ACC Corrosion/FAC

A Perspective as Introduction
to
Session 4: Chemistry and Corrosion

Third Annual ACC Users Group

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Corrosion/FAC in ACC and The Consequences

- High concentrations of iron around the cycle
  - Boiler/HRSG deposits
  - Boiler/HRSG Tube Failures
  - Steam Turbine Deposits
- Need for Iron Removal Processes
  - Condensate Polishing and/or Filters
- Limitations around the cycle
  - Condensate polishing
- Overall an ACC "controls" the unit cycle chemistry
  - International Guidelines didn't consider ACC or two-phase flow up to 2010 (IAPWS Volatile Guidance)

And we have an ACC Corrosion Index to Categorize Corrosion and Track Improvments

DHACI

(Dooley, Howell, Air-cooled Condenser, Corrosion Index)

We Know what the Corrosion Looks Like

DHACI 3

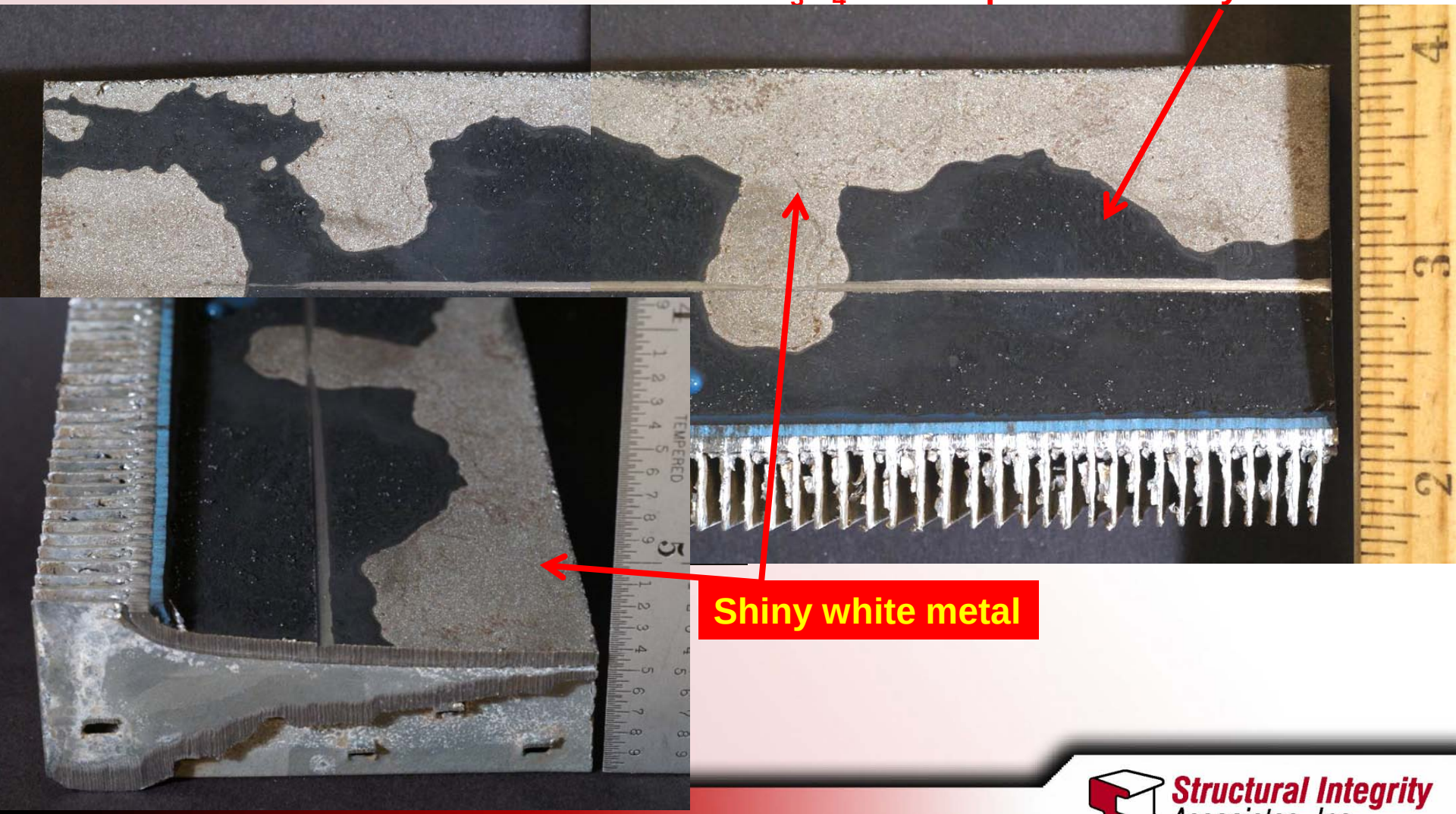
DHACI 4

DHACI 3

And what Holes at Tube Entries Look Like

Inside diameter surface of an ACC Tube

The black areas are where the Fe_3O_4 is Precipitated Locally



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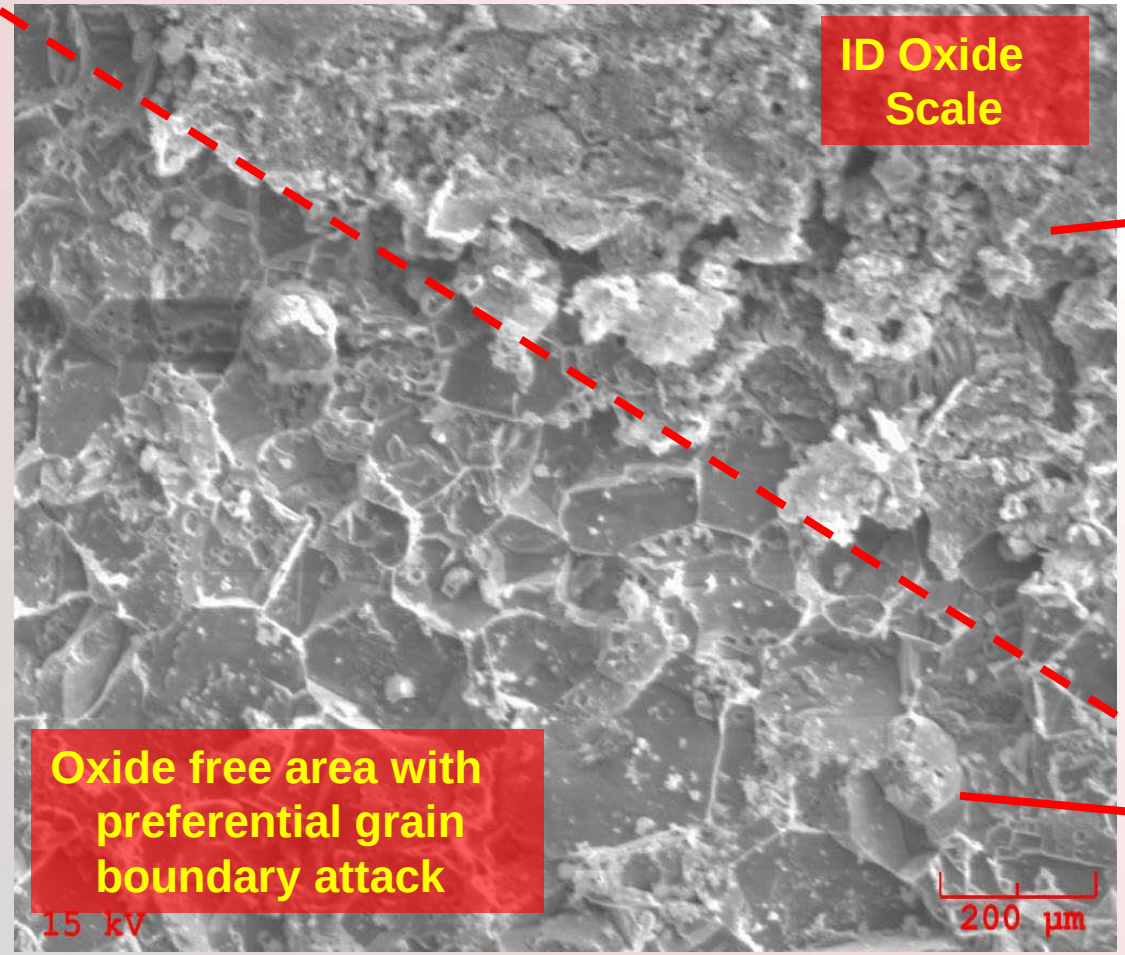
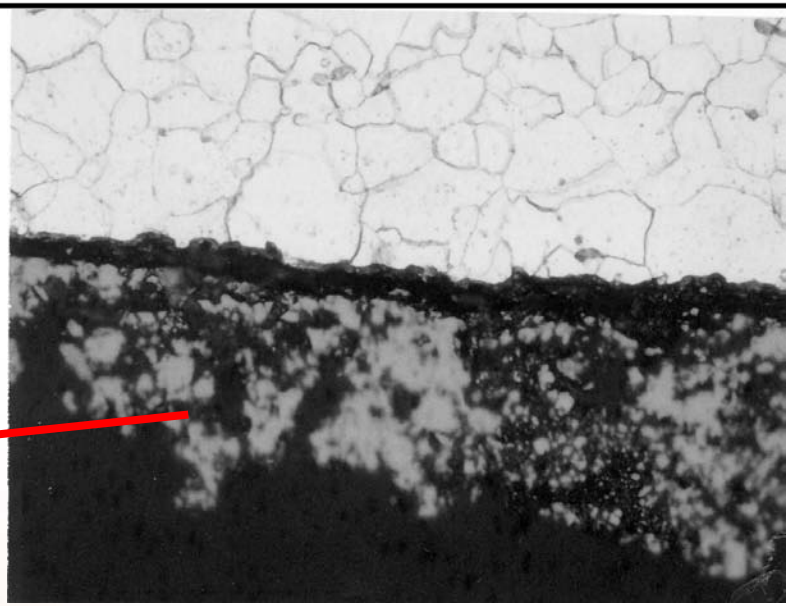
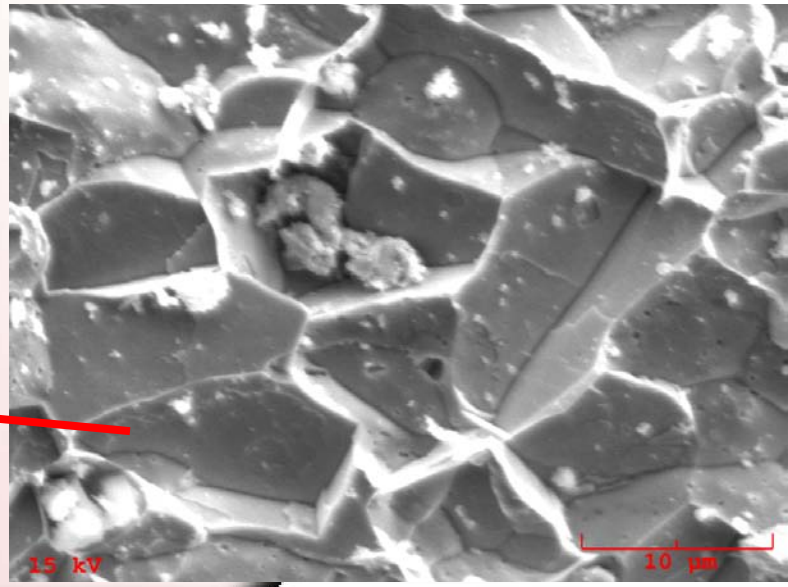
Corroded (FAC?) ID Surface of ACC Tube







