OPTIMIZING COOLING PERFORMANCE

NEW SEA WATER ANTI-SCALANT

Dr. Sai Ram Sudhakaran

Sr. Staff Scientist

NALCO – An Ecolab Company

SEAWATER COOLING PERFORMANCE IS VITAL FOR PRODUCTION

- Central to many production facilities in the Middle East is a *closed loop system* that ejects its heat to *seawater cooling towers* typically via *plate & frame* heat exchangers.
- The efficiency of heat transfer through these exchangers dictate production yield, especially during the summer months.
- In seawater systems, inefficiencies to cooling are from:
  - Scale formation
  - Biofilm
  - Macrofoulants
- Nalco have adopted an *holistic management strategy*/process to address these problems in a robust manner so as to provide consistent performance of the whole cooling system.

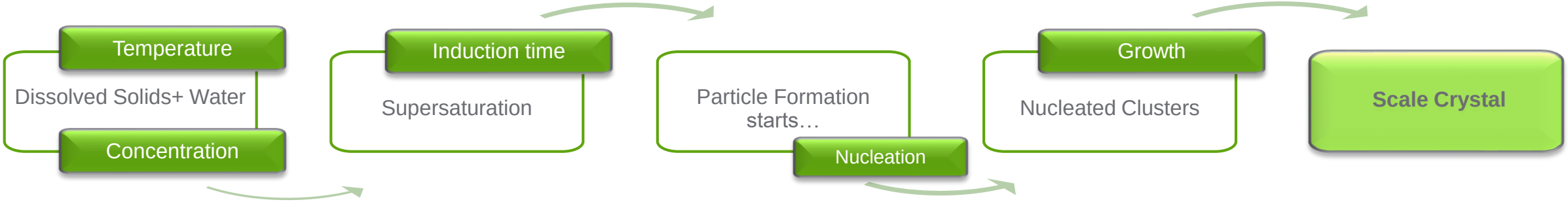
HOLISTIC TREATMENT PROGRAM DEVELOPMENT

- Advanced biofouling control
  - Cost effective and safe on-site ClO_2 generation from PURATE
  - Monitoring and control for optimisation
- New Seawater antiscalant
  - Eco-Friendly
  - Water – Energy Savings
  - 24/7 monitoring
- Aim to Deliver TCO savings:
  - Water
  - Energy
  - Chemical

SCALING IN HEAT EXCHANGERS

- Scale: The deposition of sparingly soluble salts such as calcium carbonate, calcium sulfate etc. Occurs when *the concentration of ions in solution exceed their solubility product* (supersaturation)
- Impact of scale on petrochemical refinery:
  - Reduces heat transfer across HXs→ less product yield→ system inefficiency

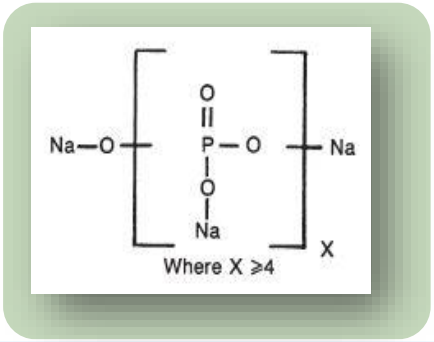
CHEMISTRY OF SCALE FORMATION



SCALE CONTROL: MOC APPROACH

Mechanical	Operational	Chemical
Heat Exchanger (design, metallurgy, flux)	pH control	Scale inhibitors
Side-stream filtration	COC/CF management	Dispersants

