

Evaluation of Corrosion Attack on Materials

**9 –11 October 2006
Bangkok, Thailand**

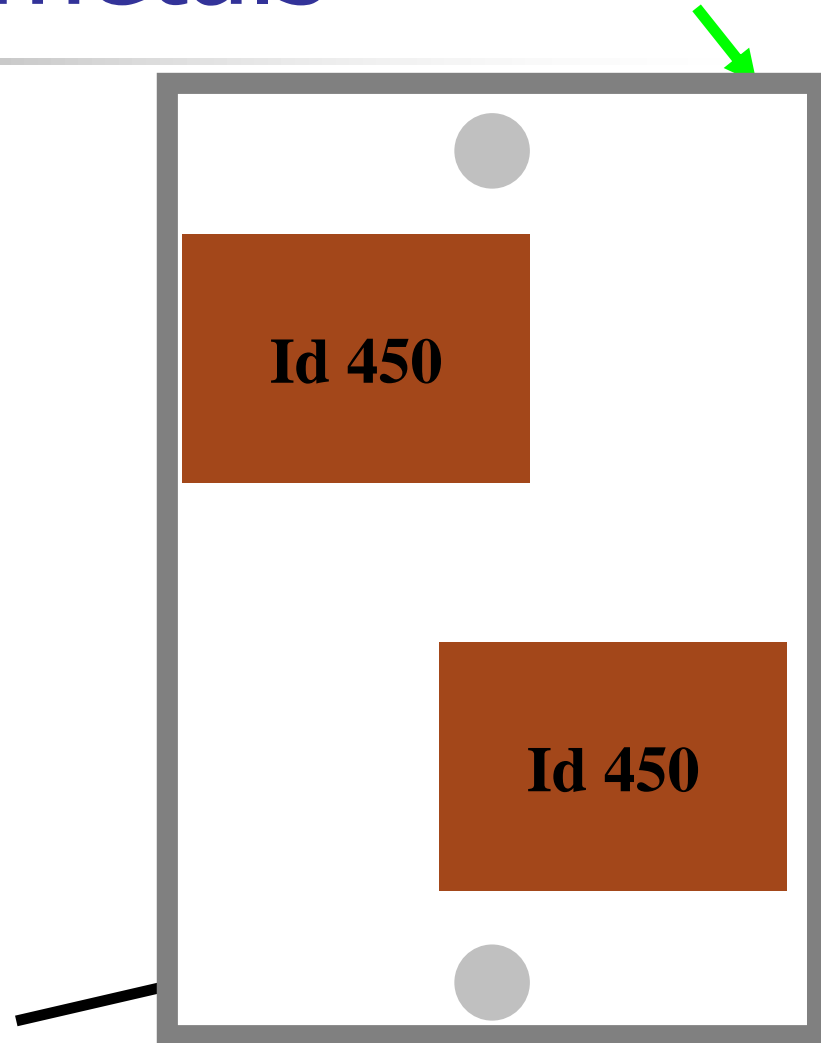
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Pre-treatment, metals

- Dimension 100 × 150 mm²
- Holes for fastening
- Marking (#5 excluded)
 - Zinc, Copper
 - Carbon Steel (Id 12)
 - Painted Steel
- Degreasing





Degreasing

- **Plastic gloves**
- Safety goggles
- Lab coat
- Degreasing solutions
 - Cu in Ethanol
 - 10 min in ultrasonic bath
 - Zn and Fe in Trichloroethylene ($\text{ClCH}=\text{CCl}_2$)
 - 5 min cold tri -> 30 s in tri steam → ×4



Pre-treatment, metals

- Drying (hairdryer)
- Cooling down, room temp (15-30 min)
- Weight
 - Balance capable of reading to 0.0001 g
- Packing
 - Drying agent
 - Plastic bags
 - Mark



Pre-treatment, painted steel

- **Plastic gloves**
- Scratch
- Edge protection (Vinylguard Silvergrey 88, Jotun)
- Marking
- Packing, as metals