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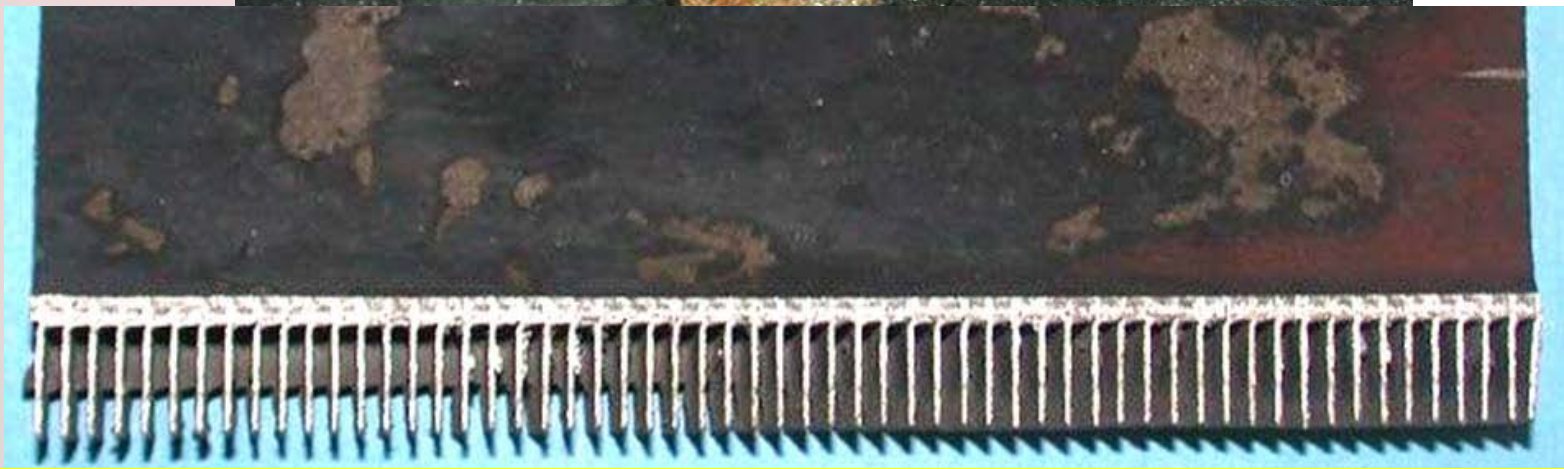
Second Tube Showed the Same Features



6 inch section of ACC tube and detail of the surface showing black deposits and white “bare” metal areas

But do we Understand the Environment and the Corrosion Mechanism?

