

Pitting and crevice corrosion

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Pitting

Pitting corrosion is a localized form of corrosion by which cavities or "holes" are produced in the material. Pitting is considered to be more dangerous than uniform corrosion damage because it is more difficult to detect, predict and design against.

- Introduction
- Electrochemical thermodynamics
- Electrochemical kinetics
- Corrosion rate measurements
- Various forms of corrosion
 - ▶ passivity
 - ▶ galvanic corrosion
 - ▶ **pitting/crevice corrosion**
 - ▶ cracking
 - ▶ erosion corrosion
 - ▶ corrosion environments
- Corrosion mitigation

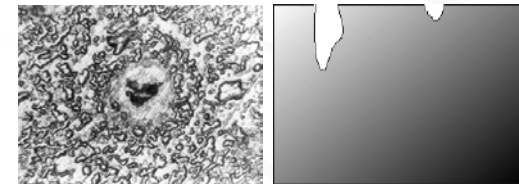
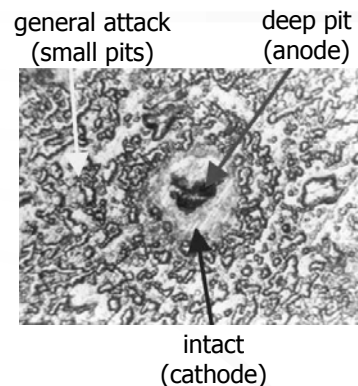


image source: Corrosion Doctors , www.corrosion-doctors.org

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A pit

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An aluminum A92519 specimen exposed to a 3,5% NaCl solution for seven days. The width of the picture is approximately 1 mm.

image source: Corrosion Doctors , www.corrosion-doctors.org

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Causes of pitting

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- Localized chemical or mechanical damage to the protective oxide film.
- Low dissolved oxygen concentrations and high concentrations of chloride (as in seawater)
- Localized damage to, or poor application of, a protective coating
- The presence of non-uniformities in the metal structure of the component, e.g. inclusions.

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Passive metals pit

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Pitting corrosion on a stainless steel bar exposed to an alkaline solution loaded with chlorides.

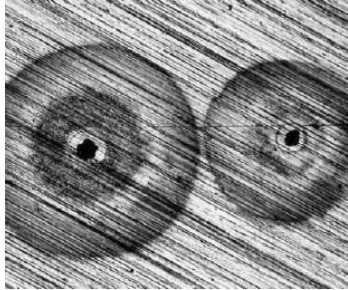


image source: Prof. Dr. H. Böhm, www.ibwk.baum.ethz.ch

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Morphology of pitting

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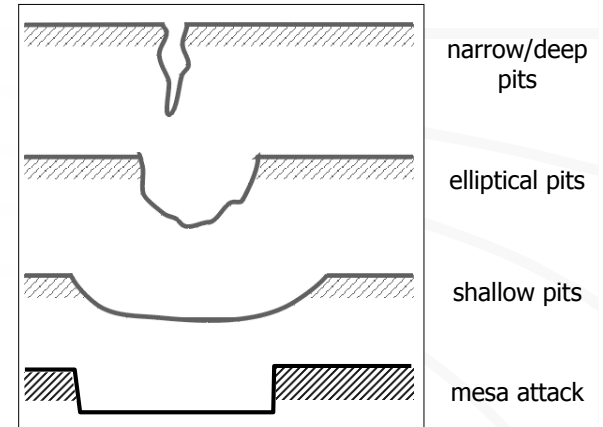


image source: Corrosion Doctors, www.corrosion-doctors.org

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Morphology of pitting (continued)

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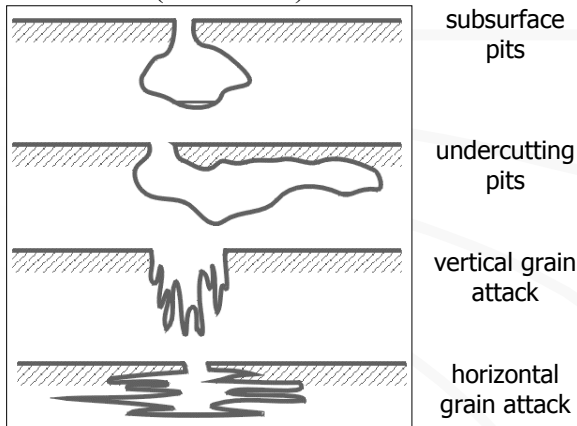
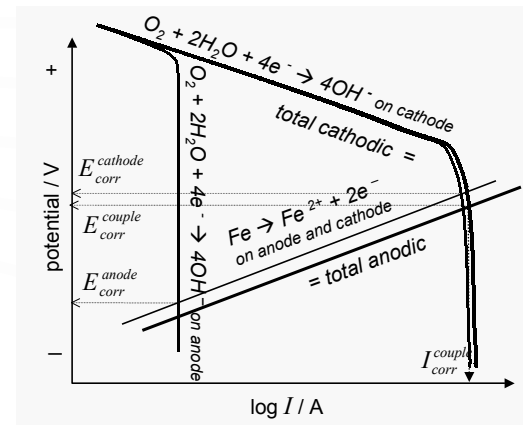


