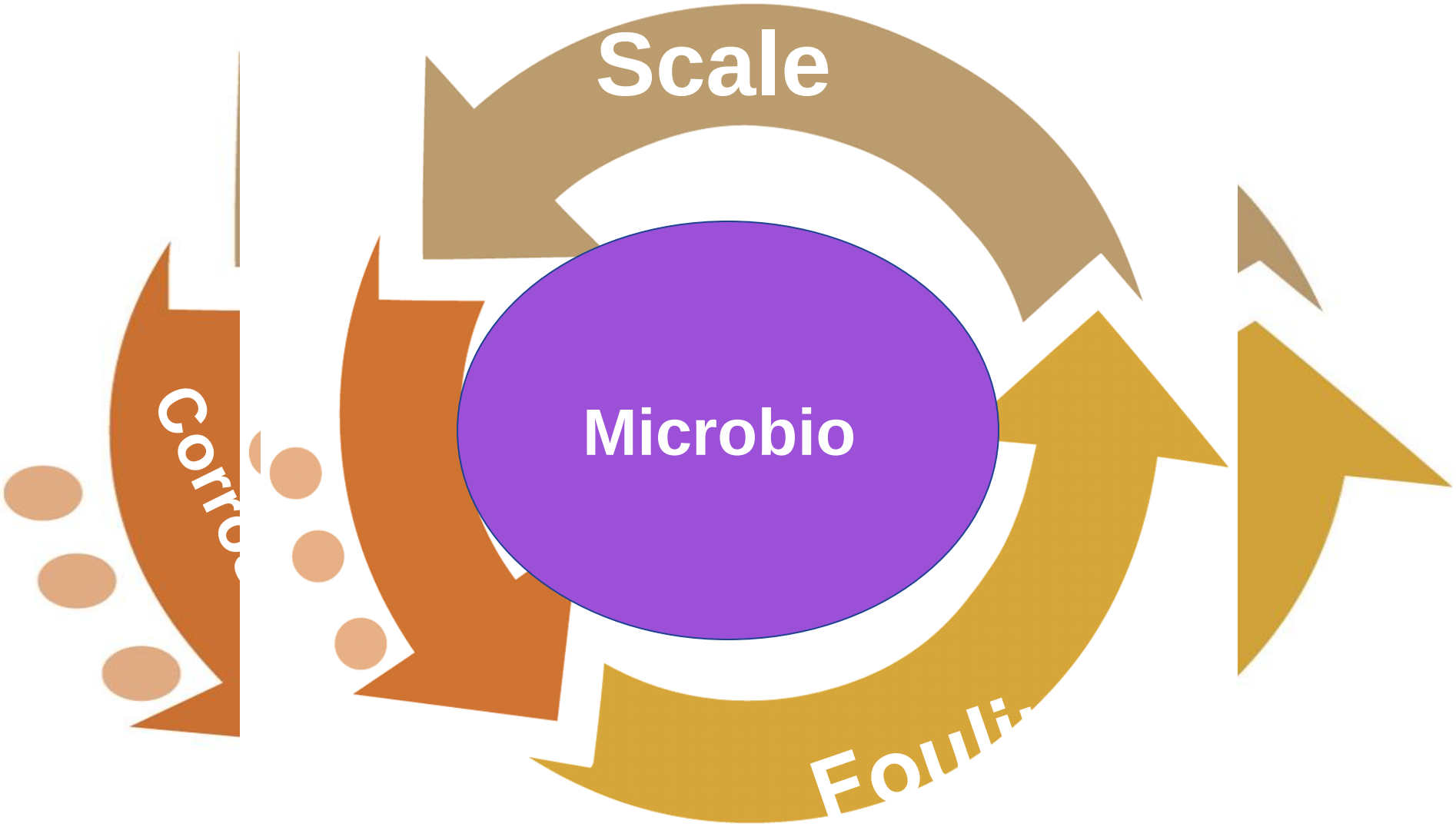
Advance Scale Control Technology For Cooling Water Systems

GE imagination at work

Agenda

- Cooling Systems Problems
- Scale
- Scale Inhibition & Control
- GE New Stress Tolerant Polymer
- Case History

Cooling Systems Problems



Scale

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Scale formation

Dissolved Atoms

↓

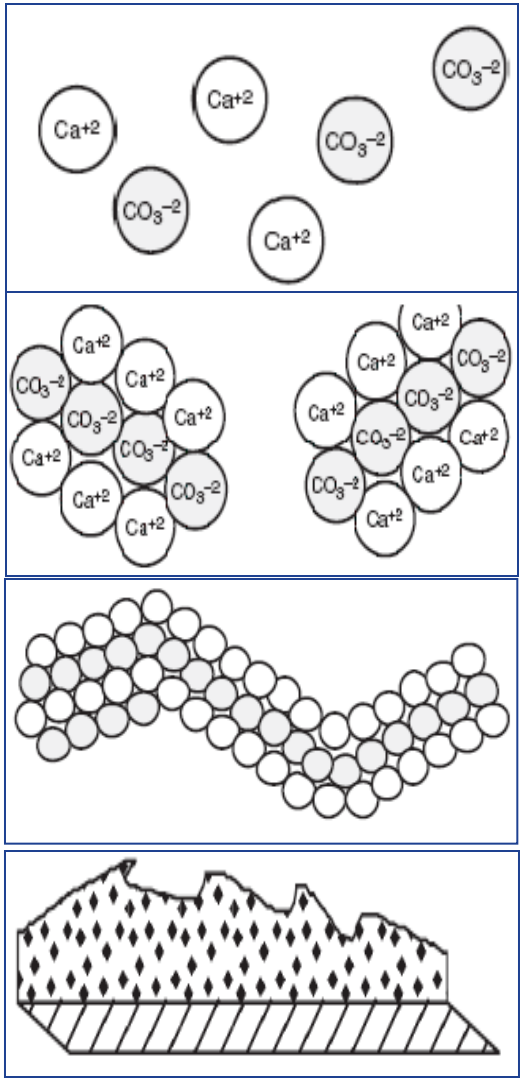
Nucleation formation

↓

Crystal Growth

↓

Scale Formation



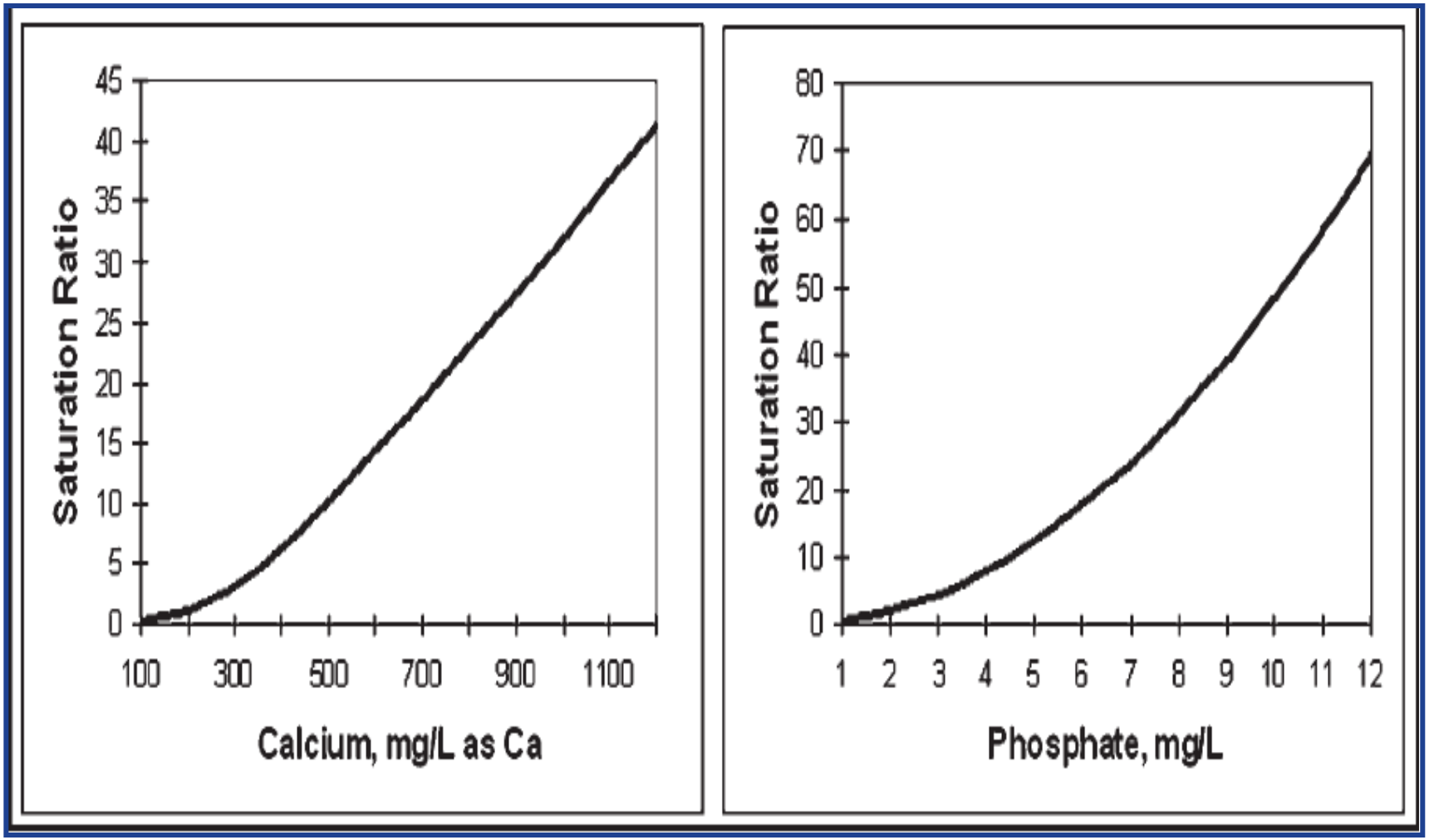
Common Scale Minerals

- Calcium Phosphate
- Calcium Carbonate
- Iron Phosphate
- Iron Oxides
- Silicate.