INNOVATION ON ANTI-SCALANTS

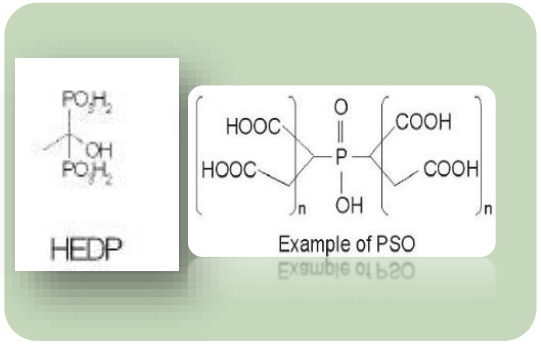


Inorganic Phosphates

•Applied in once-through systems

Innovation driver

- Ca-PO4 scaling due to hydrolysis of polyphosphate to orthophosphate



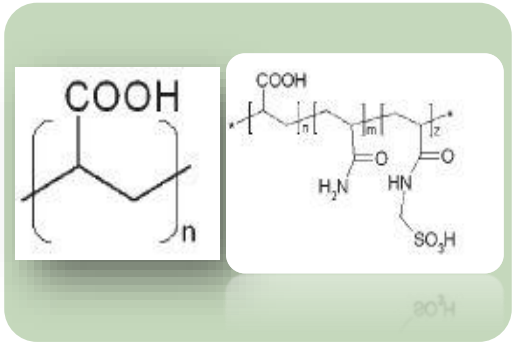
Organic Phosphates

•Applied in cooling towers

Innovation driver

•Environmental: P-containing (algal blooms)

•Water- Energy Savings: Unstable at higher cycles



Polymers

•Scale inhibitor and dispersant

•Non-P and dispersant

•Better performance at high cycles

IDEAL SCALE INHIBITOR PROFILE

Taking all the application factors into consideration, the ideal scale inhibitor product for seawater cooling systems should be:

NALCO SOLUTION: 3DT435

Eco-friendly

Non - P

Water – Energy Savings

High COCs -Low costs

24/7 monitoring

3DTrasar enabled

3DT435

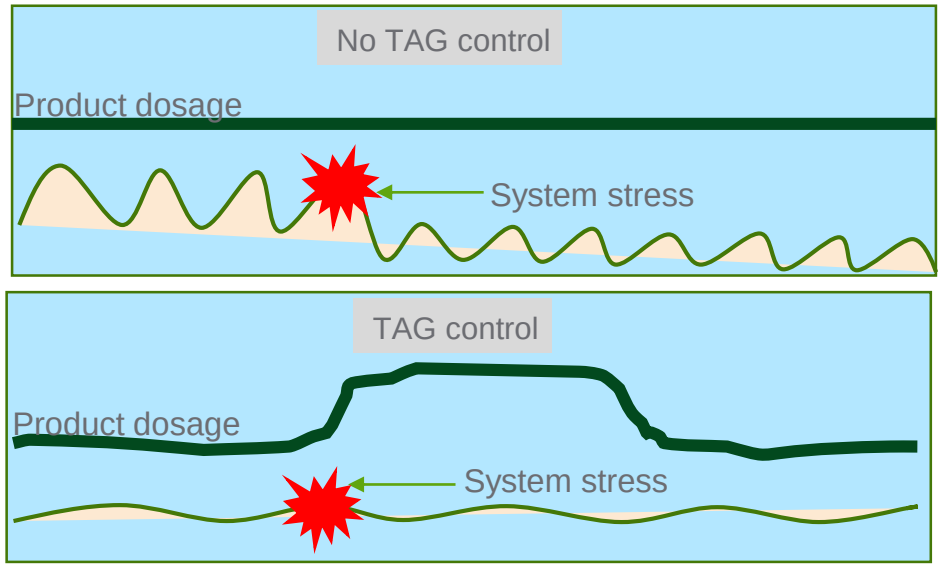
EFFICIENT USE OF 3DT (TRASAR/TAG CONTROL)