Solutions are already being applied

Increase bulk pH up to 9.8

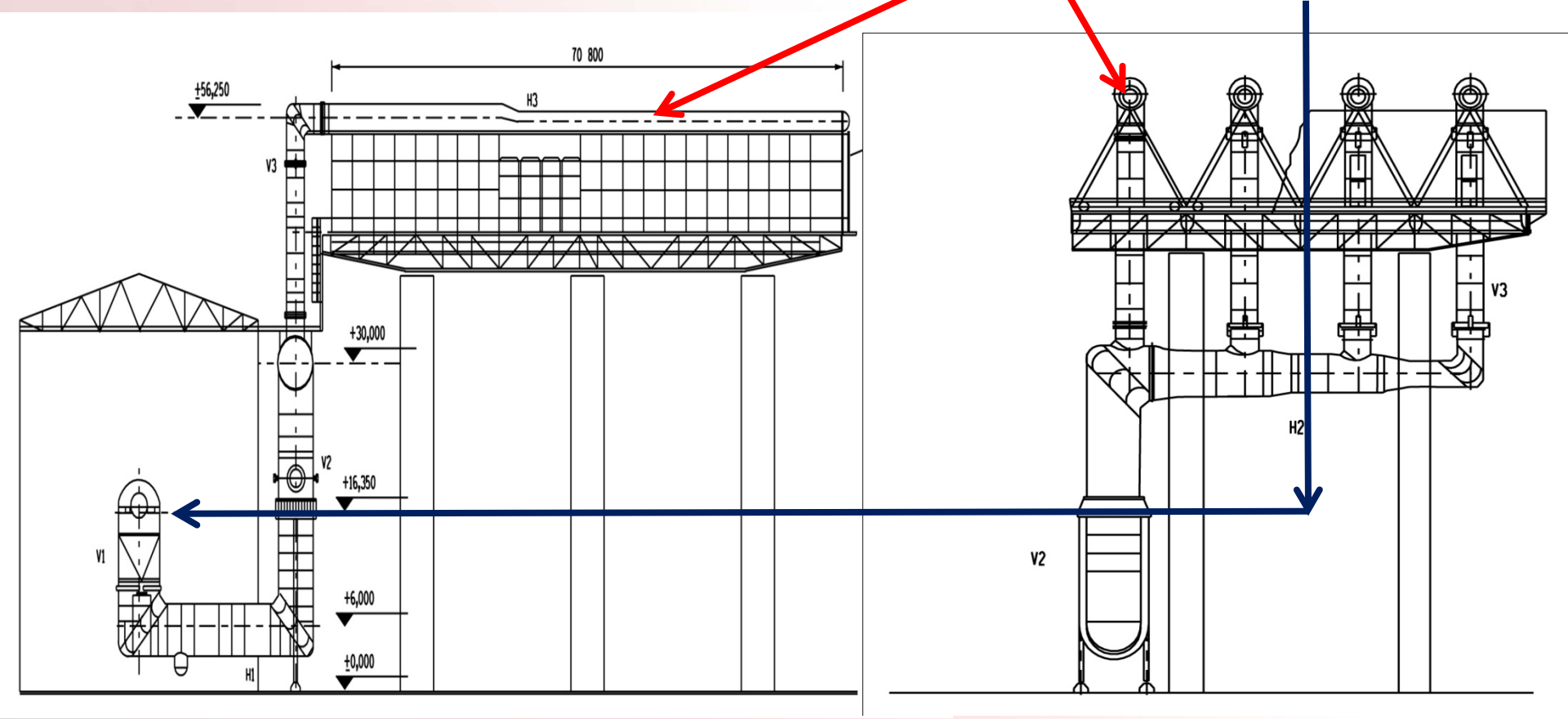
Increase local pH (amines)

Coatings (epoxy), Sleeves, Inserts

Materials

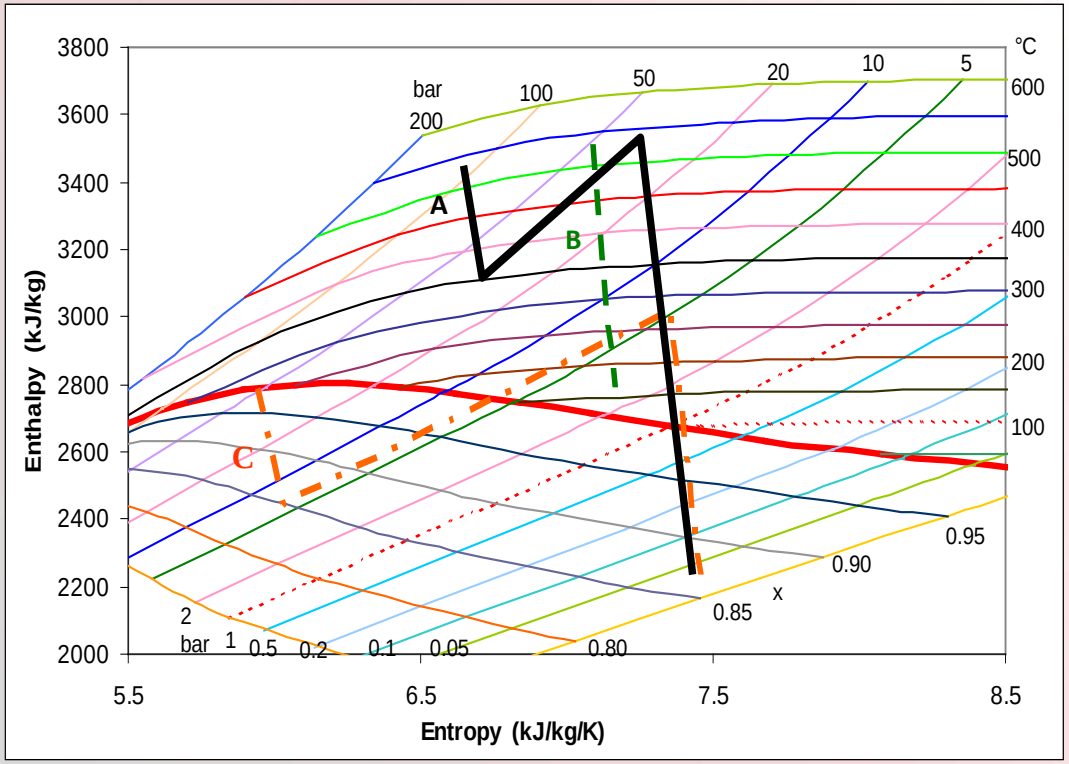
Designs?