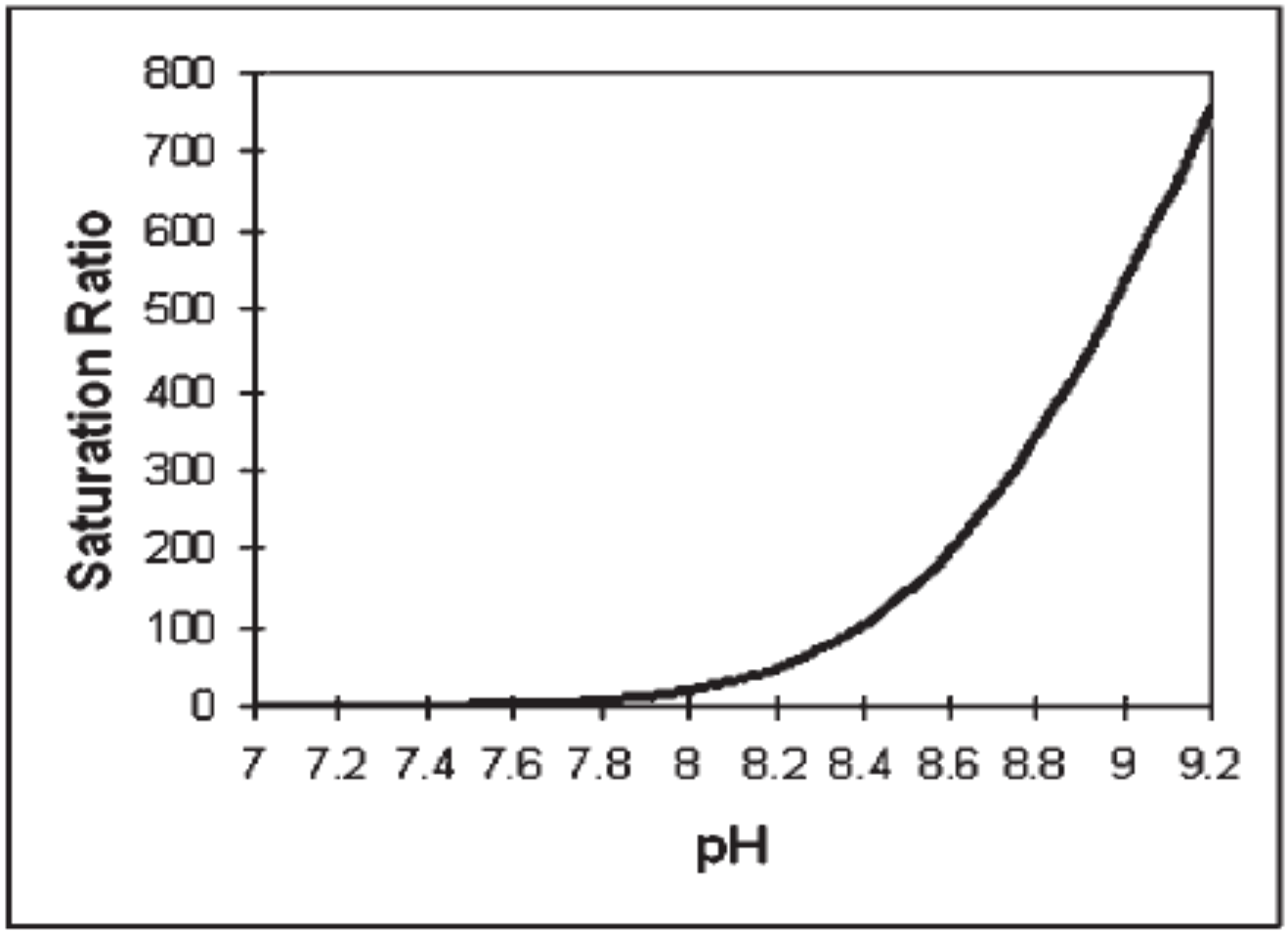
Factors Affecting Scale formation

- Water composition
- pH
- Temperature
- Water velocity
- System metallurgy

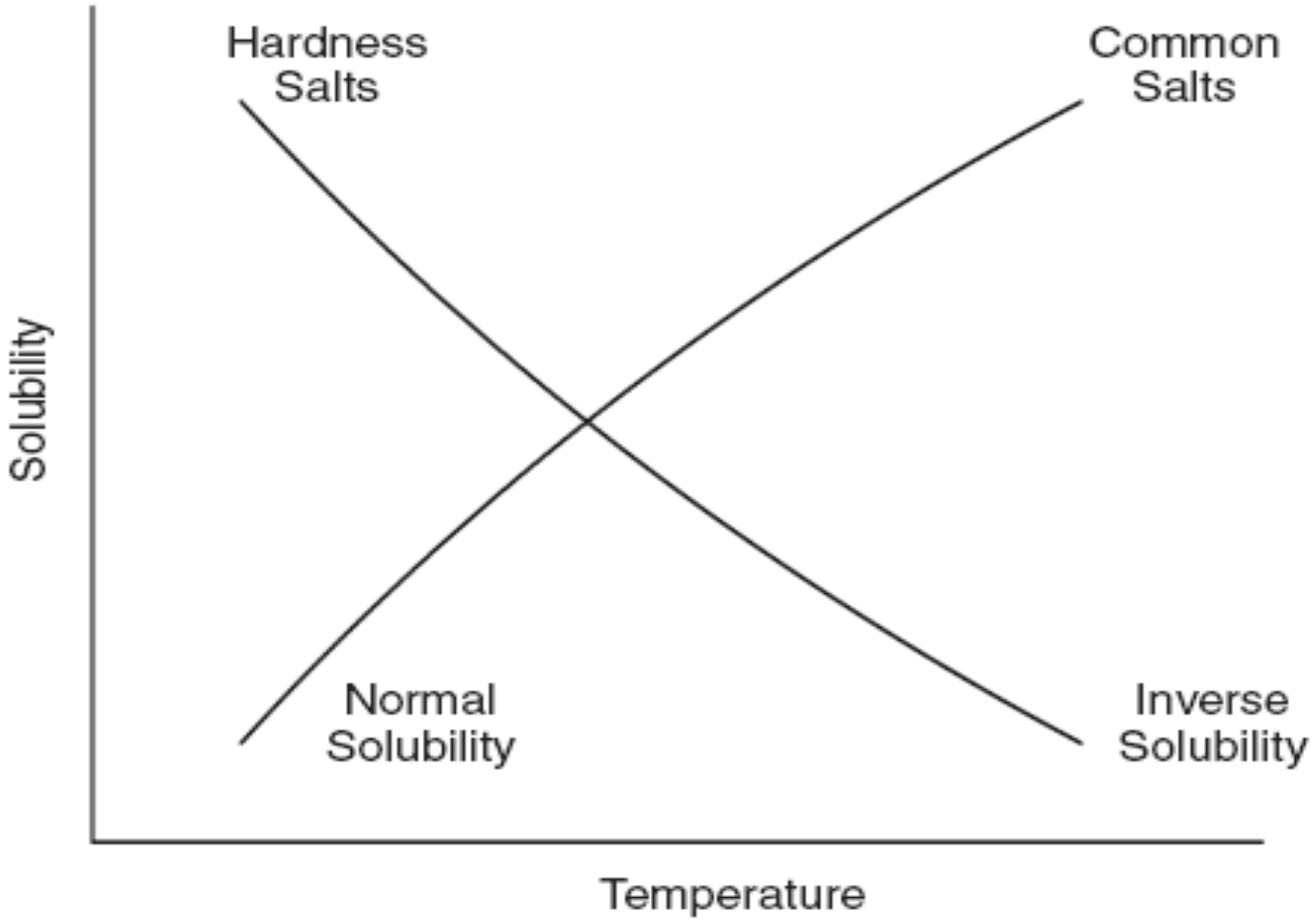
Water Composition



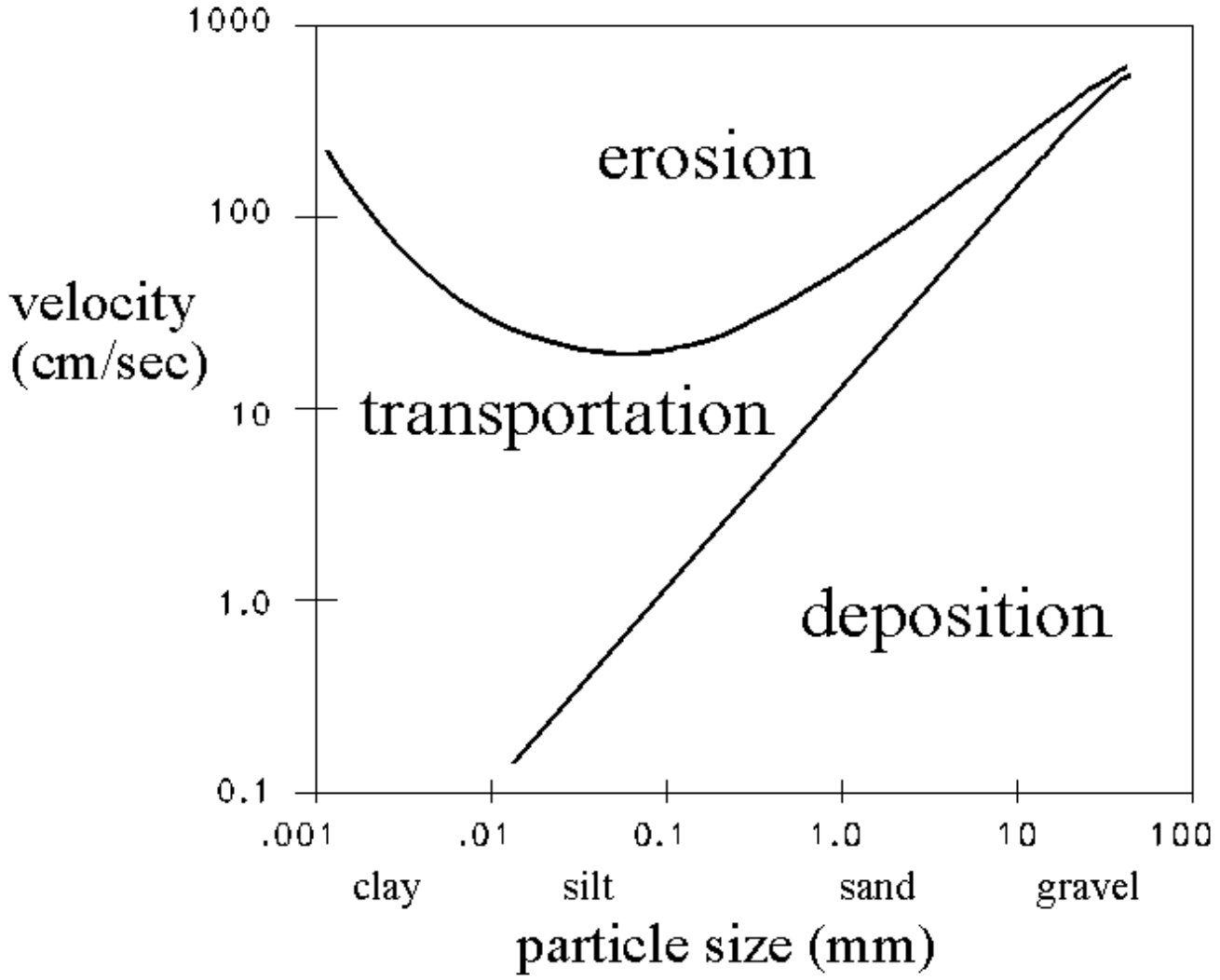
pH


Saturation Ratio
800
700
600
500
400
300
200
100
0
7
7.2
7.4
7.6
7.8
8
8.2
8.4
8.6
8.8
9
9.2
pH