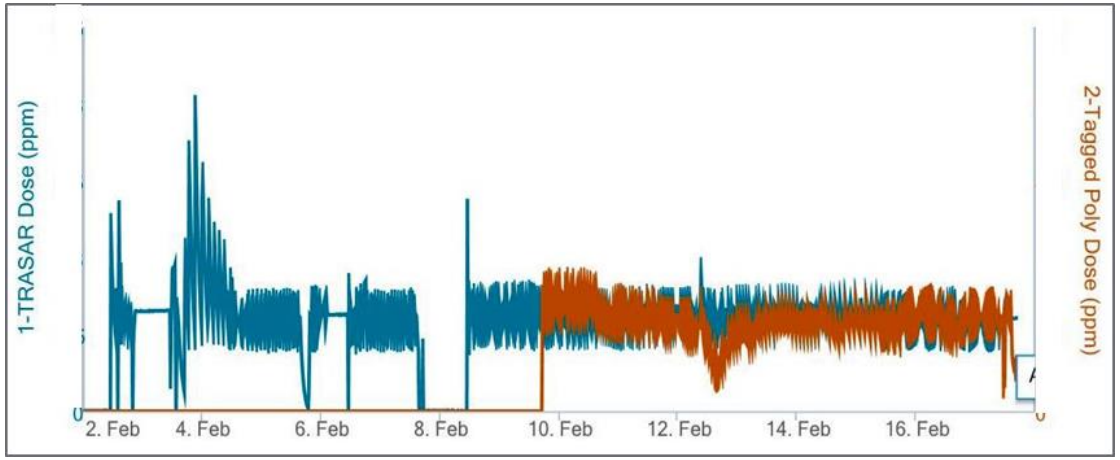
Over Dose

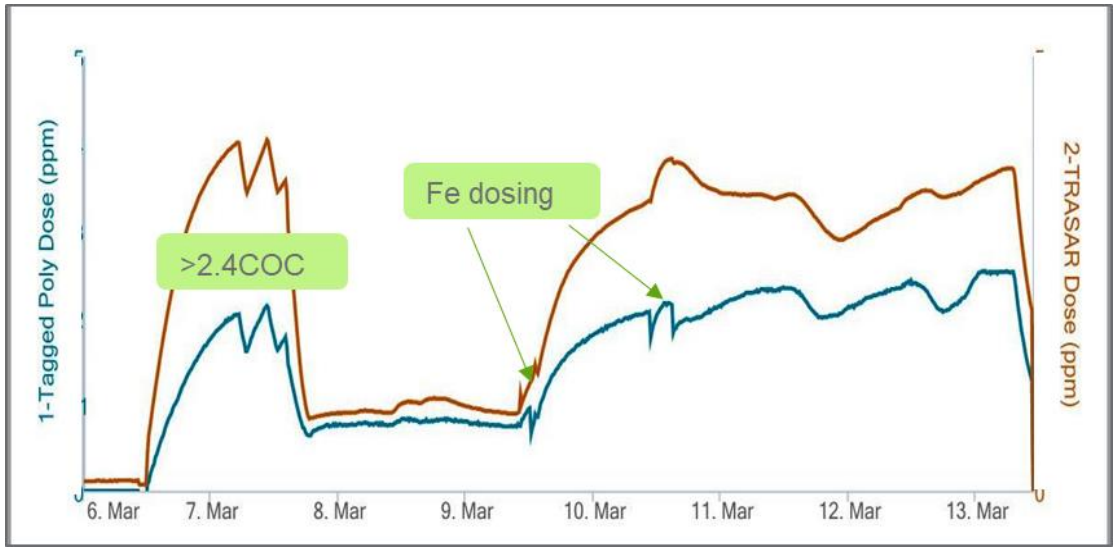
Optimal Dosing with TRASAR control

- Efficient system performance
- Alarm can be sent by SMS/email during upset conditions

