

Plant Shutdown Challenges and Innovative Solution

Total Value Delivery (TVD) Under Stress

Dr. Lei Wen

Principle Industry Technical Consultant

June 9th – 11th, 2026

ECOLAB[®]

NALCO Water

FAILURE



Self Introduction



Lei Wen

Principal Industry Technical
Consultant

Email wlei@nalco.com

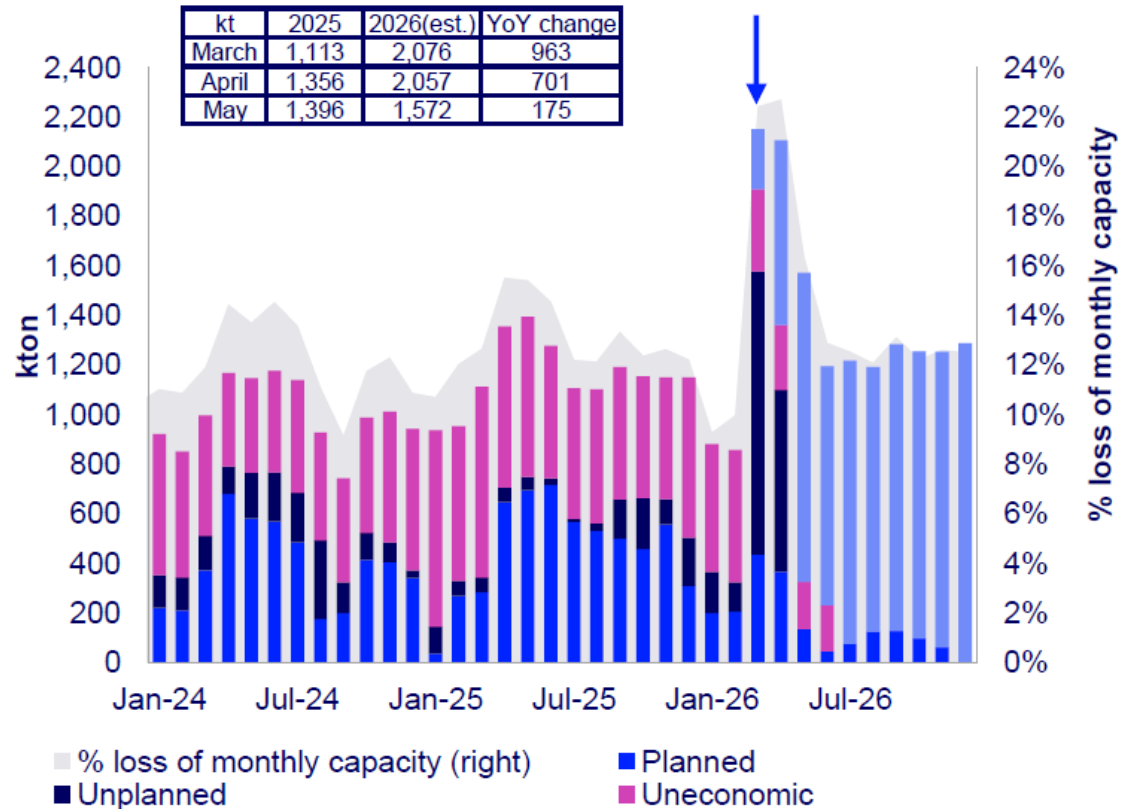
Location: Singapore

- ▲ Bachelor from Tsinghua University, China
- ▲ PhD from National Univ. of Singapore, Chemical Engineer
- ▲ 6 years as Lecturer in Tsinghua University
- ▲ Join Nalco R&D in 1999 as researcher, focus on cooling and boiler water application
- ▲ Lead AP WPS Innovation between 2009-2014 and Product marketing 2014 - 2015
- ▲ Site supported hundreds Refinery, Power, PMI, F&B customers on water related applications
- ▲ 25 yrs expertise in Cooling, Boiler & Steam, Membrane, Wastewater and Demin System
- ▲ As Principal Consultant & Water M&O Lead for Nalco Water DS since 2015