Pre-treatment, stone samples

- Sample size $50 \times 50 \times 8 \pm 2$ mm
- Hole in the center
- Drying
 - 60 °C (3 hours) -> 105 °C (~16 hours)
- Remove dust
- Weight
- **Packing in marked plastic bags**

Exposure

- **Gloves**
- Plastic distances
- Screws and nuts
- Stone samples
 - **Marked positions**
- **Note the exposure date**





After exposure

- **Gloves**
- Dismounting
- Packing
 - Stones in correct plastic bag (correct ID)
- Drying samples on stands in room temp.
- Re-pack



Evaluation, metals

- Weigh samples ($W_f - W_i = \textit{weight gain}$)
- Take photographs
- Determine weight loss by Pickling
- Solutions
 - Cu in Sulfaminacid ($\text{H}_2\text{NSO}_3\text{H}$) 50 g L^{-1}
 - Zn in saturated glycine ($\text{C}_2\text{H}_5\text{NO}_2$) 250 g L^{-1}
 - Fe in Clark's solution (antimony trioxide, Sb_2O_3 , (20 g L^{-1}) and tin chloride, $\text{SnCl}_2 \times 2\text{H}_2\text{O}$, (60 g L^{-1}) dissolved in concentrated hydrochloric acid, HCl)

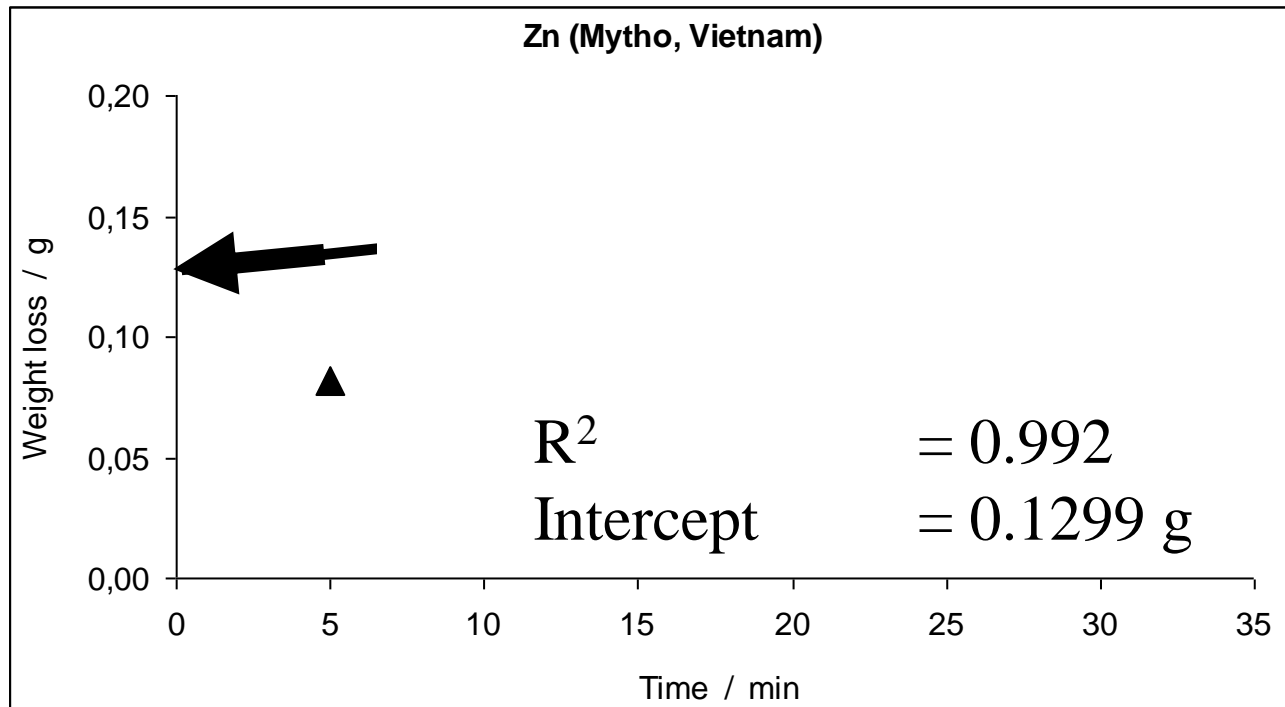


Pickling

1. Clean samples from dirt with hard plastic brush under running tap water (greasy samples use acetone)