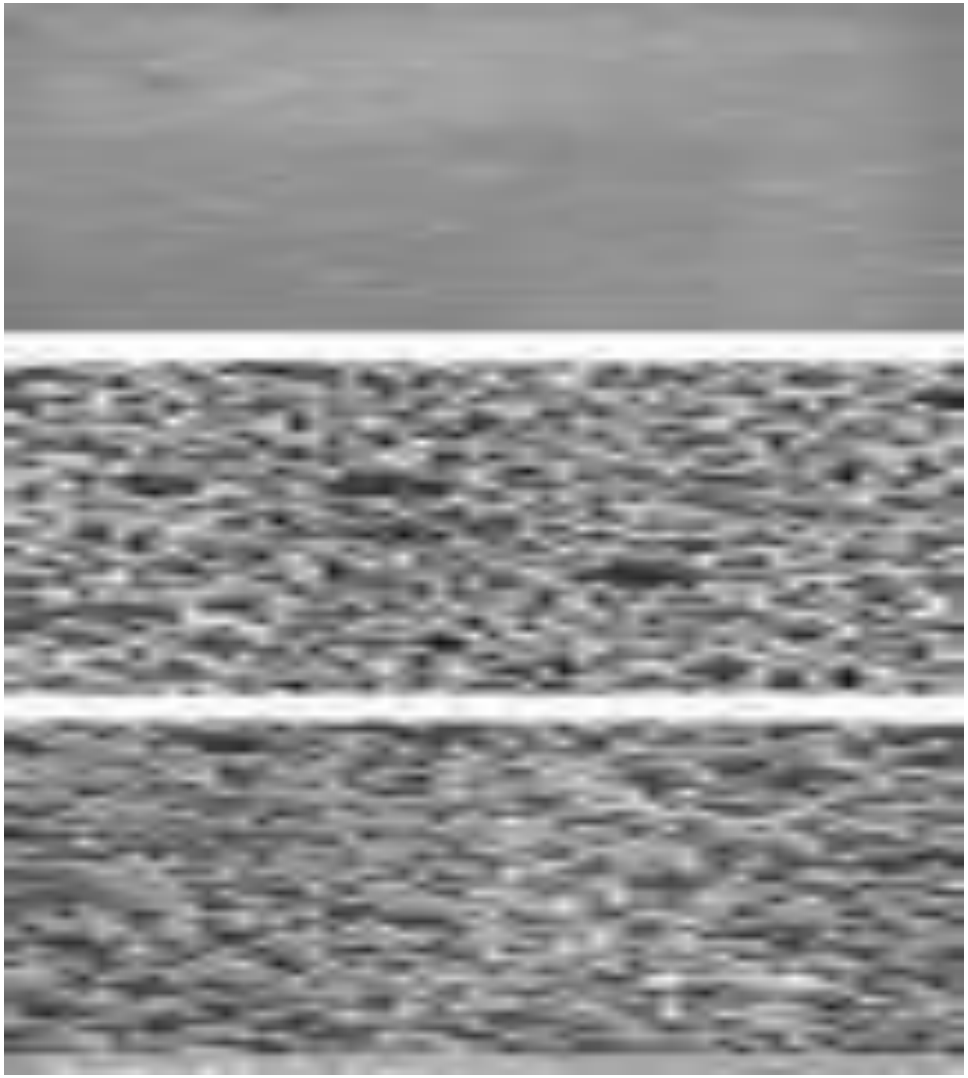
Temperature



Water Velocity

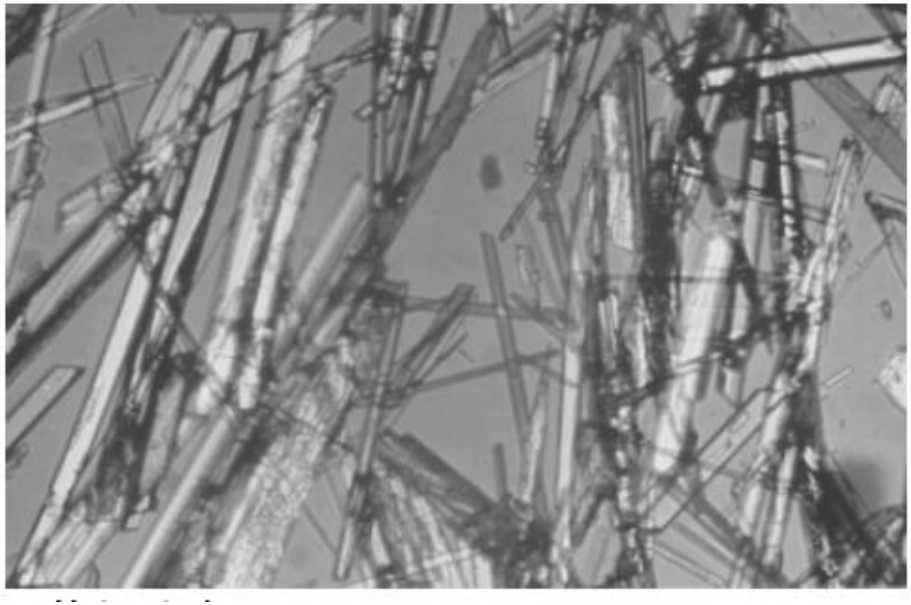


System Metallurgy



Scale Inhibition & Control

- Change in Operation parameters such as water chemistry.
- Mechanical Methods.
- Change in system metallurgy.
- Use chemical Inhibitors.



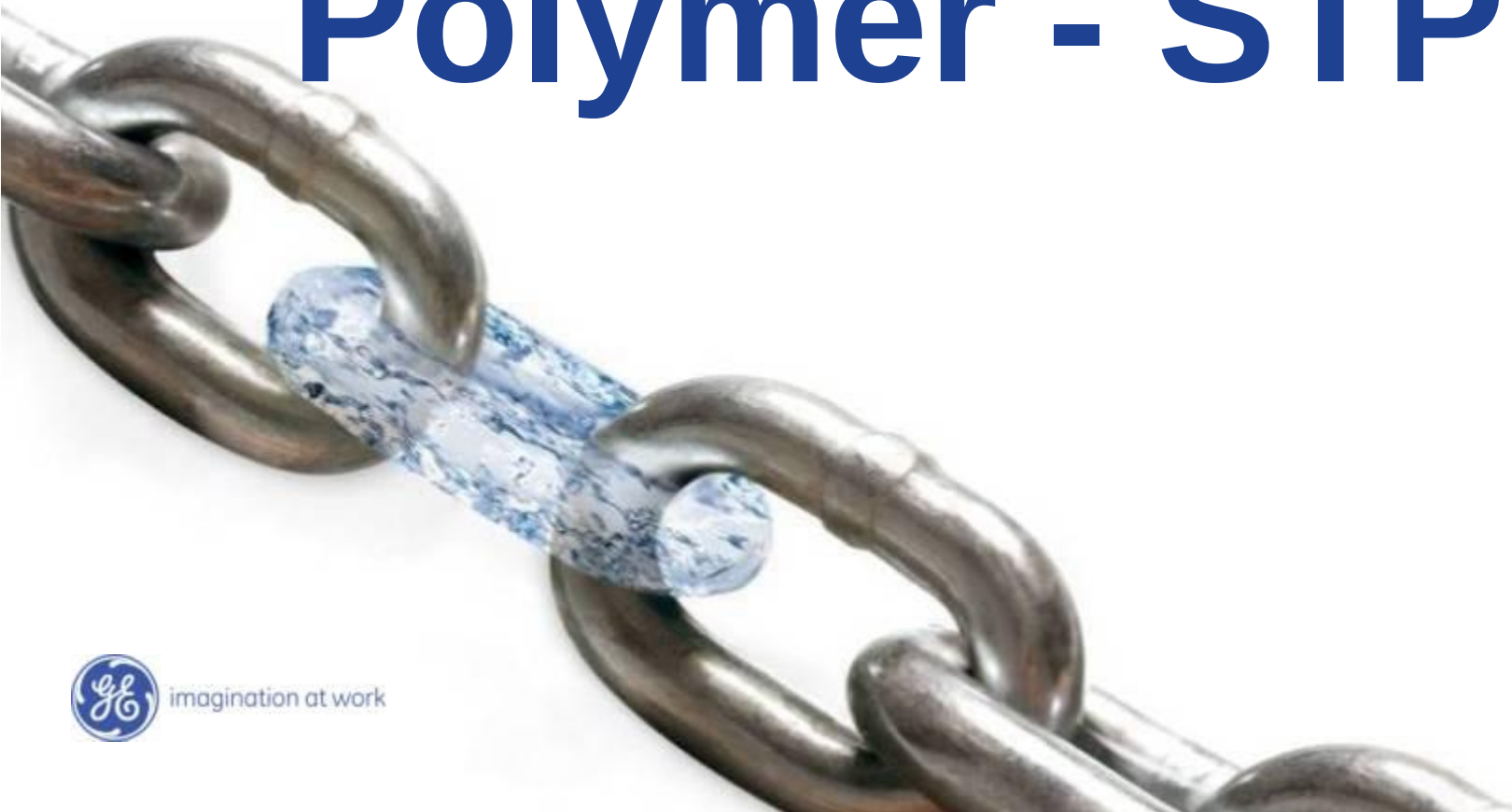
Chemical Inhibitor Mechanism

- Threshold inhibition
- Crystal Modification
- Sequestration.
- Dispersion.

Polymeric Scale Dispersant

- PAA (Polyacrylic Acid)
- PMA (Polymaleic anhydride)
- AEC (Alkyl Epoxy Carboxylate)
- TMPS (Terpolymer)
- HPS (Hydroxy Propyle Ether Sulfonate Copolymer)
- ACM (Acrylamid Copolymer)

GE New Stress Tolerant Polymer - STP



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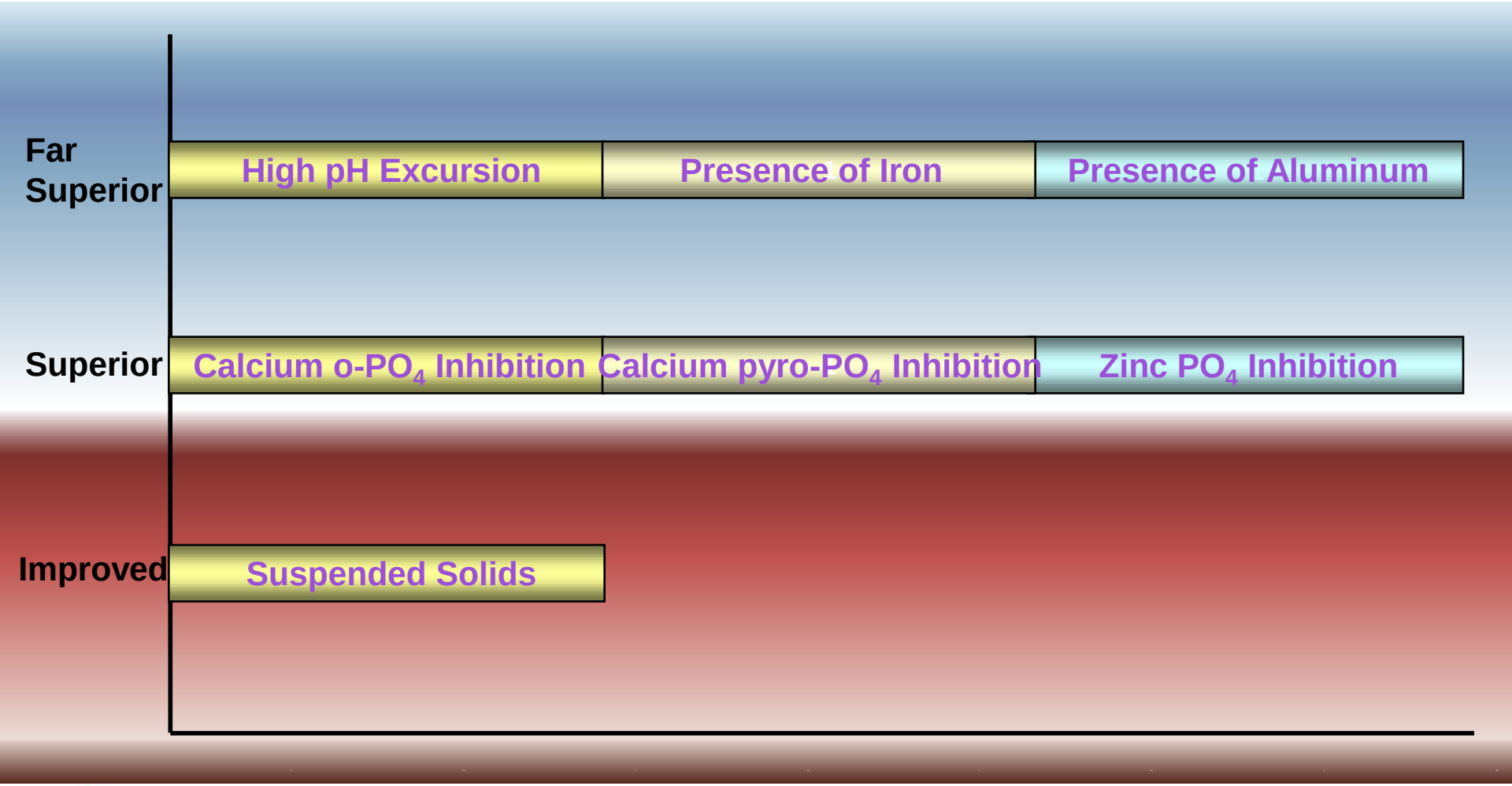
Stress Tolerant Polymer (STP) - Overview