Under Dose







APPLIED RESEARCH

KAUST STUDIES

Product launch

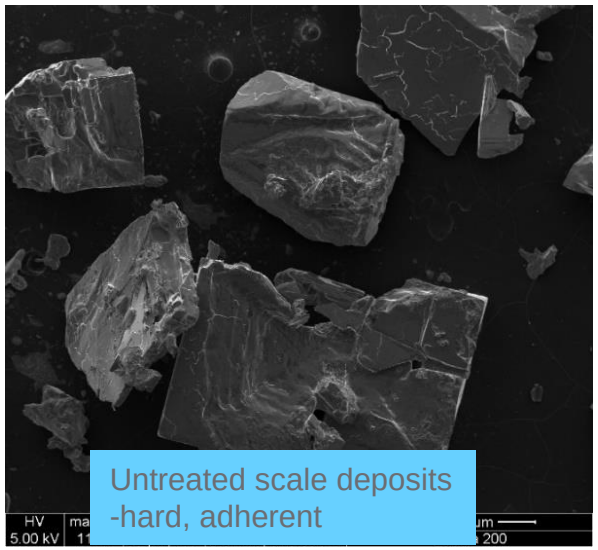
Commercial application

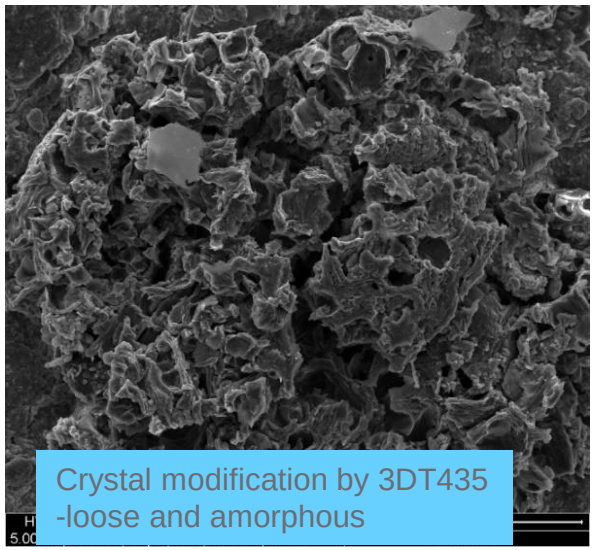
Pilot Cooling tower studies

Benchtop studies

SCALE INHIBITION MECHANISM

3DT435 scale inhibition by crystal modification: SEM images



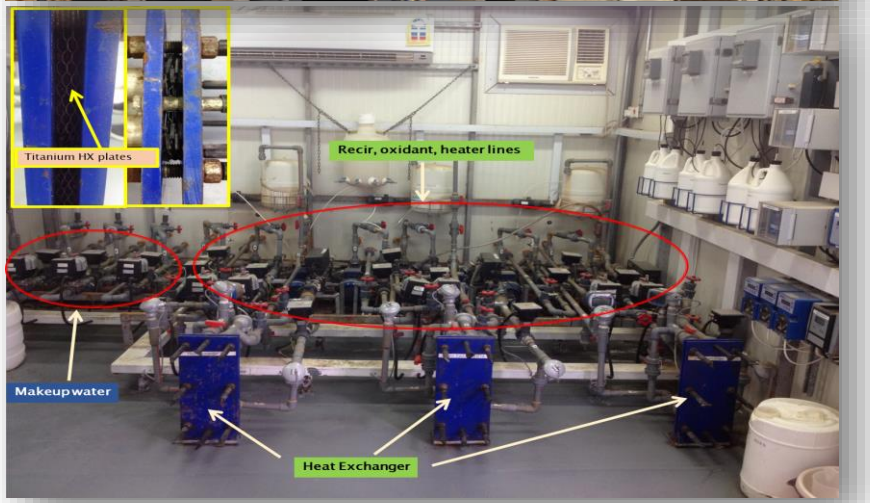


Key findings from benchtop experiments

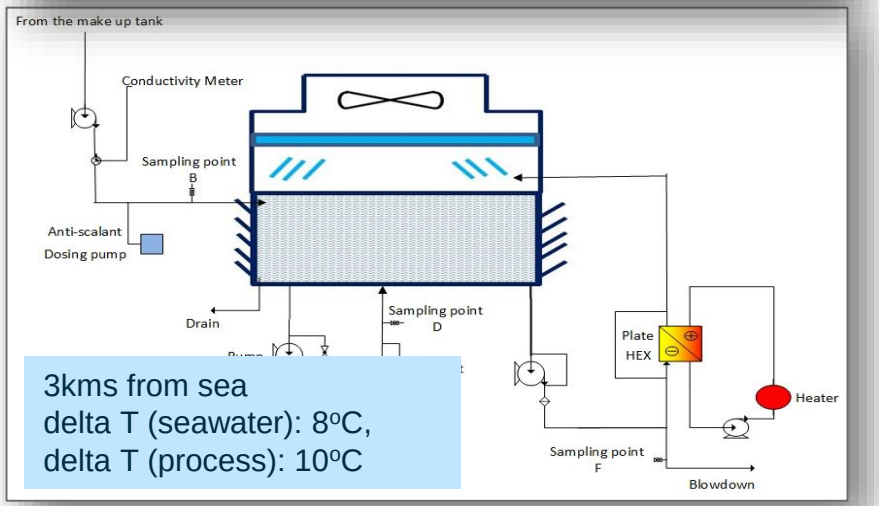
1. 3DT435, as lead candidate was identified after performing several benchtop studies
2. It has both TRASAR and TAG components enabling TRASAR/TAG control
