

De-Carbonizing the Campus: Planning, Tools & Technologies

CampusEnergy2023

February 27 – March 2, 2023

Gaylord Texan Resort & Convention Center | Grapevine, Texas



INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION

Novel Volatile Filming Corrosion Inhibitor for Steam Boilers

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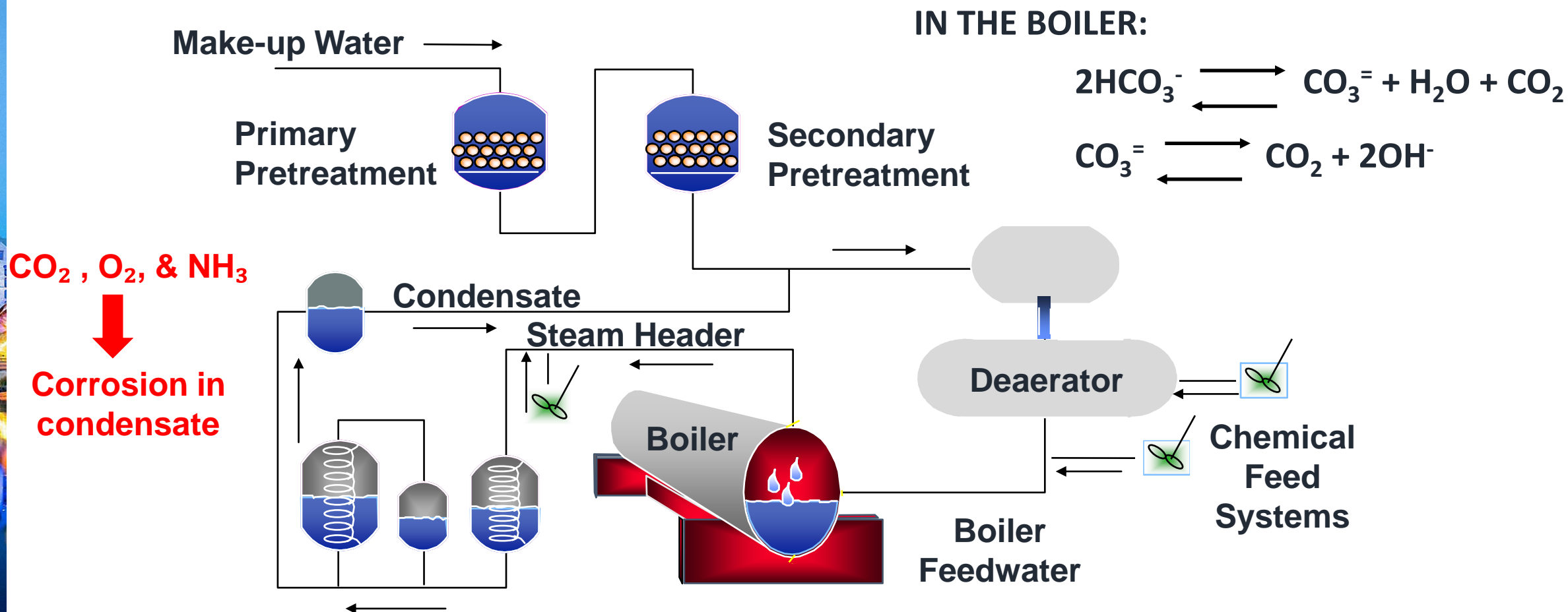
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Today's Technology Discussion

- **Review of condensate treatment options**
- **Novel surface adsorption corrosion inhibitors (filmers)**
 - **Volatile FDA filmer technology**
- **Research and trial applications**
- **Key points of Volatile FDA approved filmer**

Typical Boiler System



Condensate Treatment Products



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graph TD; A[Condensate Treatment Products] --> B[NEUTRALIZERS]; A --> C[FILMERS]; A --> D[FILMER-NEUTRALIZER COMBINATIONS]; A --> E[PASSIVATOR-NEUTRALIZER COMBINATIONS];
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NEUTRALIZERS