To Understand the Corrosion Here we need to Understand the Environment in the PTZ



The PTZ Environment in the LP Steam Turbine is Completely Understood

Generation of the ACC Environment



Heterogeneous droplet Nucleation and Liquid Films on ST Blades

(Droplets and Liquid Films in the ACC don't contain any oxygen until during shutdown)

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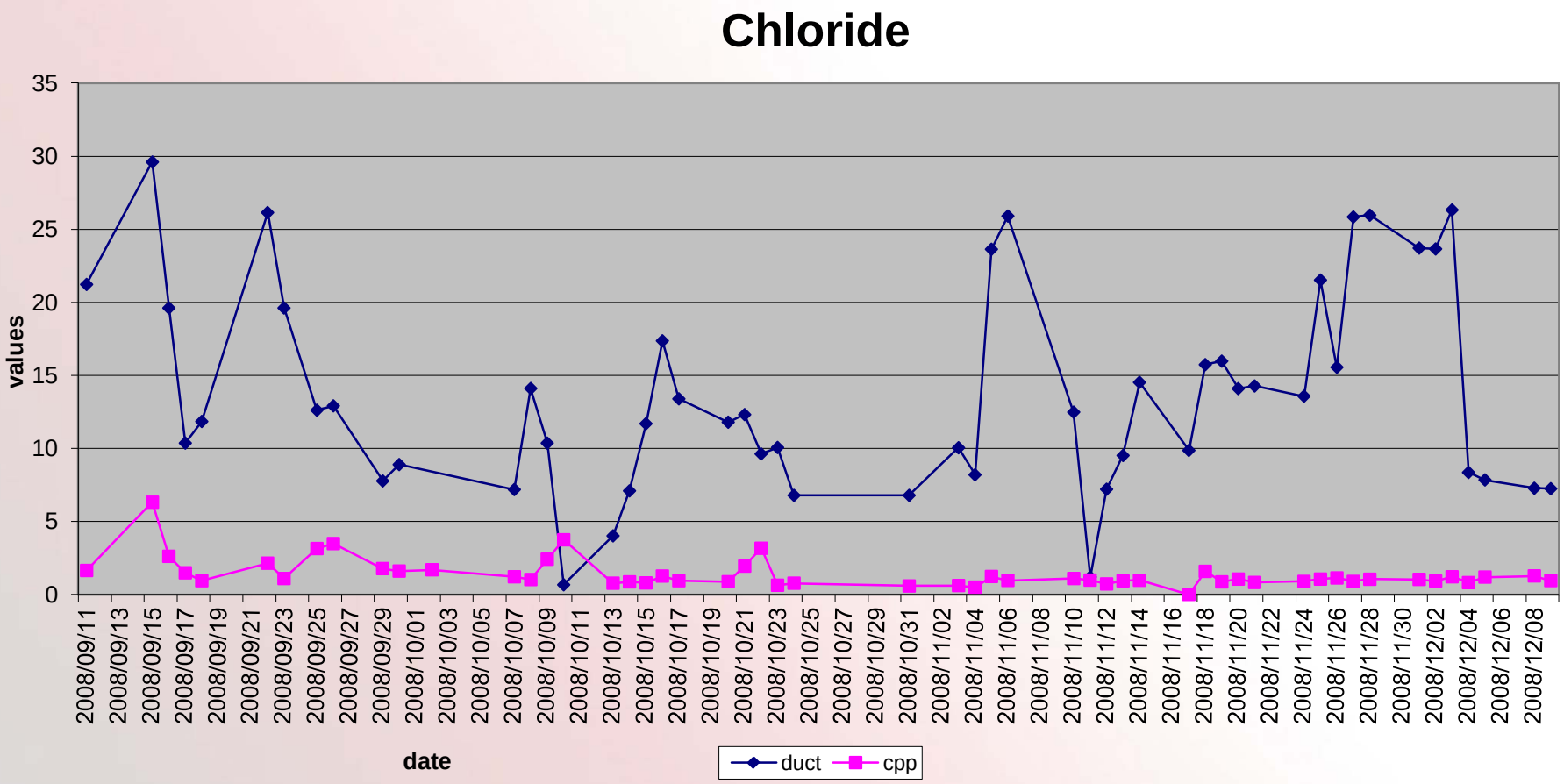
The Liquid in ACC Upper Ducts