- **Superior Performance**
  - Under Neutral pH Conditions
  - Under Alkaline pH Conditions
- **Chlorine Stable**
- **High Performance at the presence of Fe and Al**
- **Testable**
  - Off-line
  - On-line

New Stress Tolerant Polymer (STP)

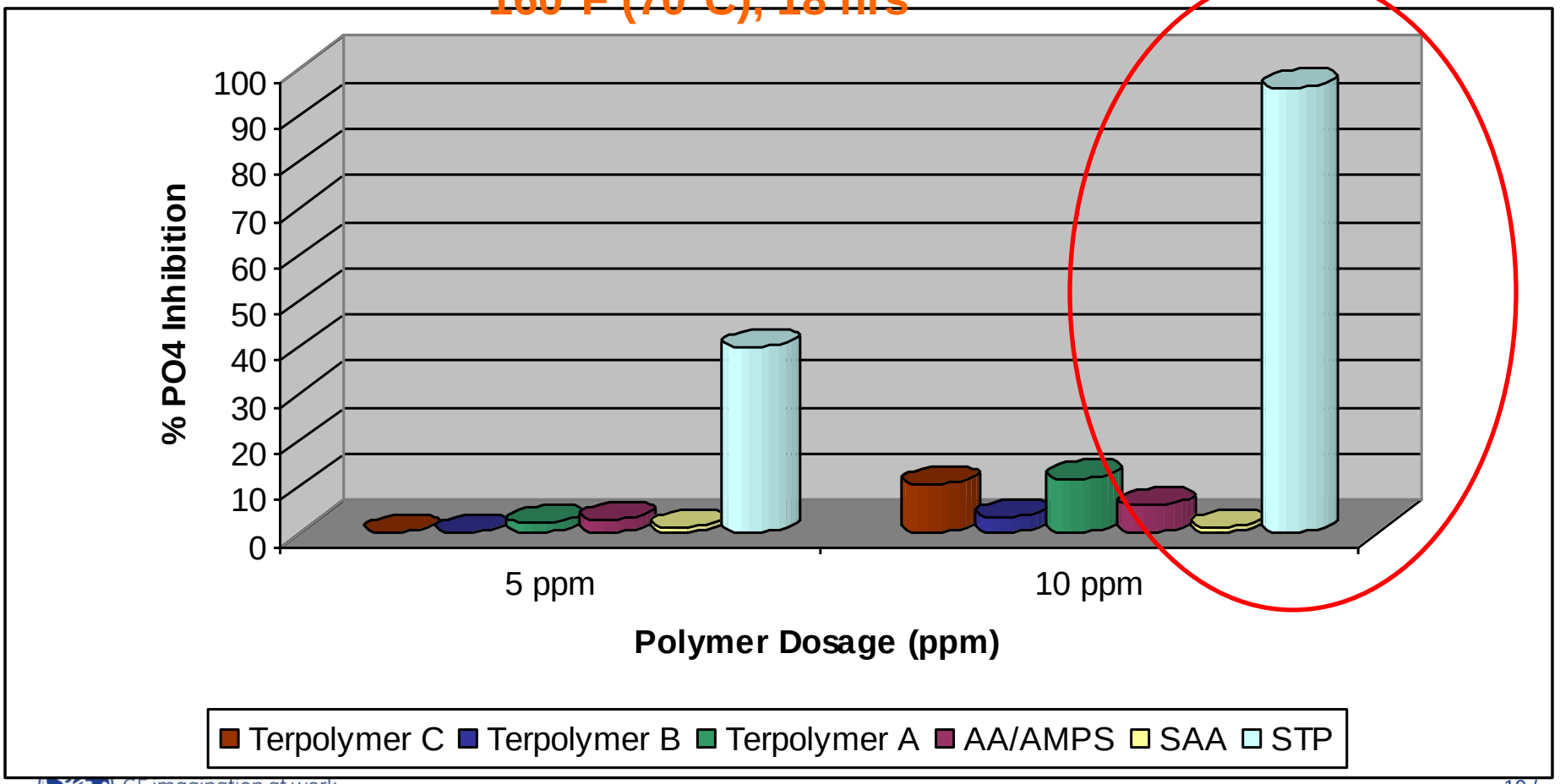
STP Performance vs. SAA



Calcium Phosphate Inhibition

Static Bottle Test

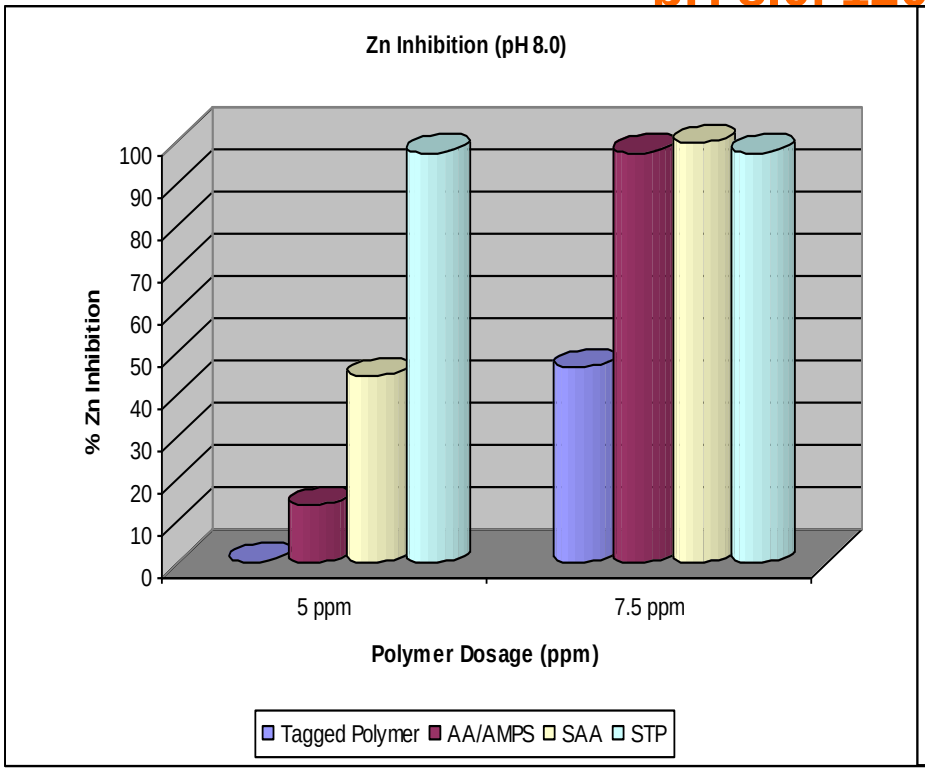
Water Conditions: 400 ppm Ca, 100 ppm Mg, pH 8.2, 10 ppm PO_4, 160°F (70°C), 18 hrs

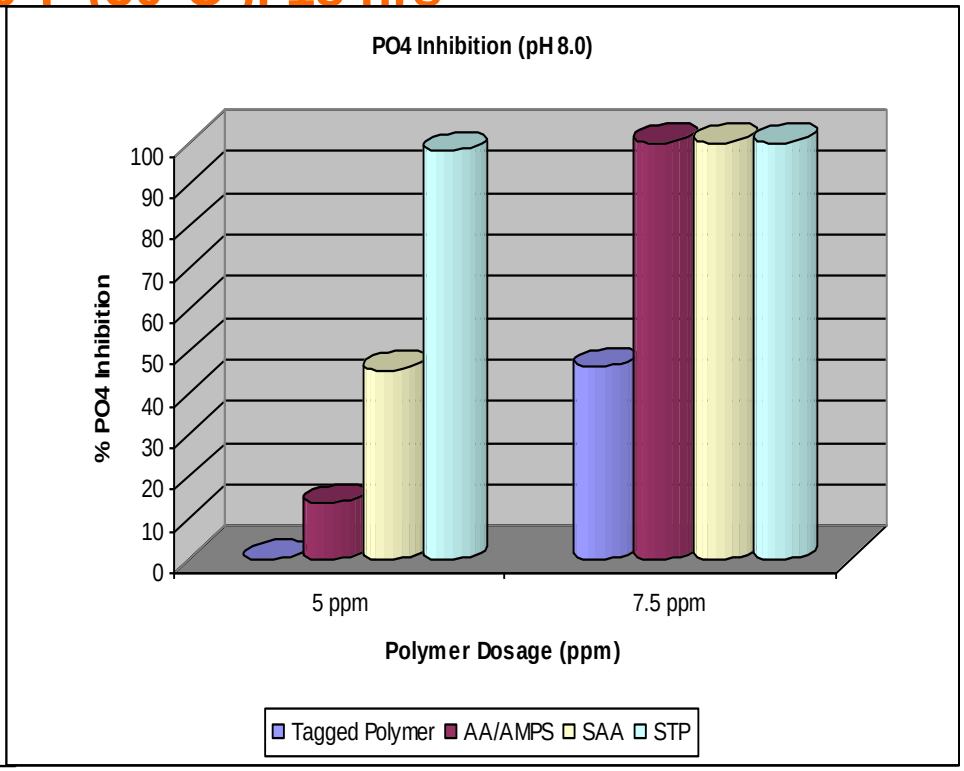


Zinc Phosphate Inhibition

Static Bottle Test

Water Conditions: 300 ppm Ca, 10 ppm PO_4, 5 ppm Zn, pH 8.0, 120°F (50°C), 18 hrs