**pH adjustment
only**

FILMERS

**Barrier film
only**

FILMER- NEUTRALIZER COMBINATIONS

**pH adjustment +
barrier film**

PASSIVATOR- NEUTRALIZER COMBINATIONS

**pH adjustment +
metal passivator**

Condensate Treatment Selection Rationale

- CO₂ loading
- Volatile
- Cost
- Feed Location
- O₂ Corrosion
- System Design
- Regulatory Requirements
- Ease of application/convenience

**Its got to be FDA,
cheap, high tech,
non-toxic, easy to
feed . . .**



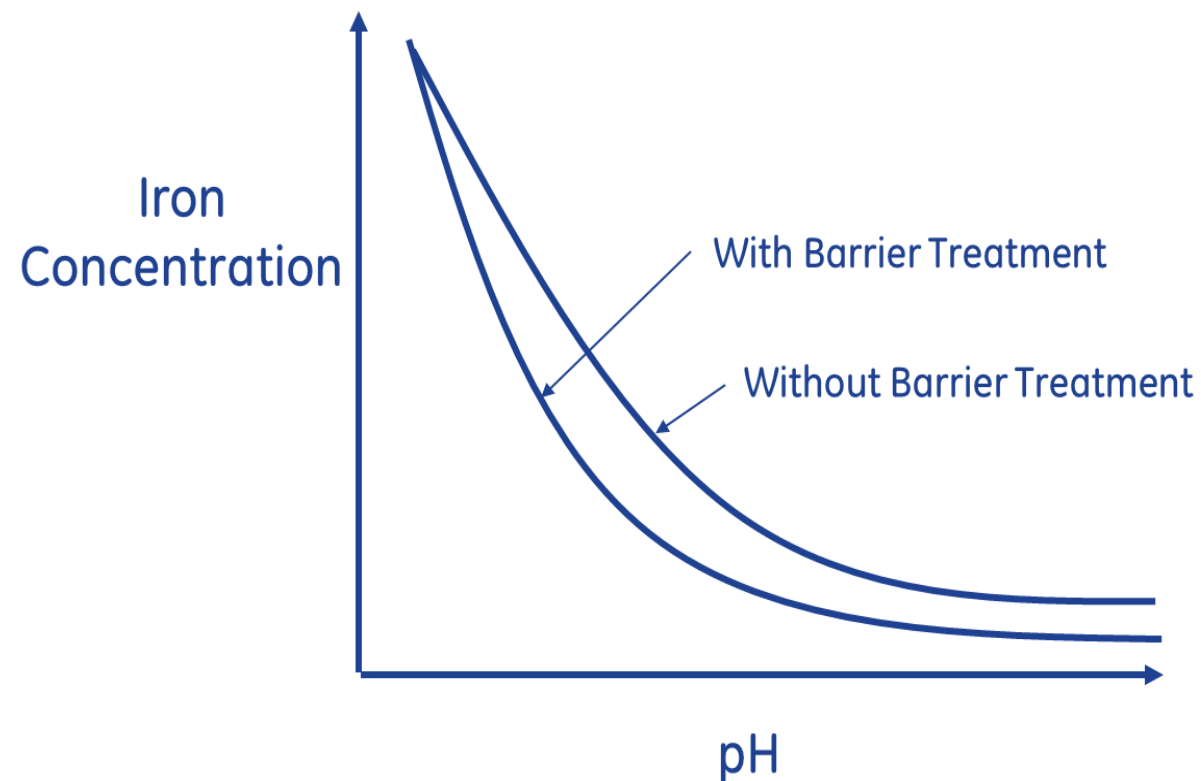
Barrier Technology/Filmers

- Advantages

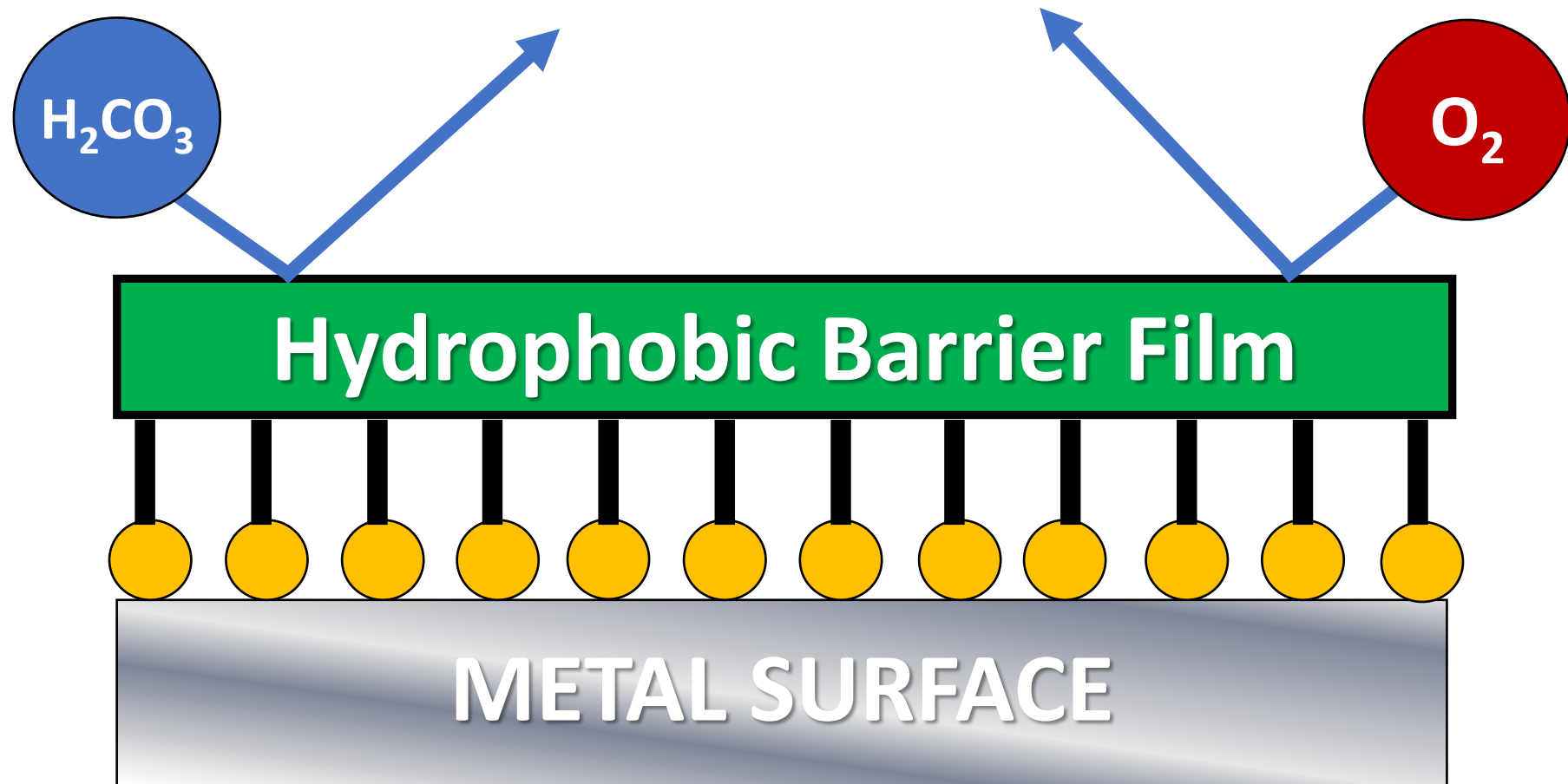
- Less expensive for high alkalinity systems
- Effective in the pH range of 5.5 - 8.5
- Protects against dissolved O_2 (0 - 100 ppb)
- Provides some protection against erosion-corrosion