Courtesy Setsweke Phala, Eskom

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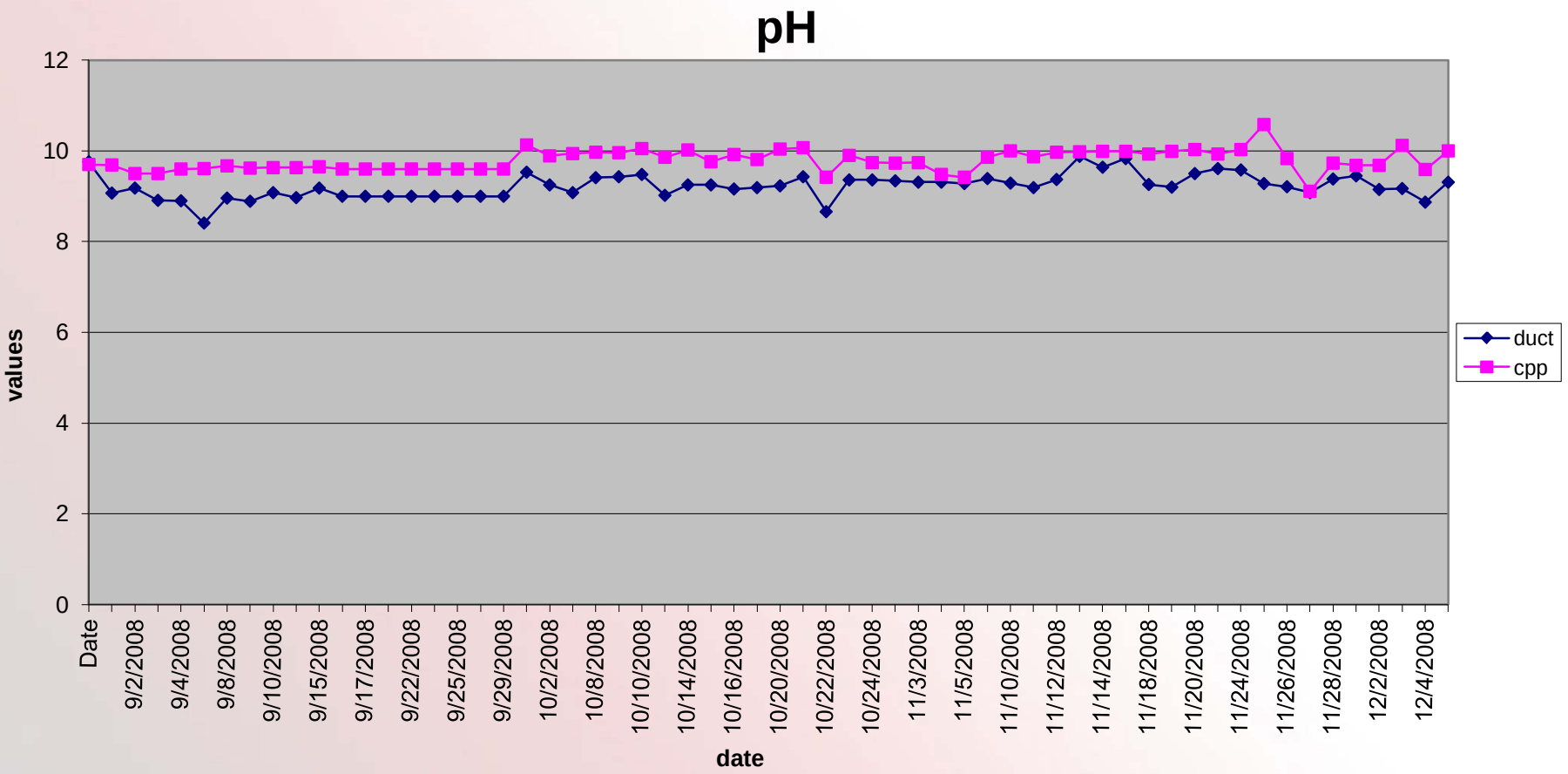
The Liquid in ACC Upper Ducts



Courtesy Setsweke Phala, Eskom

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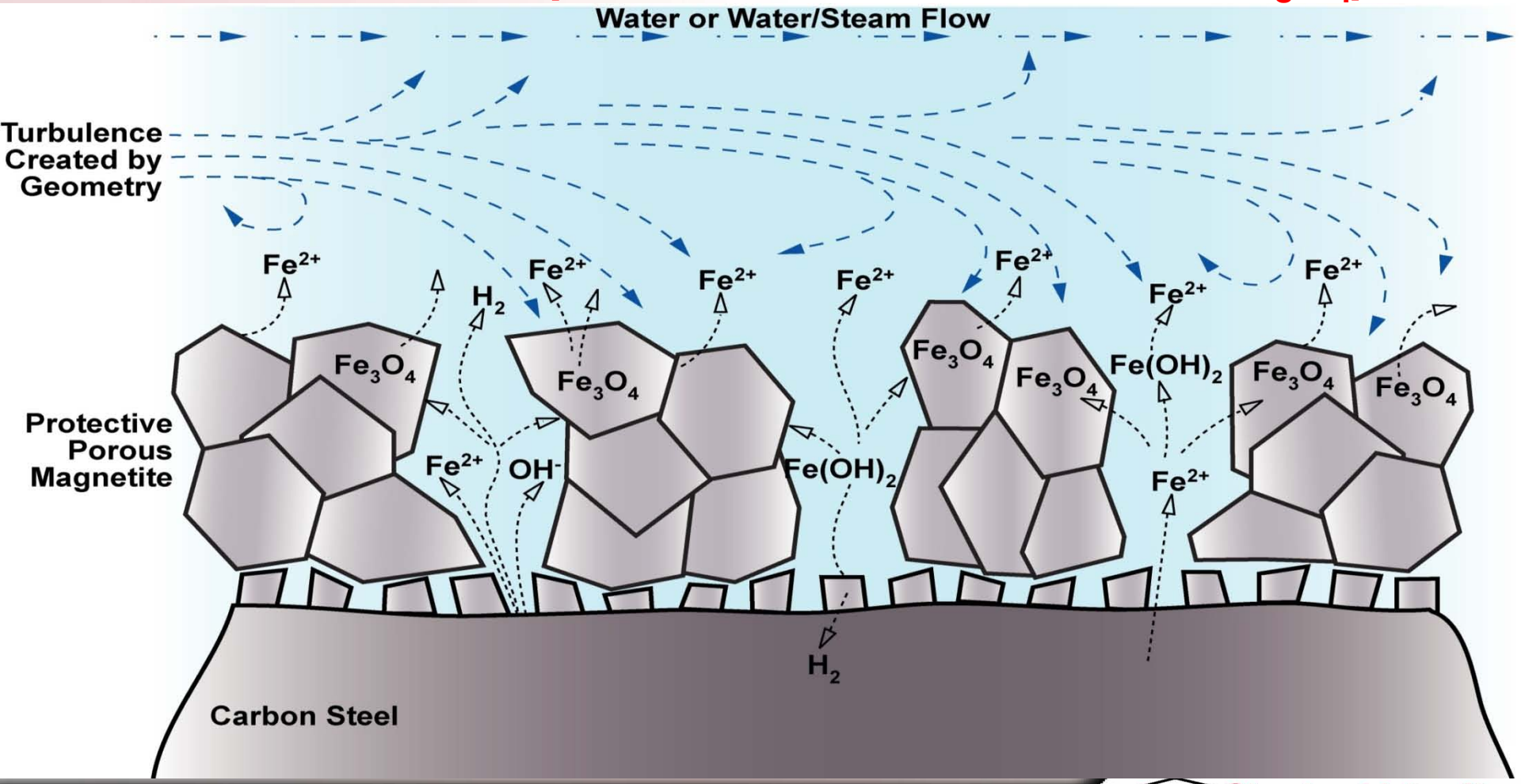
So is the ACC Corrosion Mechanism Low Temperature FAC?