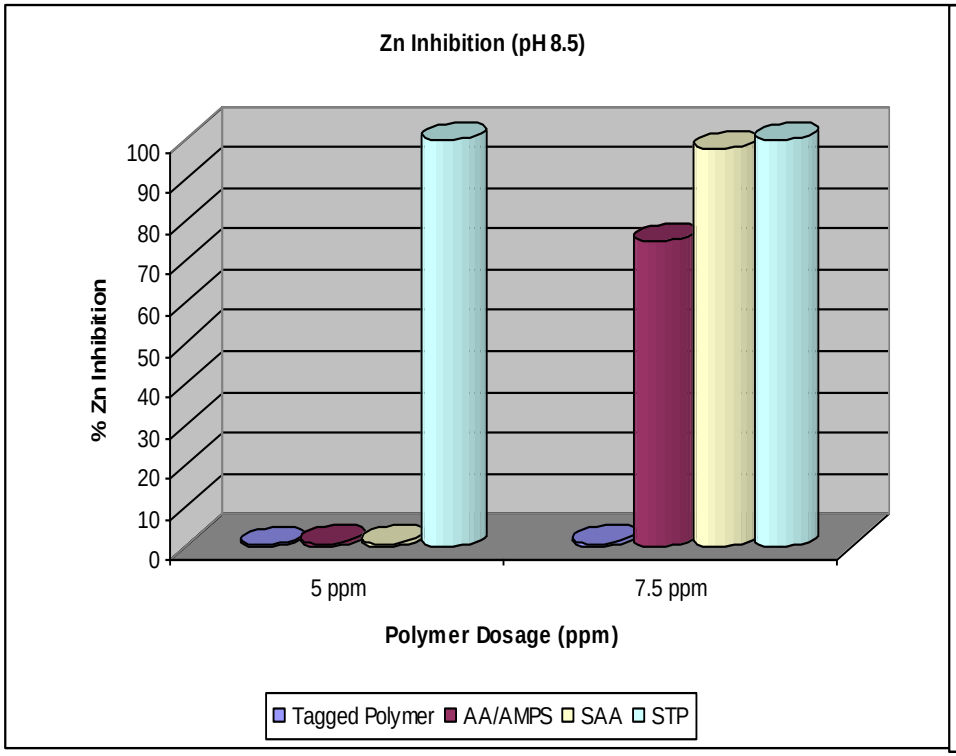


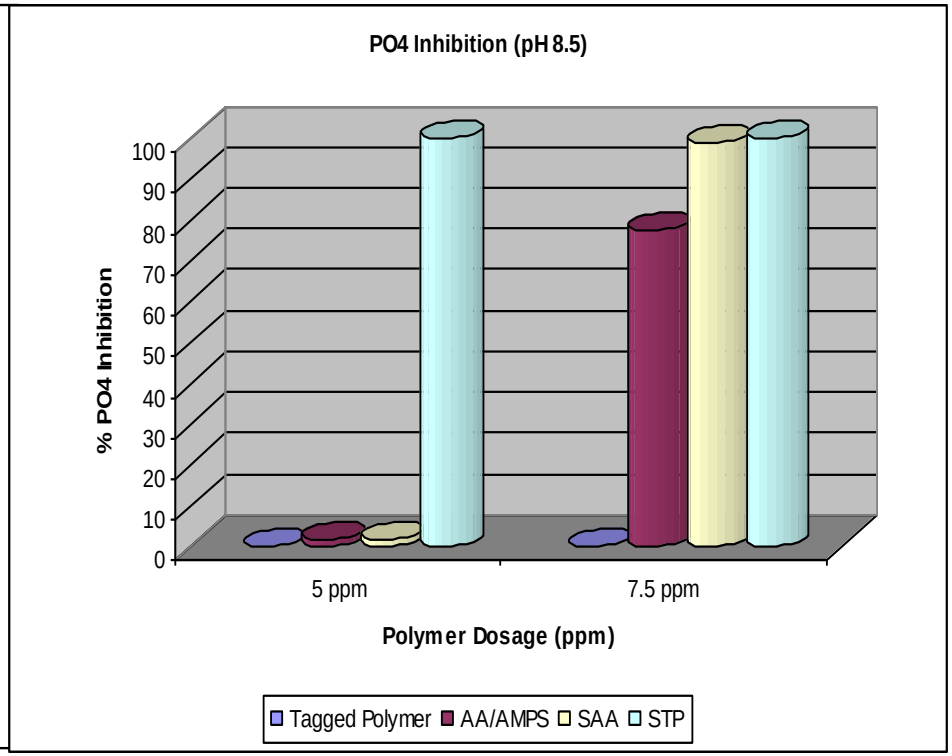


Zinc Phosphate Inhibition

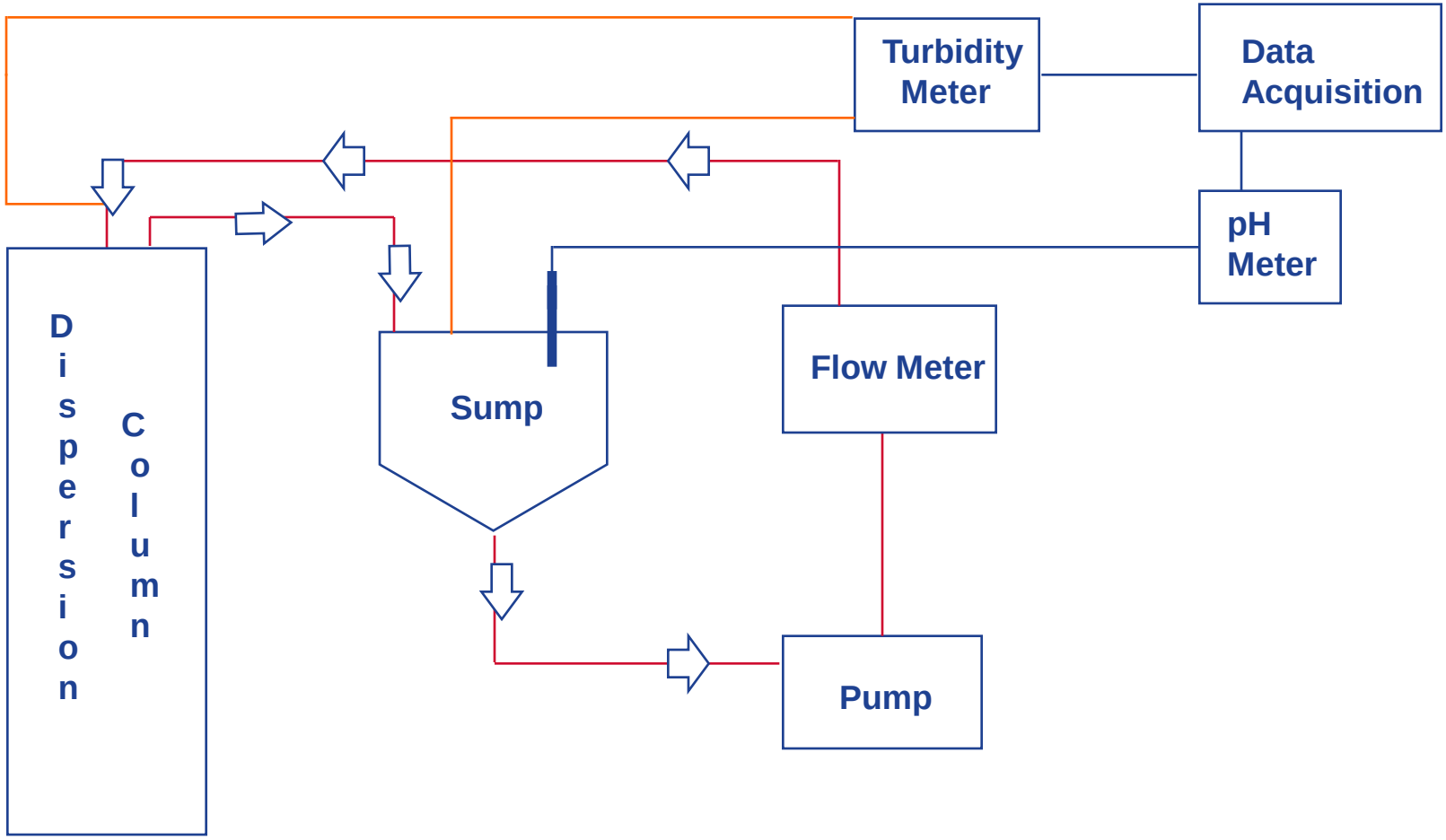
Static Bottle Test

Water Conditions: 300 ppm Ca, 10 ppm PO_4, 5 ppm Zn, pH 8.5, 120°F (50°C), 18 hrs