- Limitations

- Potential for gunking (traditional filmers)
- Can be difficult to feed



Surface Adsorption Corrosion Inhibitors



FDA Volatile Filmer Origin

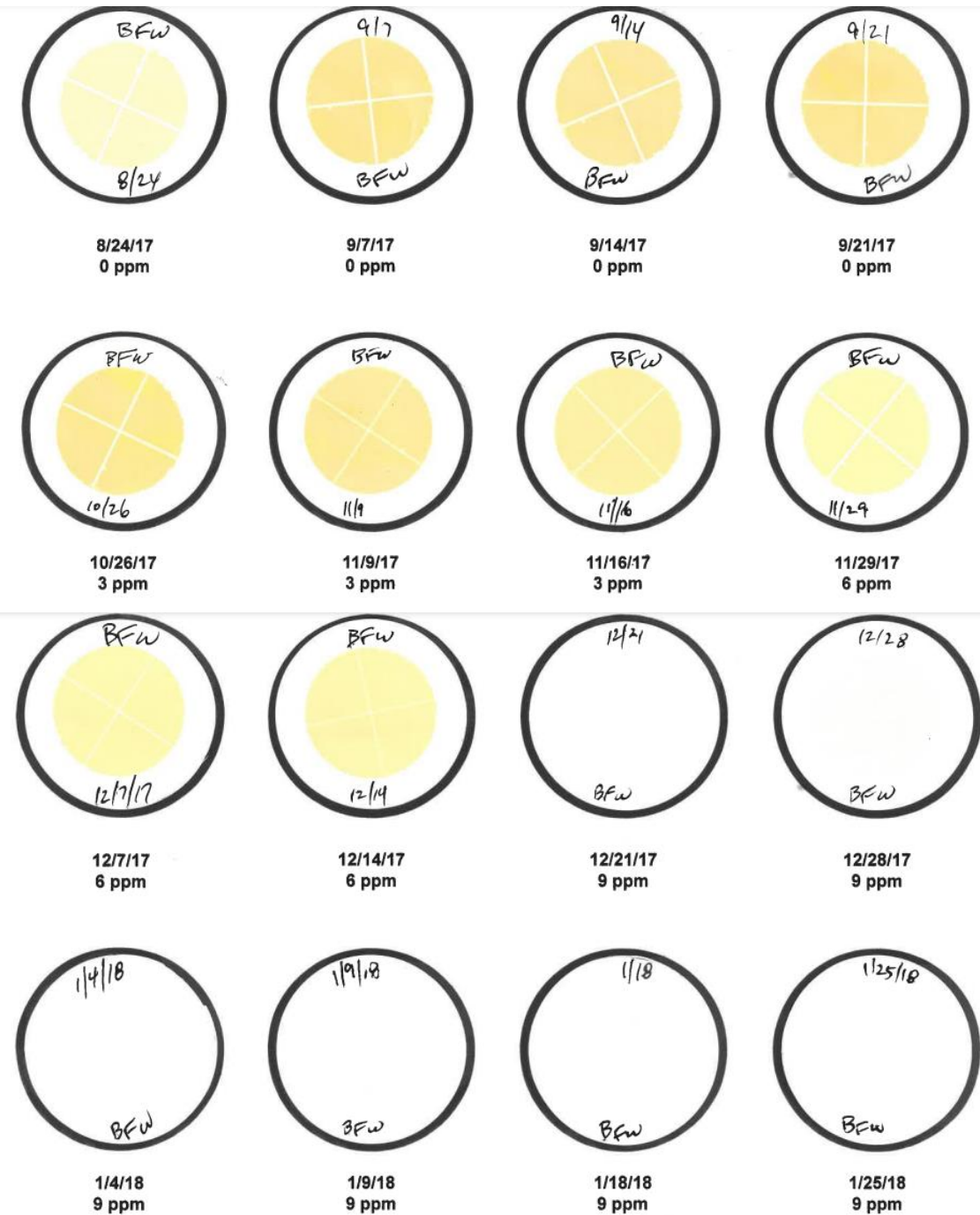
Challenge

COGEN plant challenged us with changing their existing steam condensate treatment (eliminating volatile neutralizing amines) with limited capabilities to feed a product.