Dependent on Removing the Saturation of Fe_3O_4 at the Surface and Precipitating it Adjacently

Two-phase FAC in Flowing Turbulent Flow at ACC Tube Entries (Removes the Saturation of Fe_3O_4)



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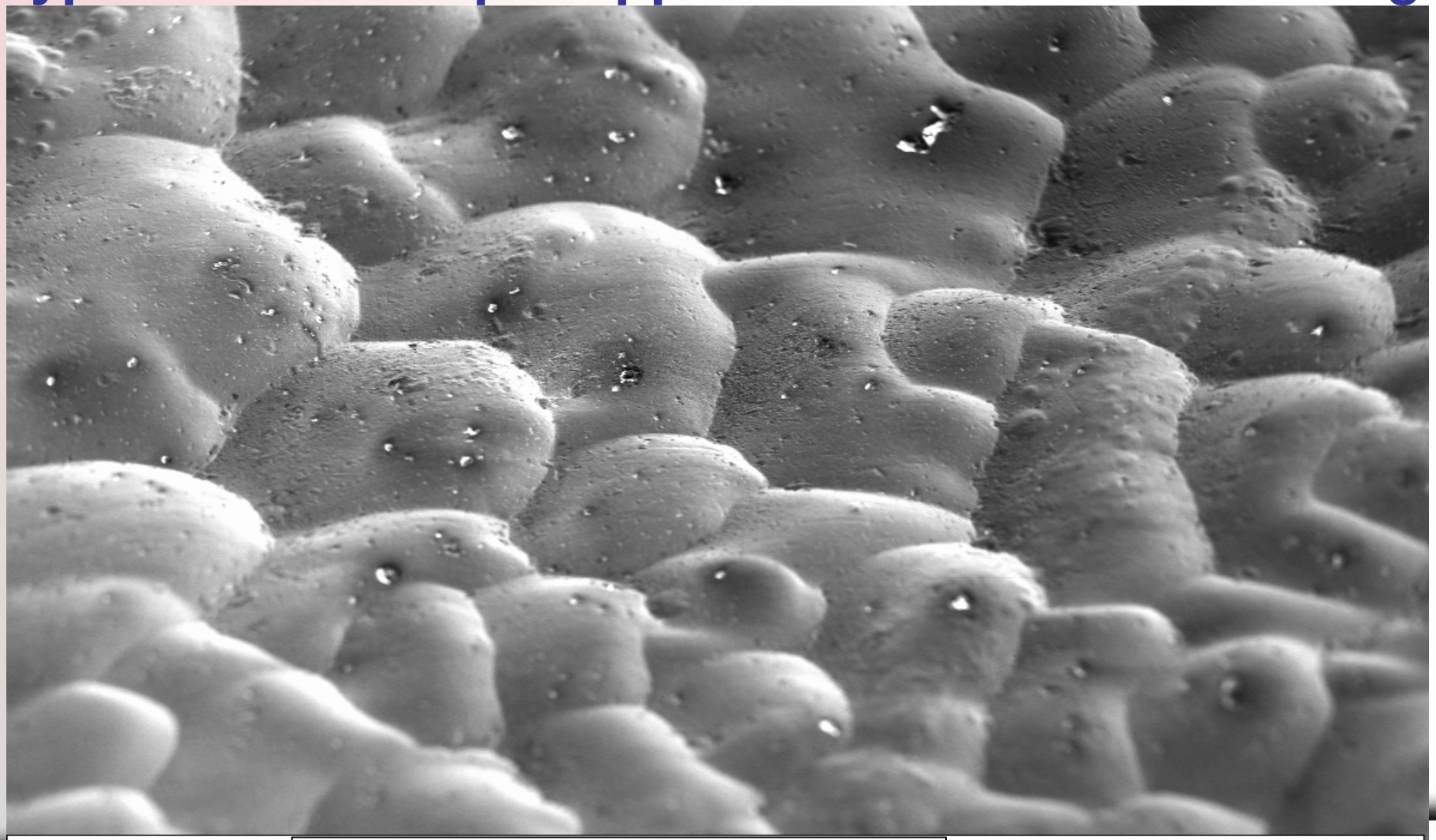
Typical Microscopic Appearance of FAC is Missing