3. 3DT435 enables higher cycles, thereby ensures water and energy savings

PILOT COOLING TOWER STUDIES – RED SEA WATER

Open environs (dust, pollutants, molds, humidity etc)



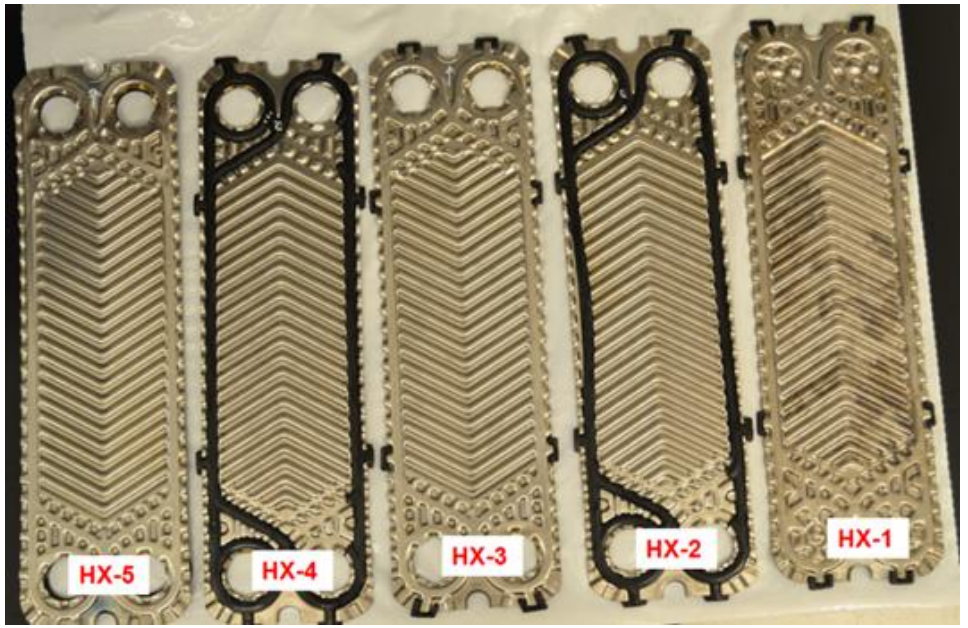
LabView
3DT system



3kms from sea
delta T (seawater): 8^{o}C,
delta T (process): 10^{o}C

TRIAL #1 : LOW CYCLES AND TRASAR CONTROL

Trial #1	
Cycles of Concentration (COC)	1.25 (+/- 0.05)
Total Residual Chlorine (TRC)	0.2 ppm
Results	
Visual Observation of HX's	No Scaling
Delta T (seawater)	8°C
Delta T (process)	10°C
Bio-fouling	Negligible ($<10^4$)