image source: Corrosion Doctors, www.corrosion-doctors.org

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Background: theory of differential aeration

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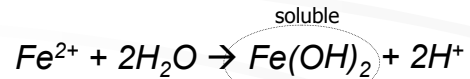


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Anode acidifies

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... due to depletion of oxygen anode acidifies:



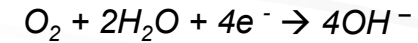
... leading to even more iron dissolution

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Cathode passivates

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... due to rapid oxygen reduction on the cathode and a more alkaline solution :

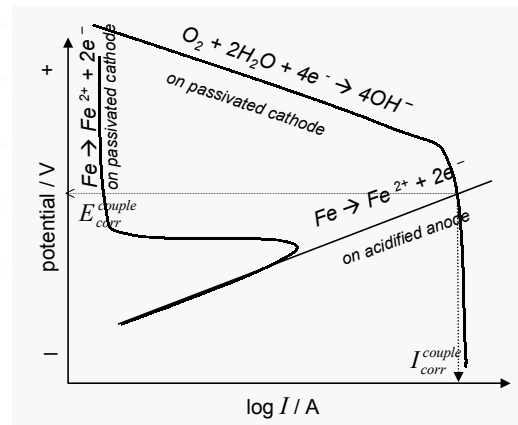


... it passivates

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An active/passive differential aeration cell

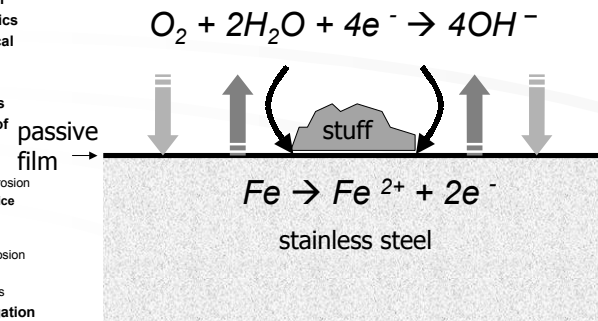
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Under deposit pitting of passive metals

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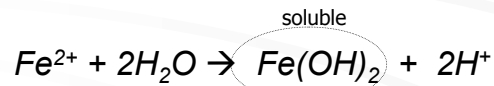


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Under deposit acidification

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- Corrosion mitigation

... due to the depletion of oxygen and due to increasing concentrations of dissolved iron under the deposit, the solution acidifies:

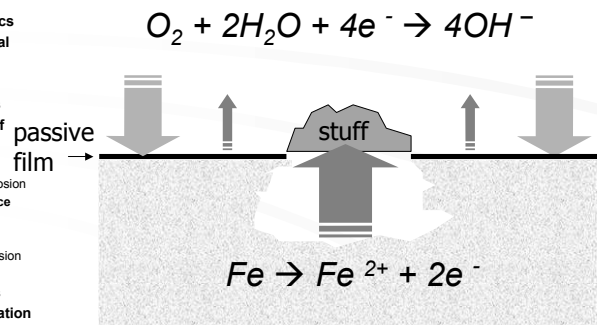


... leading to activation (active dissolution) of iron under the deposit and rapid growth of a pit

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Under deposit pit growth

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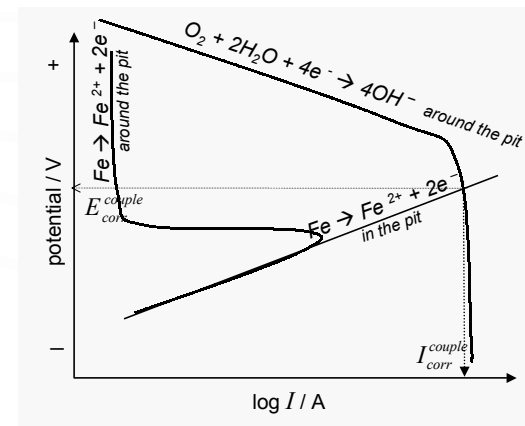


pitting aggravated by a large cathode/anode ratio

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Pit: a differential aeration cell

