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MATERIALS AND EMERGING TEST TECHNIQUES

Paper ID: 11025_2024

HIGHLY EFFICIENT NOVEL CORROSION PROTECTION COATINGS FOR ELECTRICAL EQUIPMENT UNDER HARSH ENVIRONMENTAL CONDITIONS

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Motivation

Optimization of zinc epoxy primers to achieve following goals:

- Reduction of zinc content
- Effective alternative to energy-intensive galvanizing
- Use of modern, solvent-reduced binder-systems
- Improved Adhesion on smooth steel
- Contribution to the environment

Objects of investigation

(1) 2-pack-epoxy-zincprimer

(2) Field of application e.g. Transformers

(3) Protection mechanism

1

2

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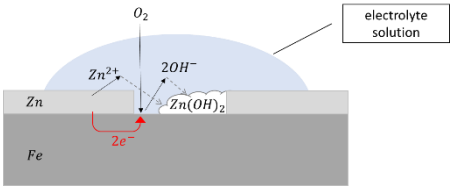

- Electrochemical prevention of corrosion of steel
- Zinc „sacrifices“ itself and corrodes first
- Needed in highly corrosive environments (e.g. Offshore)

Experimental setup

(4) Salt spray test ISO 9227

(5) Condensation test ISO 6270-2

(6) Open-circuit potential

(7) Surface resistivity

4

5

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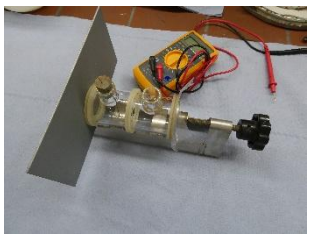

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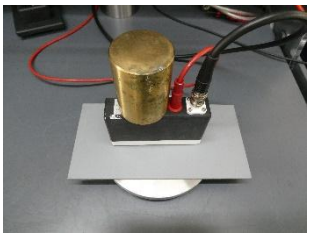
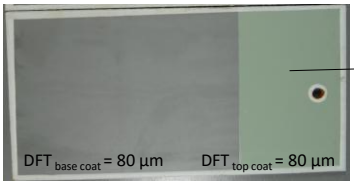


(8) Preparation of test panels (blasted steel + smooth steel) coated with epoxy-based zinc primers with different zinc content

8



Adding of a suitable 2-pack-polyurethane-top-coat according to **ISO 12944** to examine intermediate adhesion between base and top coat

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Zinc and environmental risks

(1) Formation of zinc salts during corrosion process

(2) Chronic aquatic hazard – category 1 (H410)

(3) High energy consumption for zinc production

required embodied energy for production of 1 m³ of…

Epoxy Resin	*= 84 GJ*
Steel	*= 157 GJ*
Zinc	*= 357 GJ*

1

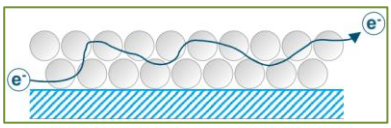
2

3

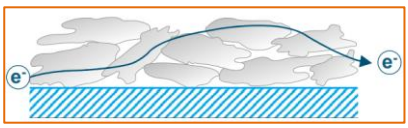
Method/Approach

In coatings zinc is used in form of **zinc dust** –> **Solution:** Altering the particle shape into lamellar **zinc flakes**

To ensure an effective electrochemical reaction and sufficient electrical conductivity…



…with zinc dust up to **60 %** by volume is needed

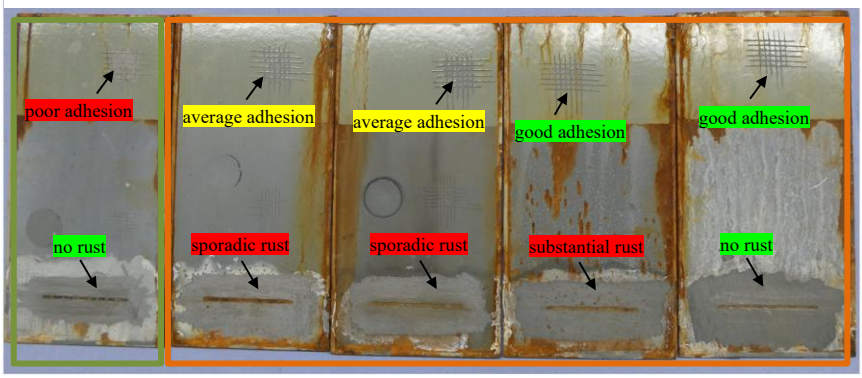


…with zinc flakes up to **15 %** by volume is needed

Test results

➥ What is the lowest possible zinc flake content while maintaining the qualitiy of a conventional zinc dust primer?

60 vol% **zinc dust** **3,4** vol% **zinc flake** **7,5** vol% **zinc flake** **10,1** vol% **zinc flake** **13,8** vol% **zinc flake**



Sample panels after 1000 h of salt spray test (ISO 9227)

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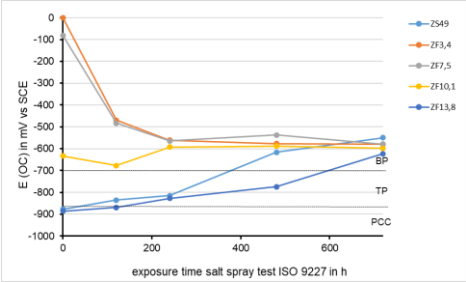
Test results

(1) Course of open-circuit-potential over load time

	cathodic protection ?
BP: Barrier phase	no
TP: Transition Phase	partial
PCC: Phase of cathodic corrosion protection	yes

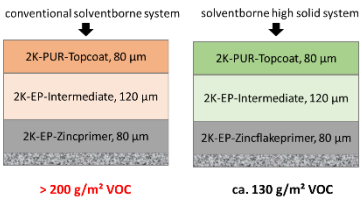
1



Discussion

- About 14 % zinc flakes by volume are needed to achieve a sufficient cathodic corrosion protection
- Lamellar zinc pigments can be implemented into modern VOC-reduced coating systems (2)
- Zinc flake primers show better adhesion on steel than zinc dust primers due to a higher binder content (3)

2



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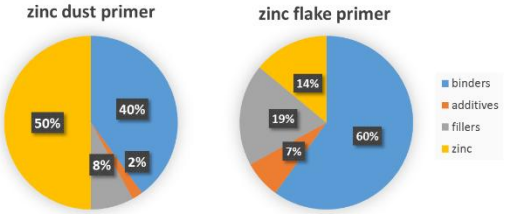

Conclusion

- When using zinc flake primers up to 60 % zinc compared to zinc dust primers can be saved – up to 80 % compared to galvanization
- Significant benefits in terms of energy savings, environmental protection and conservation of zinc resources
- Overall properties of zinc flake primers are equal to zinc dust primers or even better
- Many positive side effects like lower density of coating material, ability to flood application, higher formulation flexibility and lower price per m²
- Wider field of application than ISO 12944 possible (smooth steel, thin walls)
- At present only zinc dust is mandatory according ISO 12944 - the inclusion of zinc flake primers in the current standard is necessary and should be implemented