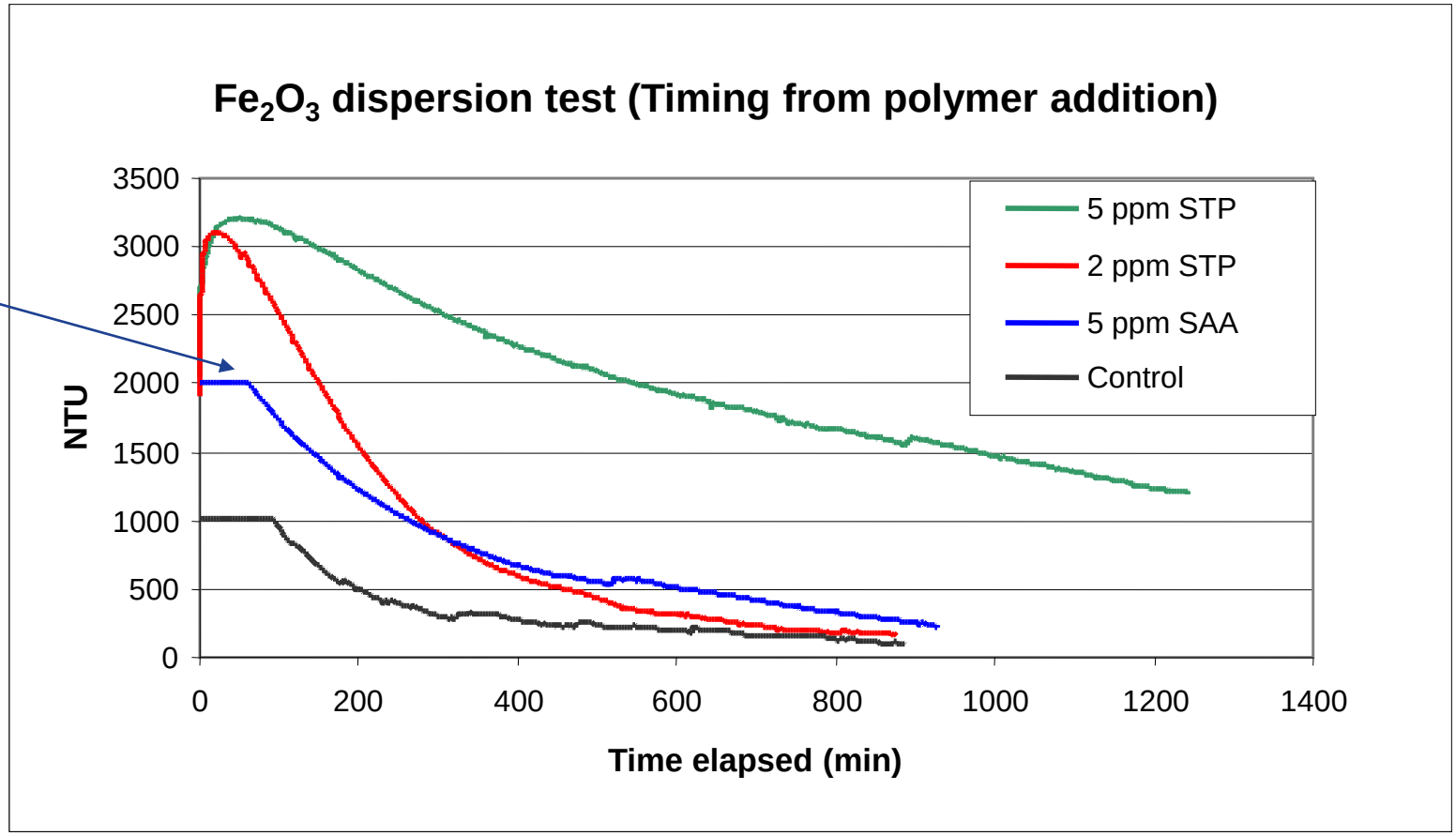
Dynamic Dispersion Tester



Dynamic Iron Oxide Dispersion Test

Water Conditions: 500 ppm Ca, 200 ppm Mg, pH 7.5
750 ppm Fe_2O_3

NTU > 2000 was over scale



Lab Data

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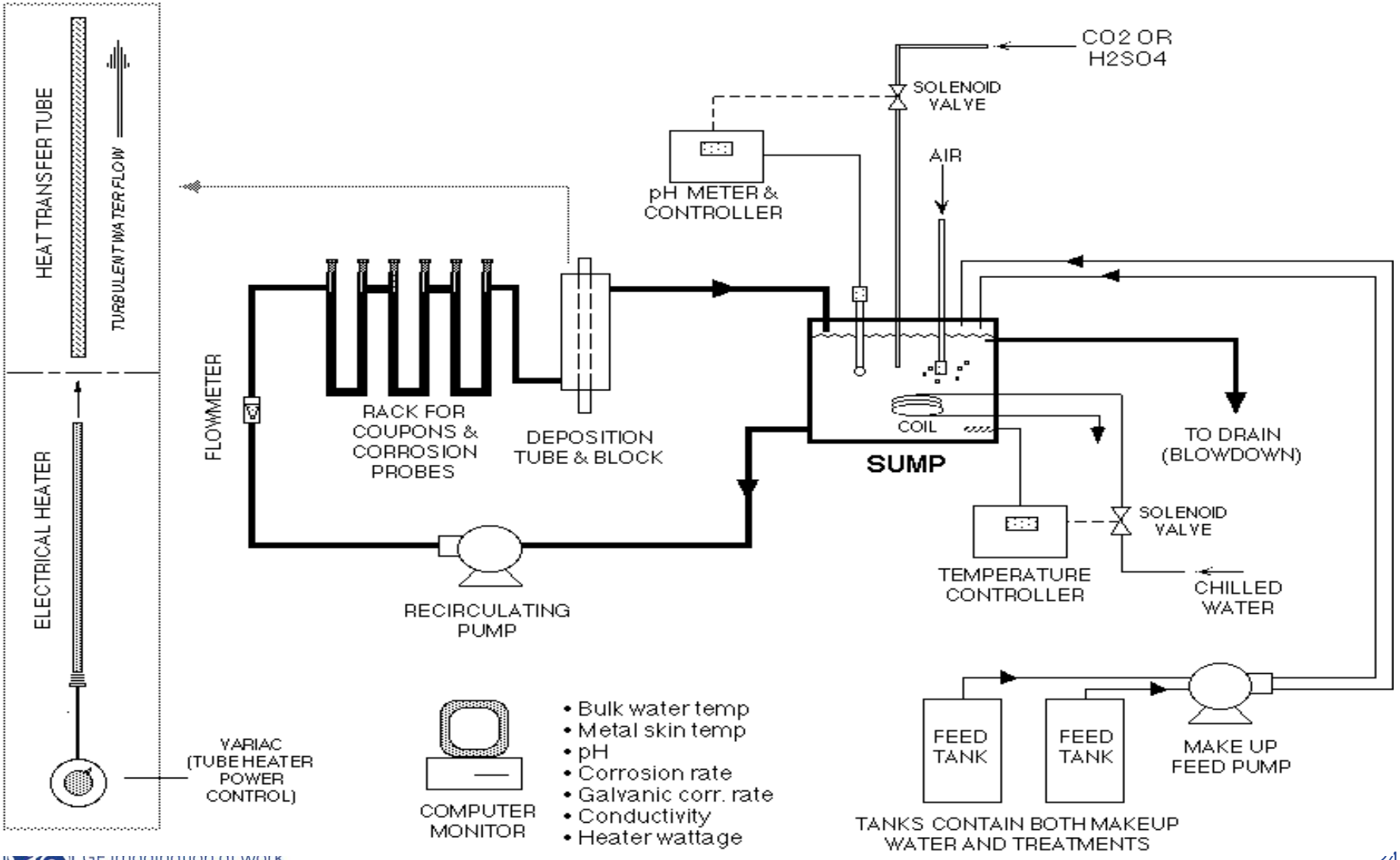
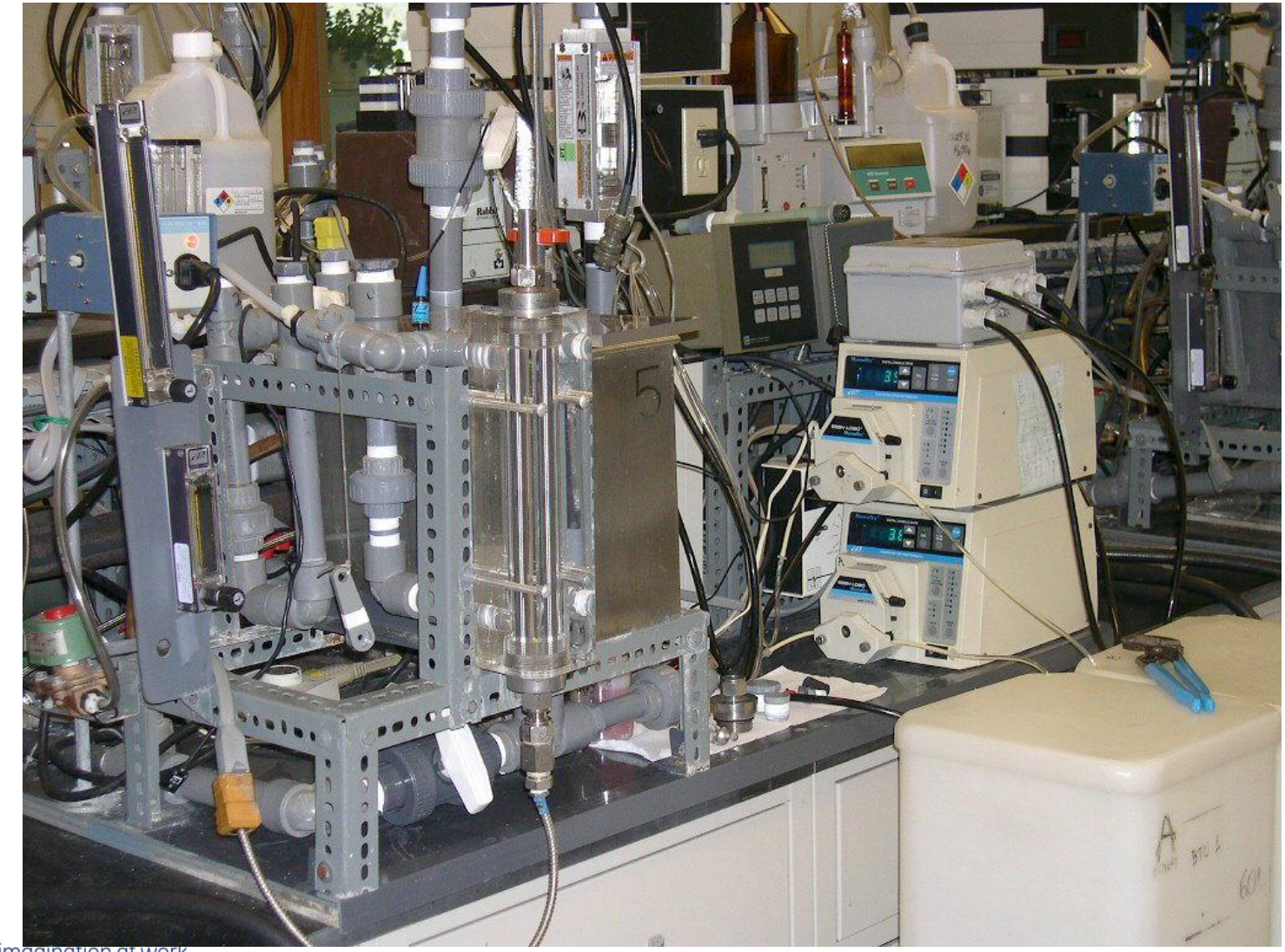
Bench Top Recirculating Unit - BTU



Bench Top Recirculating Unit - BTU



Iron Testing

Neutral pH Program: Stabilized Phosphate

Water Conditions: 3 ppm iron, 600 ppm Ca, 300 ppm Mg, pH 7.2
15 ppm o-PO_4, 3 ppm pyro-PO_4, 1.2 HRA
135°F (57°C) Surface Temp, 120°F (49°C) Bulk Temp

STP

LCS 0.2 mpy
ADM 0.0 mpy

Same Polymer Dosage (7 ppm)

ST

SAA

SAA

LCS 2.4 mpy
ADM 0.5 mpy

Lab Data

GE imagination at work

Polymer Dosage as Function of pH

Treatment Program: Stabilized Phosphate

Standard Water Conditions: 600 ppm Ca, 300 ppm Mg, 15 ppm o-PO_4, 3 ppm pyro-PO_4, 1.2 ppm HRA, 120°F (49°C) Bulk