Solution

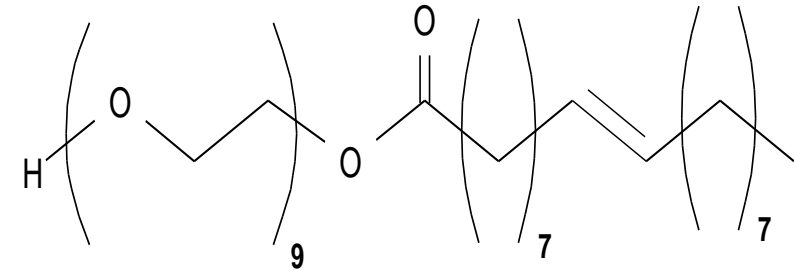
Existing filmer product utilized although fed to turbine condensate to get into the BFW and provide complete system protection. Reduced iron throw via millipores with no steam purity, foaming, or gunking issues.



FDA Volatile Filmer Origin

Existing FDA Filmer – Optifilm

- ✓ FCN NO. 97 (must be fed in steam header)
- ✓ Hogan Lovells opinion letter – allowed to feed in BFW

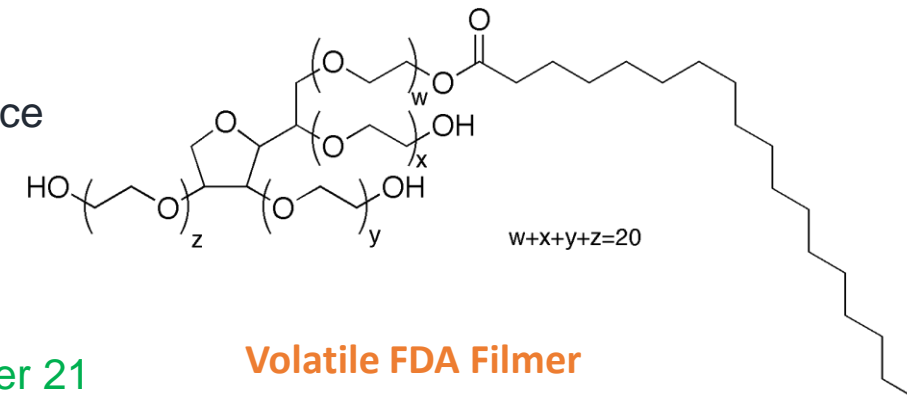


Optifilm

New Volatile FDA Filmer

- ✓ Optifilm + another active (21 CFR 173.310)
- ✓ Can be fed in BFW
- ✓ Additional component controls foaming and enhances performance
- ✓ Both molecules hydrolyze under boiler conditions
- ✓ By-product fatty acids are volatile
- ✓ Fatty acids are permitted additives for direct addition to food under 21