TRIAL # 2: HIGHER CYCLES AND TRASAR/TAG CONTROL

Trial # 2	
Cycles of Concentration (COC)	1.5-1.8
COC last 10 days	1.8 stepwise to 2.0
Total Residual Chlorine (TRC)	0.2 ppm
Results	
Visual Observation of HX's	No Scaling
Delta T (seawater)	8^{o}C
Delta T (process)	10^{o}C
Bio-fouling	Negligible (<10^{4})

COMMERCIAL APPLICATION: SAUDI SEAWATER TOWER

SMALL TOWER, 18,500 M^3/H RECIRCULATION; USING NON-P TREATMENT

Trial Period was greater than 1 year and run at high COC

THE DEVELOPED SOLUTION: 3DT435

Eco-friendly

Non - P

Water – Energy Savings

High COCs -Low costs

24/7 monitoring

3DTrasar enabled

QUESTIONS???

THE 79TH ANNUAL International Water Conference®
November 4–8, 2018

FURTHER READING: IWC CONFERENCE 2018; PTQ Q3 2019

New No P Scale Inhibitor for Inhibiting Scale under Highly Demanding Conditions Such as Sea Water cooling and Thermal Desalination:

Jasbir Gill, Ph.D. and Matt Chudomel, Ph.D., Nalco Water, Naperville, IL; Santanu Banerjee, Ph.D., Nalco Water India Limited, Pune, Maharashtra, India; Sairam Sudhakaran, Nalco Champion MEA, KAUST, Thuwal, Kingdom of Saudi Arabia

Demand for non-P scale and corrosion inhibitors has necessitated a move from phosphonates to polymers for scale inhibition. This in conjunction with the use of impaired water such as seawater for cooling has significantly raised the performance bar as compared to phosphonates, polyacrylic acid and polymaleic type of scale inhibitors. This paper presents unique new composition of the new inhibitor that outperforms most of inhibitors currently available to the water treaters. The data presented in the paper compares its performance to the phosphonates and other polymers in the cooling water system where the seawater is used as make up water....

Eliminating phosphorus from cooling treatment

Non-phosphorus programmes for corrosion and scale control in water cooling systems reduce environmental impact and operating costs

RENATE RUITENBERG and EMREGUL CETIN
Nalco Champion, an Ecolab Company

The water footprint of a refinery or petrochemical plant is in large part made up of the water used for process cooling. Typically, most of the treatment programmes contain phosphorous (P) as a key component in corrosion or scale control. These P based programmes raise concerns of eutrophication in sensitive water bodies receiving the cooling water blowdown. Although surface run-off and sewage disposal are the main sources of eutrophication,[1] industrial producers have started to seek more environmentally friendly for instance in all organic cooling programmes.

Legislation has tightened significantly in countries such as China that have been impacted by the negative effects of algal blooms. The main challenges associated with phosphorous are:

- Algal blooms in the receiving sensitive water bodies
- Tricalcium phosphate scaling potential at high heat flux
- High levels of phosphate if recycled wastewater is used
- Variable background levels causing control issues.

are low, hence the seawater intake is high, resulting in high water fees as well as high electricity costs. The high scaling potential results in limited cycles of concentration when P based antiscalants are used, leaving room for total cost of operation improvement.[3] The goal of safeguarding production while reducing the water and energy footprint can be achieved by increasing the cycles, provided that biofouling and scaling are kept under control.

Biofouling is the key challenge in these climates and has a much higher impact on heat transfer than