Temp

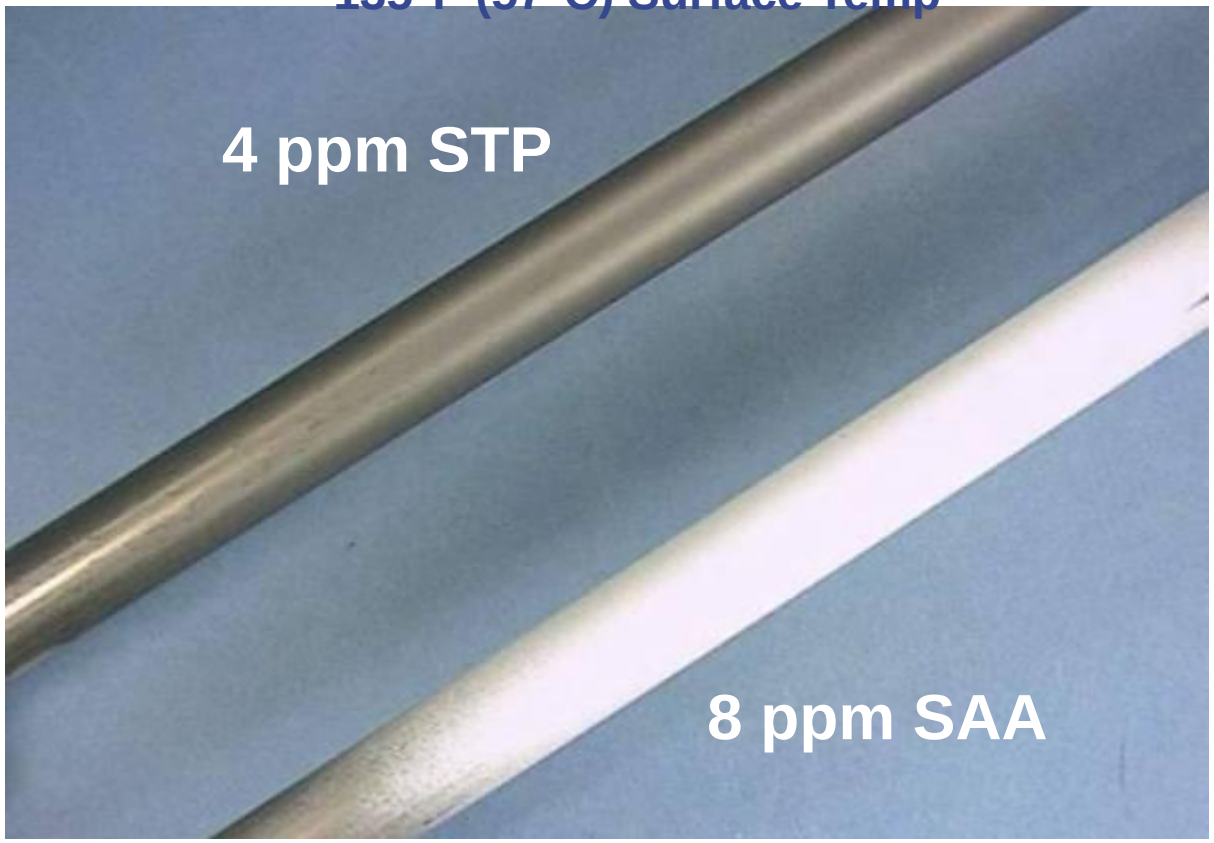
Test	pH	Surface Temp., °F	Polymer	Polymer Dosage, ppm	Turbidity, NTU	Delta ppm PO_4	Heat Exchanger Tube Appearance
1	7.2	130	SAA	4	0.32	0.1	Surface free of deposits
2	7.2	130	STP	2	0.35	0.1	Surface free of deposits
3	7.4	130	SAA	8	0.3	0.3	Surface free of deposits
4	7.4	130	STP	4	0.3	0.4	Surface free of deposits
5	7.6	130	SAA	13	0.5	0.5	Surface free of deposits
6	7.6	130	STP	8	0.5	0.5	Surface free of deposits
7	7.8	130	SAA	18	0.7	0.6	Surface free of deposits
8	7.8	130	STP	12	0.9	0.2	Surface free of deposits

High pH Excursion

Neutral pH Program

Standard Water Conditions: 600 ppm Ca, pH 7.9, 15 ppm o-PO4, 3 ppm pyro-PO_4

135°F (57°C) Surface Temp



Lab Data

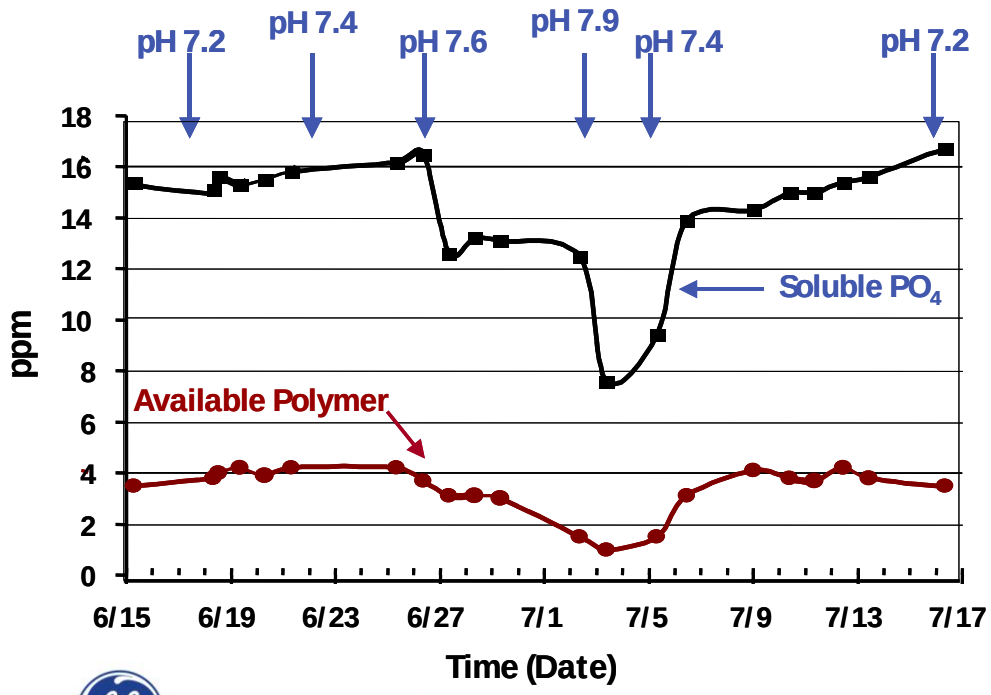
Effect of pH Excursion on Calcium Phosphate Control

Neutral pH Program

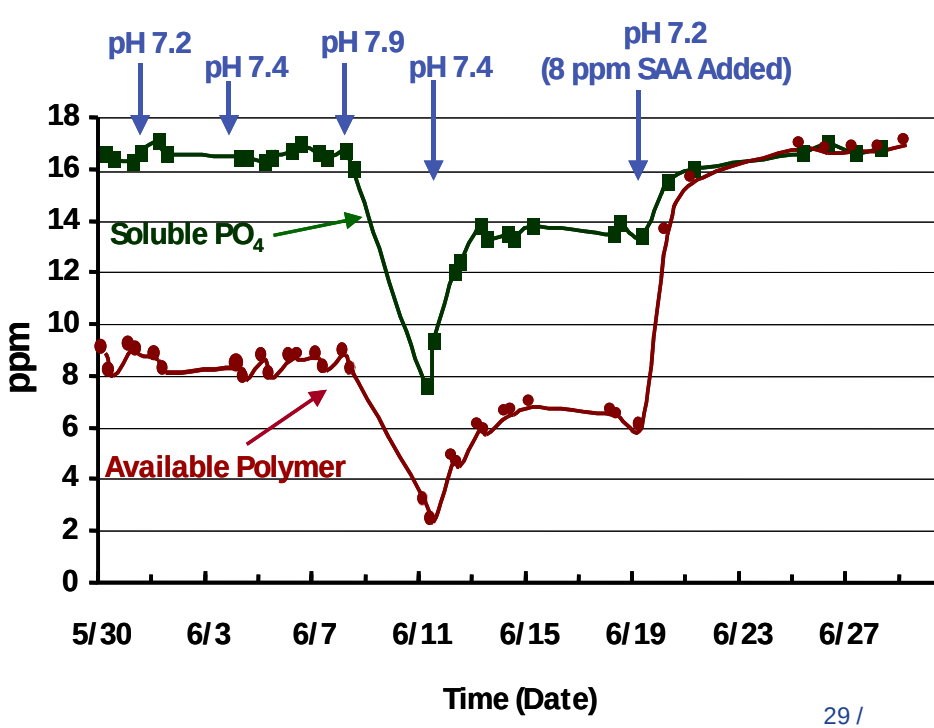
Standard Water Conditions: 600 ppm Ca, 300 ppm Mg, pH 7.2 - 7.9, 15 ppm o-PO4, 3 ppm pyro-PO_4 , Surface Temp, 120°F

135°F (57°C) (49°C) Bulk Temp

4 ppm STP – Standard Conditions



8 ppm SAA – Standard Conditions



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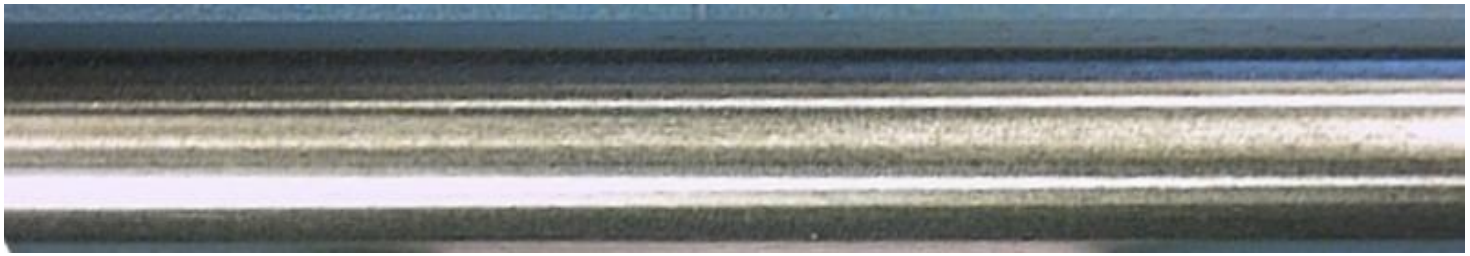
Aluminum Testing

Neutral pH Program: Stabilized Phosphate

Water Conditions: 2 ppm Aluminum, 600 ppm Ca, pH 7.2, 15 ppm o-PO_4, 3 ppm pyro-PO_4, 135°F (57°C) Surface Temperature

Same Polymer Dosage (5 ppm)

STP - Surface free of Deposits



SAA - Moderate $AlPO_4$ Deposit

Lab Data

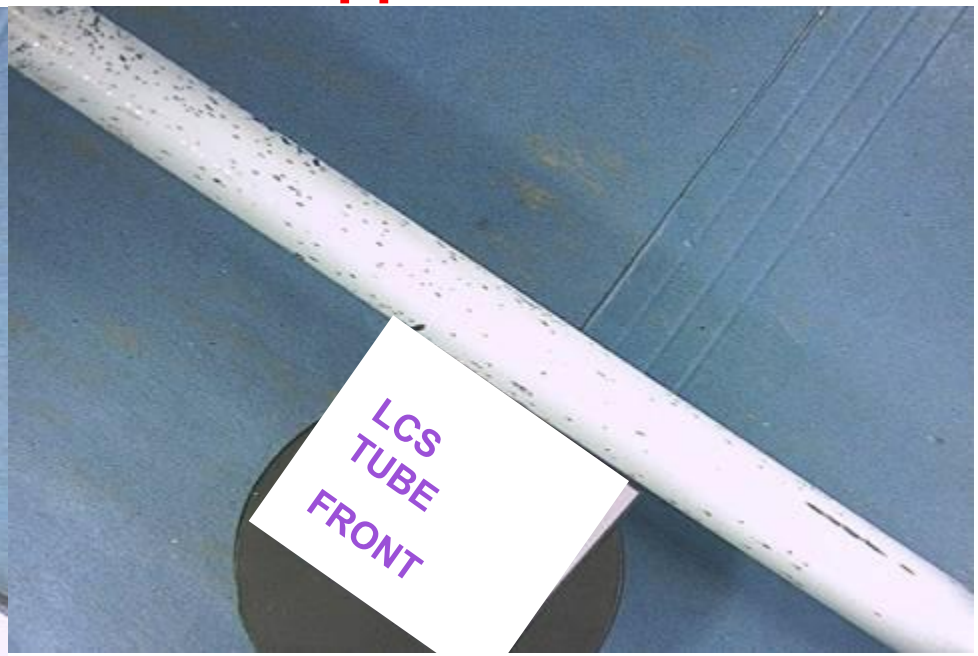
200 ppm Clay Test

Alkaline pH Program

Water Conditions: 400 ppm Ca, pH 8.6, 4 ppm o-PO_4, 3 ppm Penta

13 ppm STP

15 ppm SAA



Lab Data

Polymer Dosage as Function of Temperature

Treatment Program: Stabilized Phosphate

Standard Water Conditions: 600 ppm Ca, 300 ppm Mg, pH 7.2
15 ppm o-PO_4, 3 ppm pyro-PO_4, 1.2 ppm HRA