CFR sections 172.860, 172.862, 172.808 respectively



Volatile FDA Filmer

Boiler FDA Volatile Filmer – Excellent Distribution

Steam phase



Liquid Phase

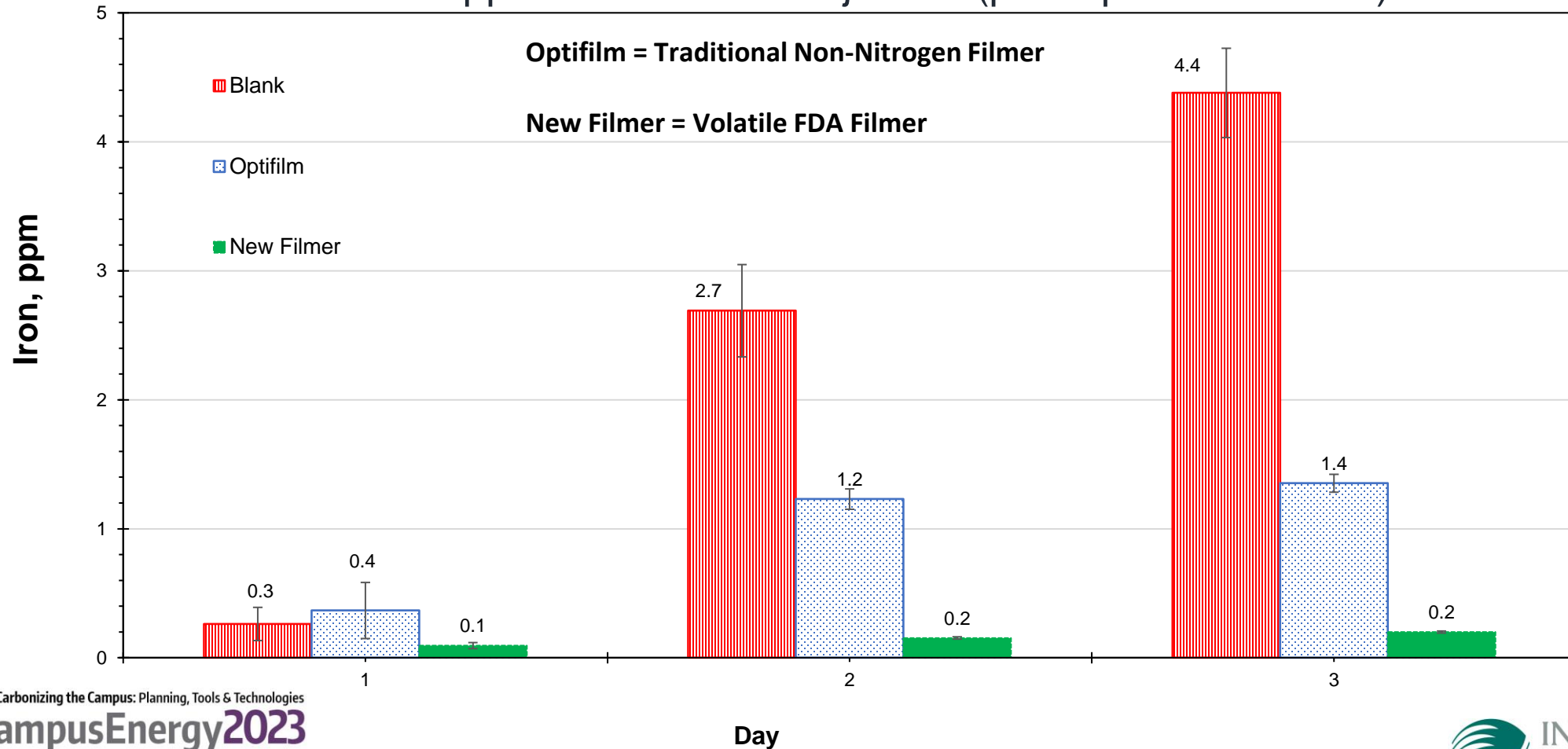


Distribution Ratio Comparison

Compound	0 psig	200 psig	1000 psig
FDA Volatile Filmer	1.8	8.0	6.1
Cyclohexylamine	4.0	23.3	9.3
DEAE	1.7	4.5	3.4
MOPA	1.0	2.4	2.5
Morpholine	0.4	1.6	0.98