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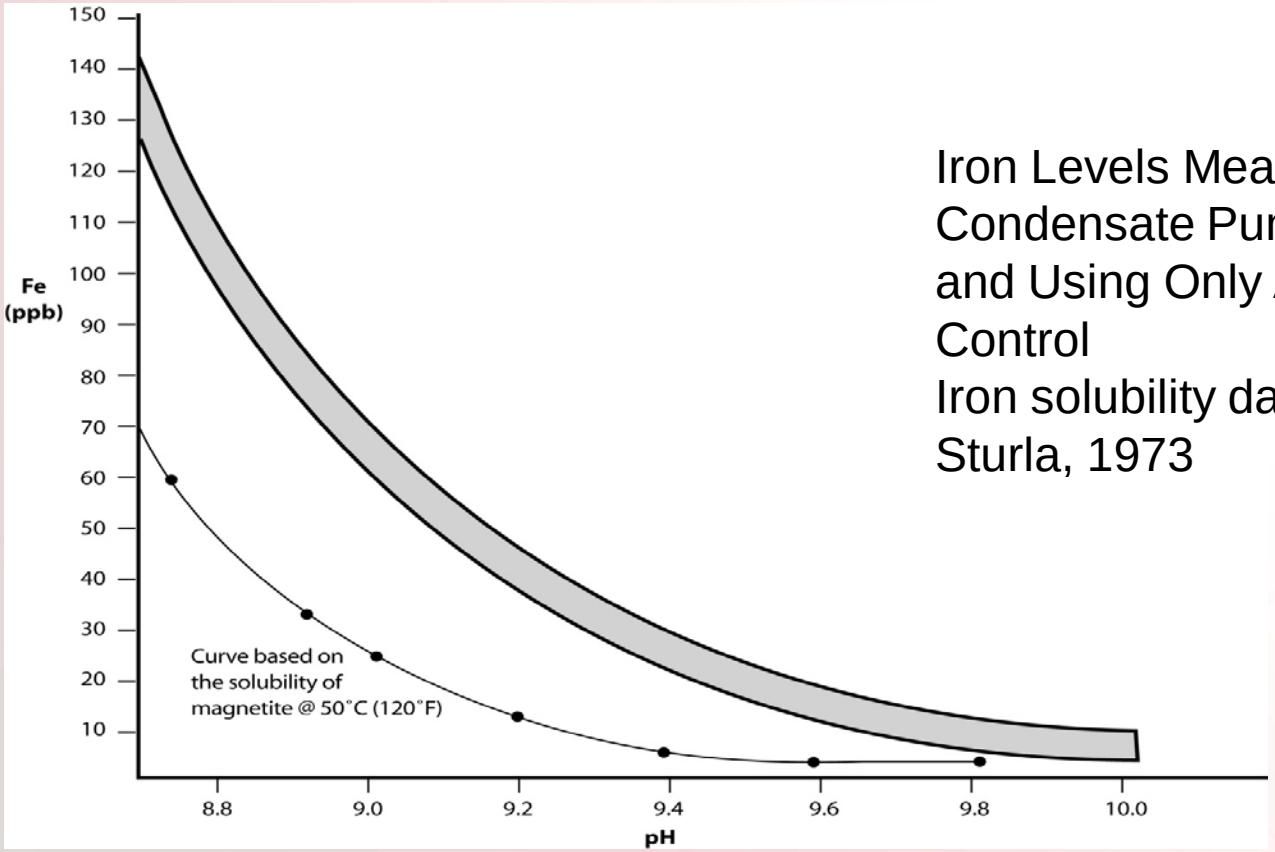
Or is the ACC Corrosion Mechanism Something Other than FAC?

and if so

Why does the Dooley/Aspden Relationship Work ?

Dooley/Aspden pH Versus Iron Relationship



Iron Levels Measured at Condensate Pump Discharge and Using Only Ammonia for pH Control

Iron solubility data extracted from Sturla, 1973

In Summary

- **Some aspects relate to Low Temperature FAC**
  - Adjacent black and white areas in severe turbulent areas
  - Increasing pH reduces damage
- **Some aspects don't (normal FAC scalloped appearance)**
- **Environment is known and has been measured**
  - Two-phase mixture formed in PTZ of ST
  - Concentrating liquids **(Higher in chloride/sulphate, organics)**
  - Lower in pH
- **Clearly more tubes need to be analyzed**
- **Clearly we need to provide solutions which address the mechanism**