120°F (49°C) Bulk Temp

Test	pH	Surface Temp., °F	Polymer	Polymer Dosage, ppm	Turbidity, NTU	Delta ppm PO_4	Heat Exchanger Tube Appearance
1	7.2	130	SAA	4	0.32	0.1	Surface free of deposits
2	7.2	130	STP	2	0.35	0.1	Surface free of deposits
3	7.2	140	SAA	6	0.5	0.2	Surface free of deposits
4	7.2	140	STP	3	0.1	0.1	Surface free of deposits
5	7.2	160	SAA	8	0.2	0.1	Uniform Ca-PO_4 deposit
6	7.2	160	STP	4	0.4	0.4	Surface free of deposits

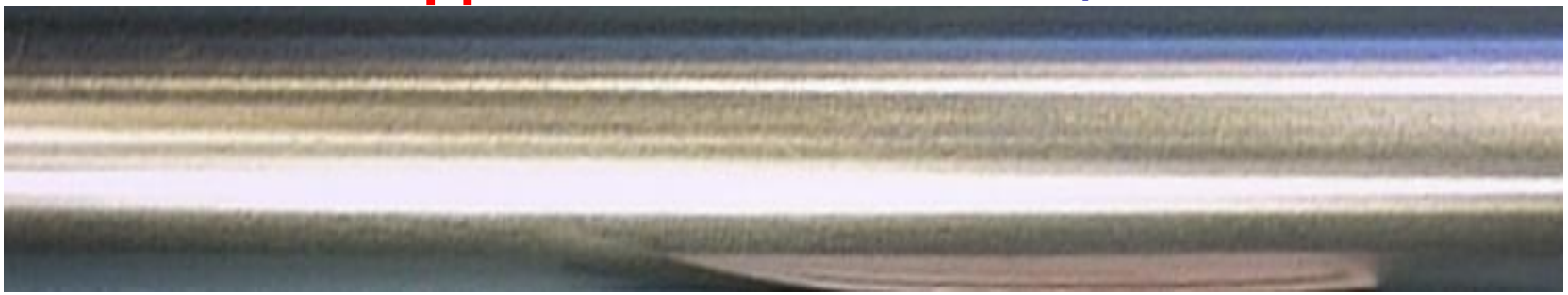
High Temperature

Treatment Program: Stabilized Phosphate

Standard Water Conditions: 600 ppm Ca, pH 7.2, 15 ppm o-PO_4, 3 ppm pyro-PO_4,

160°F (70°C) Surface Temperature

4 ppm STP - Surface free of Deposits



8 ppm SAA - Uniform $CaPO_4$ Deposit

STP Polymer

STP Testing & Monitoring

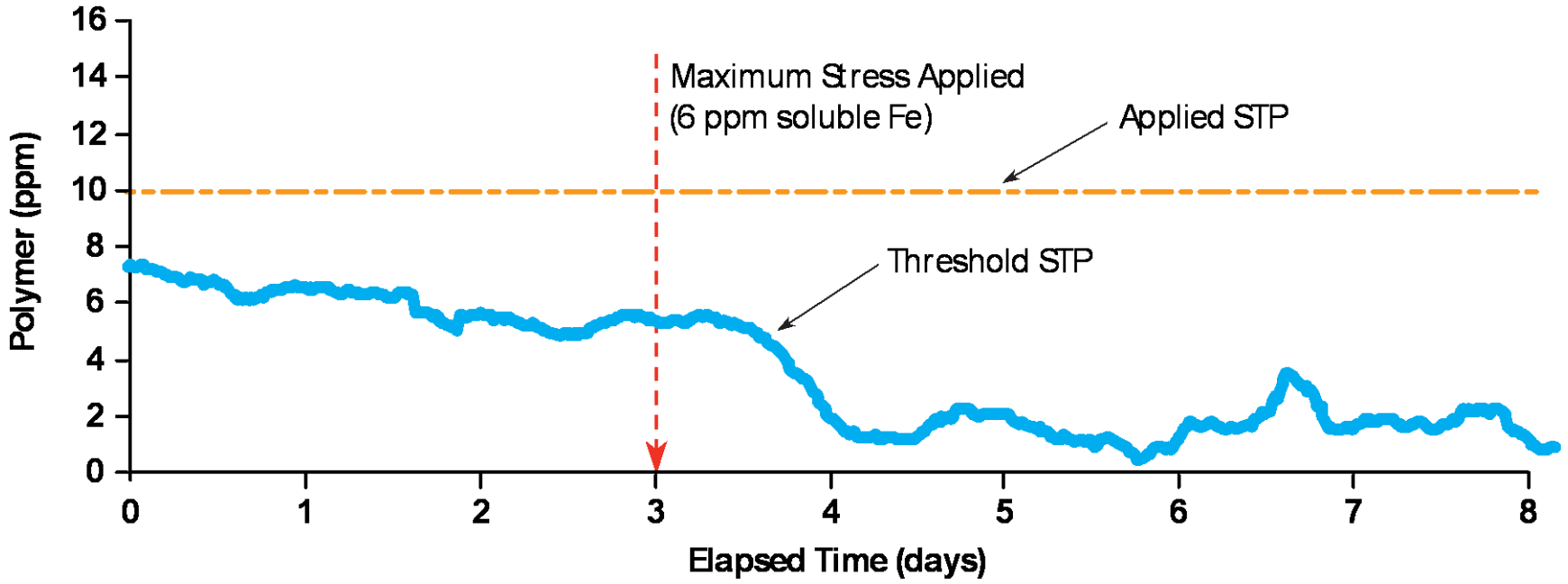
- **OFF-LINE Testing**
  - **Bench testing with spectrophotometer using new reagent chemistry**
  - **Measures polymer concentration directly**
  - **Easier than the Mo test!!**

- **TrueSense ON-LINE Monitoring**
  - **Continuous monitoring of polymer concentration in the cooling system**

TrueSense Online Dynamic Laboratory Study Without Polymer Control

Neutral pH Program

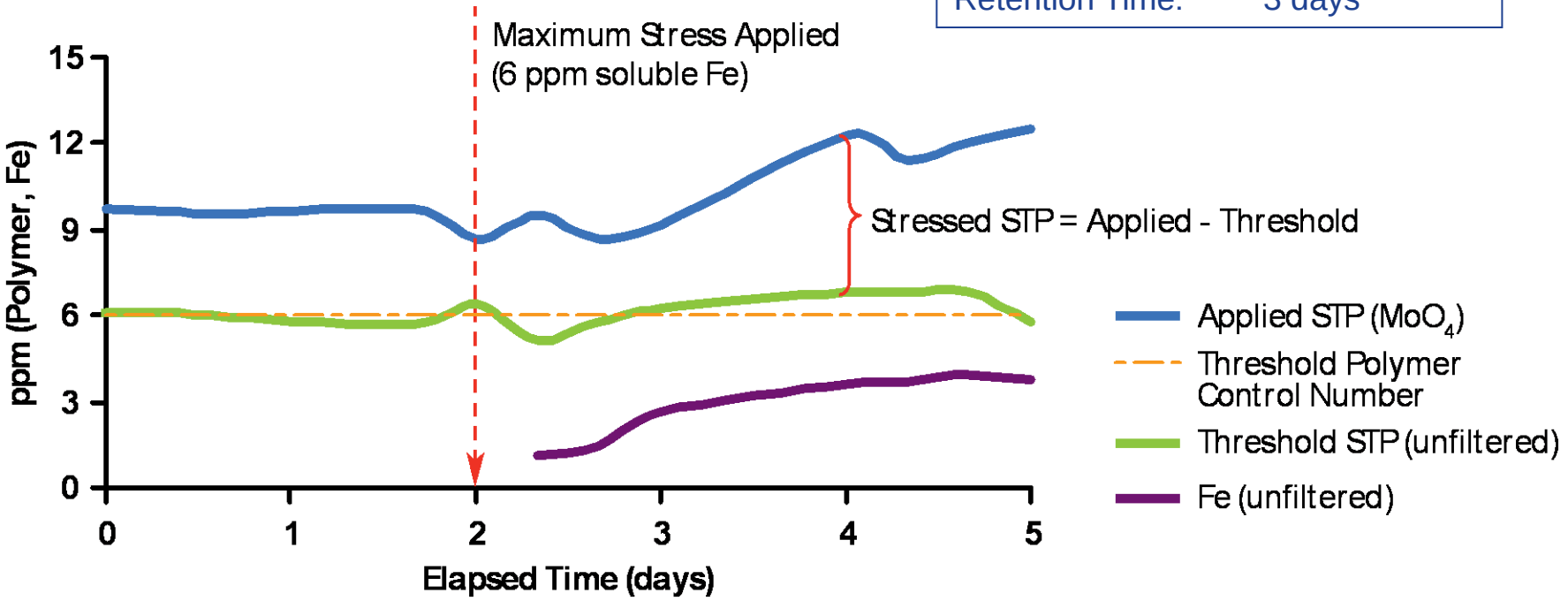
Standard Water Conditions	
pH:	7.2
Calcium:	600 ppm as $CaCO_3$
Orthophosphate:	15 ppm
Pyrophosphate:	3 ppm
Skin Temperature:	135°F (57°C)
Retention Time:	3 days



TrueSense Online Dynamic Laboratory Study With Polymer Control (continued)

Neutral pH Program

Standard Water Conditions	
pH:	7.2
Calcium:	600 ppm as $CaCO_3$
Orthophosphate:	15 ppm
Pyrophosphate:	3 ppm
Skin Temperature:	135°F (57°C)
Retention Time:	3 days



Case History

European plastics producer saves US$135,000 year with STP Technology

Goal

- Reduce phosphate discharge – new regulations made it desirable to reduce the phosphate discharge from the cooling water program
- Reduce acid consumption – with acid prices skyrocketing, any acid feed reduction meant significant savings
- Reduce water consumption

Solution

- Upgrade toSTP and revise the chemistry targets

	Original Targets	GenGard Targets
Orthophosphate	17-18 ppm	12-14 ppm
pH	7.3-7.4	7.7-7.8
Active polymer	30 ppm	22.5 ppm
Cycles	~4.0	~5.0

Results

- Discharge compliant
- 25% acid reduction
- Water reduction
- Excellent corrosion protection of <1.0 mpy
- Excellent system cleanliness – no scale
- Environmental compliance

US$135,000/year savings

Thank you