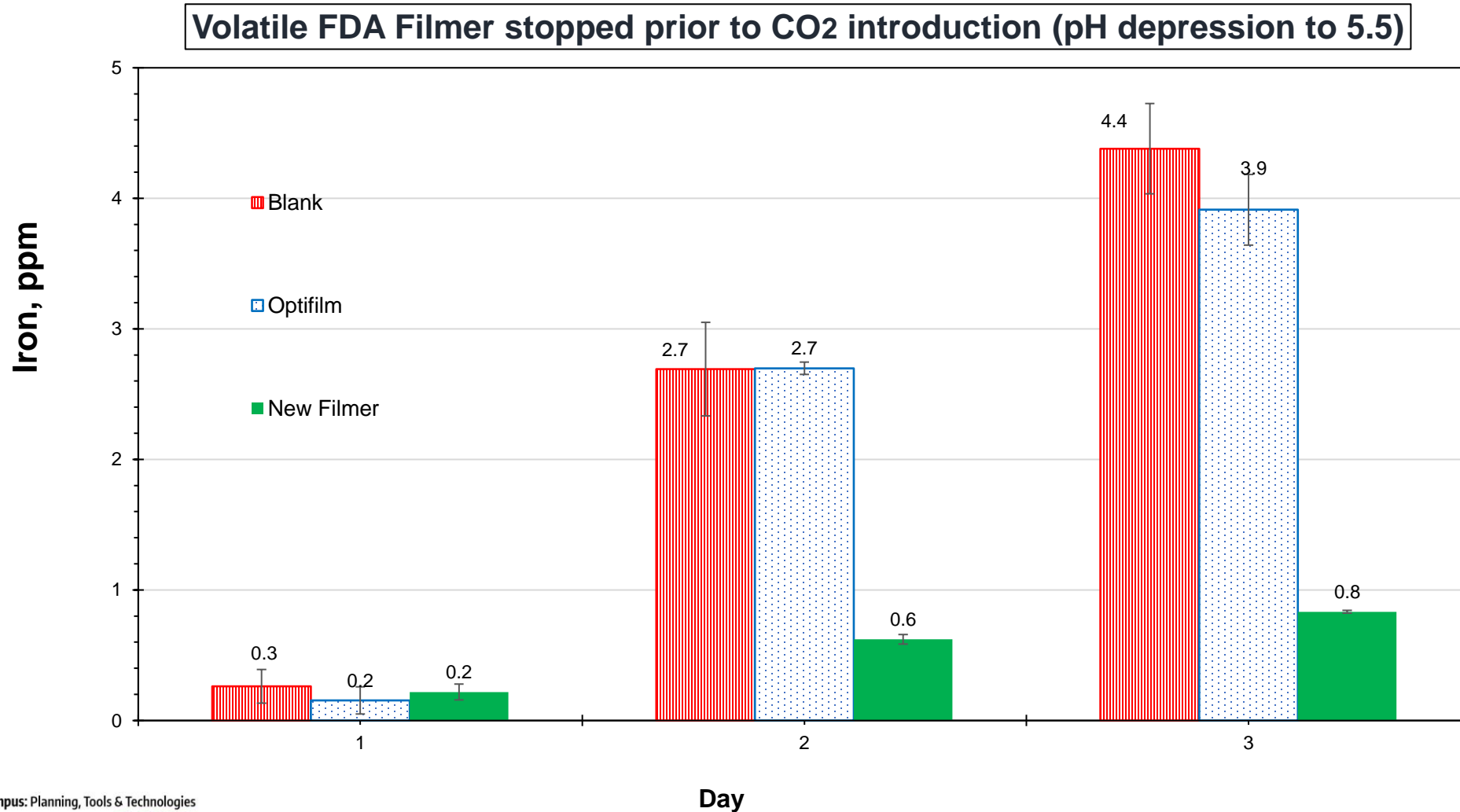
Corrosion Performance Comparison

Volatile FDA Filmer superior to Baseline and OptiFilm
Continuous application vs. CO₂ injection (pH depression to 5.5)



Corrosion Performance Comparison – Filmer Stability

Excellent Results in very aggressive conditions



FDA Volatile Filmer

Product Basics –

- **FDA approved where steam contacts food per 21 CFR 173.310**
- **Volatile** – complete system protection from a single feed point
- Performance - over traditional surface adsorption chemistry
- Dual filmer protection – **dramatically** improved corrosion protection and system coverage
- Non-nitrogen, non-gunking, non-foaming
- EHS – A “People Friendly” formula
- Next Generation – blended, patented products to include amines and dispersants

Registrations -

- FDA Food Contact
- NSF G6
- Kosher
- Health Canada (LONO) – next step

FDA Volatile Filmer

Lessons learned/where to use -

- High alkalinity BFW (e.g. softened, non-RO)
 - Better protection at equal or lower pH
 - Can't feed enough amine to achieve target pH and maintain FDA compliance
- Oxygen – barrier protection limits corrosion
 - Inadequate mechanical deaeration (e.g. hotwell)
 - Oxygen ingress (e.g. vented receivers, pump seals, surface condensers, etc.)
- Intermittent operation
 - Protection during complete or partial system shutdown (e.g. weekend, seasonal)
- Plants requiring non-nitrogen chemistry (e.g. chlor-alkali)

Why to use -

- Complete system protection during operation and downtime
- Economic benefits – can lower “cost-to-treat”
- FDA compliant
- EHS/People friendly chemistry

Thank You!



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Questions?

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