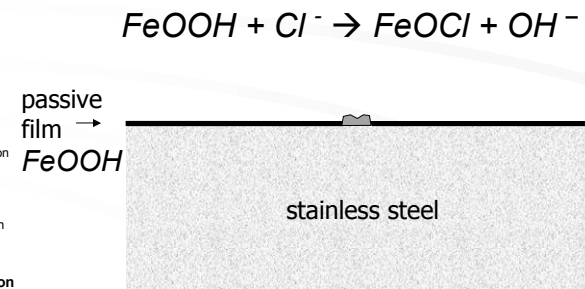
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Chloride induced pitting of passive metals

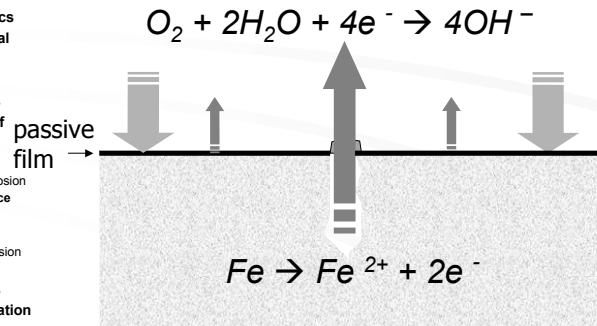
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Chloride induced pit growth

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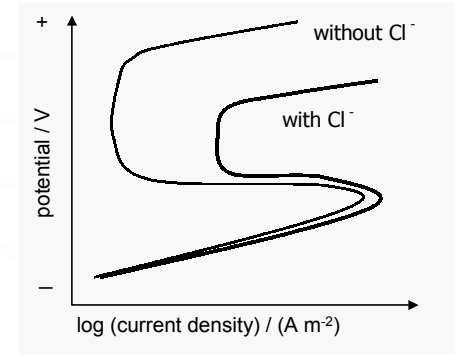


pitting aggravated by a large cathode/anode ratio

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Chloride induced pitting of passive metals

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Prevention of pitting

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 Corrosion mitigation

- decrease:
 - chloride content
 - acidity
 - temperature
- increase:
 - flow / mixing
 - surface cleaning
- eliminate
 - suspended solids
 - dead legs / stagnant sections
- add inhibitors
- material selection

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Crevice corrosion

Crevice corrosion is a localized form of corrosion usually associated with stagnant solutions in shielded areas such as those formed under gaskets, washers, insulation material, fastener heads, surface deposits, disbonded coatings, threads, lap joints, clamps, etc.

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image source: Corrosion Doctors, www.corrosion-doctors.org

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Example of crevice corrosion

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Crevice corrosion of a S30400 stainless steel washer after 30 days in 0.5 FeCl₃ + 0.05 M NaCl solution

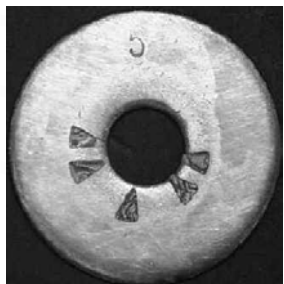


image source: Corrosion Doctors, www.corrosion-doctors.org

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Another example of crevice corrosion

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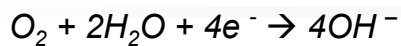


Stainless steel bolt used in seawater after 5 years of exposure.

image source: George Dinwiddie, www.alberg30.org

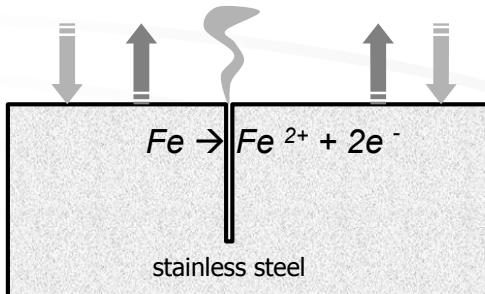
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Crevice corrosion of passive metals



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passive film →

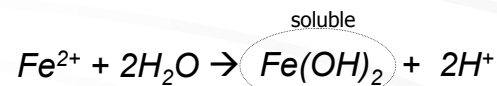


crevice corrosion aggravated by a large cathode/anode ratio

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Crevice corrosion of passive metals

... due to depletion of oxygen and due to increasing concentrations of dissolved iron in the crevice, the solution acidifies:



... leading to activation (active dissolution) in the crevice

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