weather and detach, followed by chipping / wire brushing - Inefficient!

- Acid pickling also developed – Dangerous!

- Abrasive blast cleaning now used for all new build steel to remove scale and produce a surface profile

- Power tools, UHP water jetting or wet abrasive blasting alternatives for maintenance but will not remove **millscale**
Visual Standards

Common ISO 8501-1 Standards for Visual Cleanliness

**St 3**  Very thorough hand and power tool cleaning

When viewed without magnification, the surface shall be free from visible oil, grease, dirt and from most of the mill scale, rust, paint coatings and foreign matter. The surface shall be treated thoroughly to give a metallic sheen arising from the metallic substrate.

**Sa 2½**  Very thorough blast-cleaning

When viewed without magnification, the surface shall be free from visible oil, grease, dirt and from mill scale, rust, paint coatings and foreign matter. Any remaining traces of contamination shall only show as slight stains in the form of spots or stripes.

**Sa 3**  Blast-cleaning to visually clean steel

When viewed without magnification, the surface shall be free from visible oil, grease, dirt and shall be free from mill scale, rust, paint coatings and foreign matter. It shall have a uniform metallic colour.
Surface Preparation
ISO 8501-1

RUST GRADE A
Surface completely covered with mill scale; little or no rust visible

RUST GRADE B
Surface covered with both mill scale and rust.
RUST GRADE C
Surface completely covered with rust; little or no pitting

RUST GRADE D
Surface completely covered with rust; pitting visible
Surface Preparation
ISO 8501-1

Standard Sa2
Start With Rust Grade B

Standard Sa2
Start With Rust Grade D
Surface Profile

• Recommended profile quoted in microns (µm) on relevant product datasheet
• Increases surface area
• Creates a rough surface of peaks and troughs, to which the coatings can adhere:
  Too smooth  - adhesion failure
  Too rough   - rust spots from exposed peaks.
Paint specifications

- Industry standards
  - BS EN ISO 12944 – “Corrosion Protection of Steel Structures by Protective Paint Systems”
  - CIRIA / NBS Specifications – “New Paint Systems for Protection of Construction Steelwork”
  - ISO 20340 - Performance Requirements for Protective Paint systems for Offshore and Related Structures
ISO 12944

Classification of Environment:

- **C1** Very low (Internal dry)
- **C2** Low (Internal damp, external rural & low pollution)
- **C3** Medium (Internal wet, external low salinity & Moderate pollution)
- **C4** High (Internal chemical plants/swimming pools, external industrial/coastal moderate salinity)
- **C5I** Very High (Aggressive industrial, high pollution)
- **C5M** Very High (Coastal High salinity)
ISO 12944

Protective Paint Systems:

- Standard defines generic product types

- Tables define generic systems for Corrosivity categories (C1 – C5) and durability

- (Low < 5 years, Medium 5-15 years, High>15 years)
ISO 12944

Protective Paint Systems:

• All protective paint systems must be qualified to accelerated testing regimes (e.g. salt spray)

• Systems may be tested by paint manufacturer or external laboratories
CIRIA Specifications

- E1 – External exposed (Zinc rich primer)
- E2 – External exposed (Zinc phosphate primer)
- I 1 – Internal controlled
- I 2 – Internal controlled, decorative
- I 3 – Cavity steel
- I 4 – Internal exposed (Condensation)
- I 5 – Internal frequently wet
Offshore Specifications

• ISO 20340 – *Performance requirements for protective paint systems for offshore and related structures*

• Prequalification testing for offshore systems

• Basis for NORSOK and many oil company specs
Offshore Specifications

- Pre-qualification must be performed by 3\textsuperscript{rd} party laboratory

- Testing much more onerous than ISO 12944

- Cyclic testing typically required
Changes to
ISO 12944 / ISO 20340

Revised ISO 12944 (2018)

• Combine ISO 20340 into 12944 (Part 9)

• C5M will become Cx (Extreme, offshore)

• Durability category VH (Very High > 25 years)
THANK YOU FOR YOUR ATTENTION
ANY QUESTIONS?