2. Introduce the sample in pickling solution (ultrasonic bath) **10 min**
3. Quick rinse in running tap water
4. Dip and rinse in Ethanol
5. Drying with hairdryer
6. Allow to cool down (~15-45 min)

Pickling

7. Weigh
8. Repeat 2-7 until three constant weight losses obtained





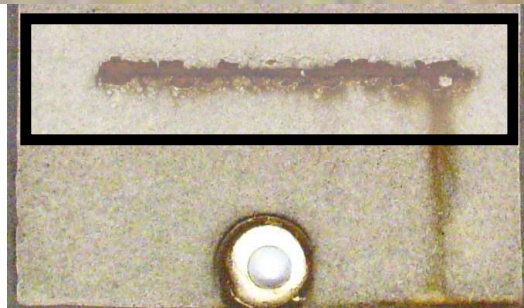
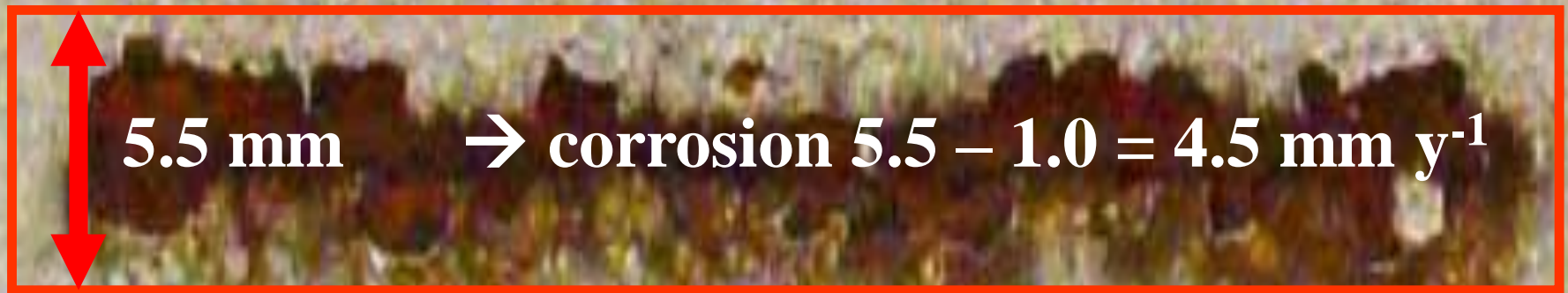
Evaluation

Zinc

Weight loss	0.1299	(g)
Area	0.03	(m ²)
Density	7.13	(g cm ⁻³)
Time	1.0	(Year)

Corrosion	4.33	(g m ⁻²)
	4.33	(g m ⁻² y ⁻¹)
	0.61	(μm y ⁻¹)

Evaluation, Painted Steel





Evaluation, stone samples

- Conditioning (60 °C, 3h → 105 °C 16h)
- Percentage change in weight

$$m\% = \frac{100 \times (W_1 - W_0)}{W_0}$$

- Recession rate

$$\begin{aligned} \mu\text{m} &= (W_1 - W_0) / (A \times r) = m\% \times W_0 / (A \times r \times 100) \\ &= \mathbf{m\% \times V / (A \times 100)} \end{aligned}$$



Additional information

- Soluble ions
 - Ion chromatography
- Corrosion products
 - Fourier transfer infrared (FT-IR)
 - X-ray diffraction (XRD)

Further questions?