Petrochemical Situation

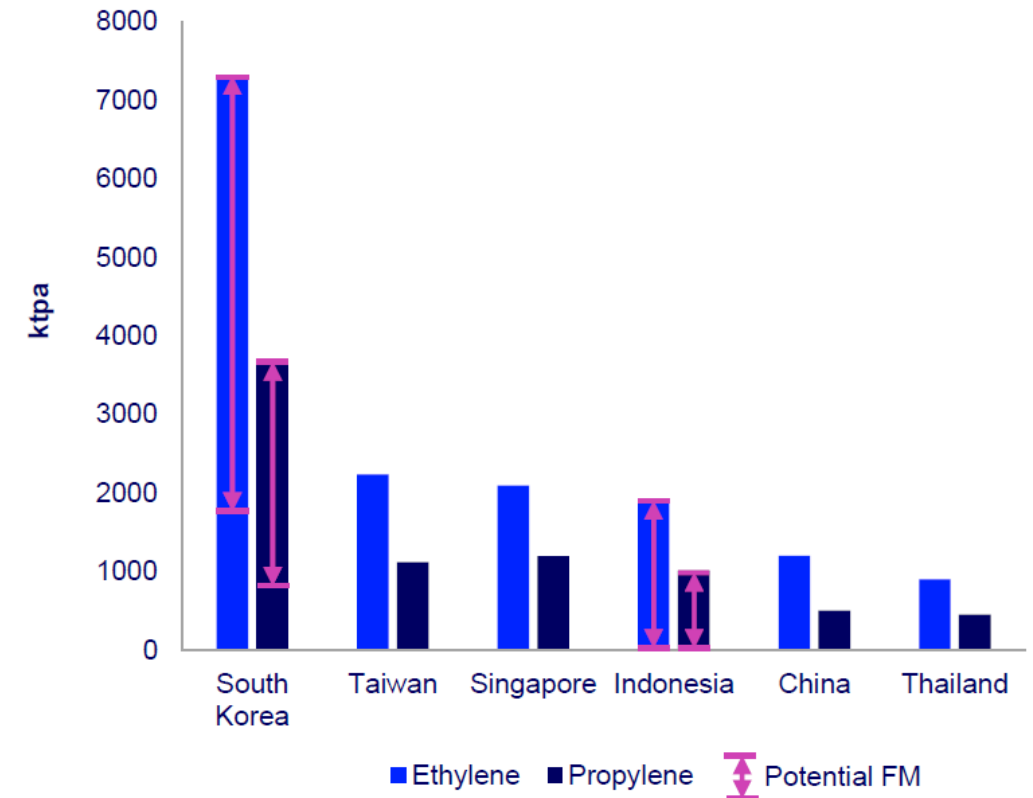
Asia ethylene capacity loss



Source: Wood Mackenzie Chemicals

Asia olefin capacity under force majeure by country

*Including potential FM



Source: Wood Mackenzie Chemicals

▲ Uncontrolled situation force several producers to shutdown commercially longer than normal.

Challenges during Plant Shutdown & Lay-up - Cooling Water System

▲ Key Concerns during shutdown & Lay-up

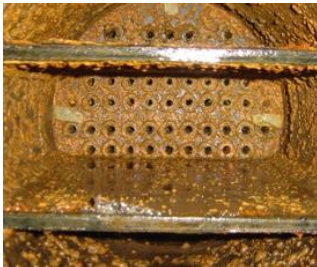
- Stagnant water corrosion, especially in underground piping and headers
- Flash (atmospheric) corrosion
- Aerobic (slime-forming) bacteria infection
- Anaerobic (corrosive) bacteria infection
- Drying/cracking of piping corrosion products – chip scale
- Iron buildup and deposit formation

▲ The damage resulting in such situations can be very significant affecting the long-term equipment life as well as premature heat exchangers problems.

Plant Expectation during temporary plant shutdown

Safety & Reliability

- ▲ Safety
- ▲ Maintain equipment integrate
 - No corrosion and deposition
 - No microbial problem
 - No corrosion in condensate system
- ▲ No hazardous discharge



Minimum TCO

- ▲ Minimal water and energy usage
 - 4,000 ~ 5,000 US\$/day to maintain pump rate 10,000 m3/hr
 - 1,500 ~ 2,000 US\$/day to keep tower fan running
- ▲ Lowest Chemical Cost
 - Preservation and Passivation
- ▲ Waste Discharge cost

Start-up Fast

- ▲ Quick Start up when needed to catch up the economical wave
 - Minimum time for water flushing and steam blowing
 - Short timing for passivation
 - Compatible with quick heat load
 - Waste Water Plant start-up fast

CW Shutdown options

Run CW as normal

- ▲ Good for plant shutdown <2 weeks
- ▲ High electricity cost for pump operation
- ▲ High HTI: avoid Cl and Fe exceed the limit
- ▲ Need full automation and control, service

Reduce Running Pump

- ▲ Good for plant shutdown <1 month
- ▲ Possible very low or stagnant water at high level exchangers
- ▲ Need moderate level of preservation chemistry to control corrosion at low flow condition

Wet Preservation



- ▲ Good for 1~12 months shutdown
- ▲ Minimum electricity cost by stopping pumps
- ▲ Higher Chemical cost: Nalco Proprietary Chemistry
- ▲ Quick start up, lowest cost for start-up & Passivation
- ▲ Compatible with heat load
- ▲ Best performing and proven option

Drain & Dry

- ▲ Lowest electricity and chemical cost
- ▲ No protection for underground piping
- ▲ Need individual handling of exchangers
- ▲ Long start-up time
- ▲ High cost for start-up and passivation

Case History: Innovative Wet Lay-up Preservation Program



> US\$2,000,000



- > 30,000 m³ water Saving**
- > 20,000MWh Power Saving**
- > 10,000 ton CO₂ emission saving**



Well Passivation CW system
for long term operation

Overall ROI: **>400%**

Background

- ▲ Refinery and Petrochemical Integrated Development
- ▲ One of the largest refinery and petrochemical complex in SEA
 - Combined >3 million metric tons-per-year production capacity.
- ▲ Huge circulation rate of 120,000m³/hr in cooling system.
- ▲ Due to Covid-19 impact, the plant decided to conduct a plant shutdown and preservation procedure for an extended period of time
 - 3~6 months standby
 - System need to be semi-ready for quick start-up if needed.
 - During this shut-down period, their cooling water system need stop the circulation for 3~6 months

Key Challenges in Cooling system Lay-up

- ▲ Huge system volume
- ▲ Long Preservation time: **3~6months**
- ▲ Huge underground piping: not able to drain completely
- ▲ Very complicated exchanger net works:
 - >200 exchangers
- ▲ Different height of exchanger location
 - From ground to 5th floor height
- ▲ Very soft make-up water: corrosive
- ▲ High cost needed to keep the circulation **(>\$2m for 6 month)**
- ▲ May need quick start-up when needed
- ▲ Basin water: may cause serious algae growth when stagnant

NALCO Water Customized Solution

NALCO Water recommend to use a combination of corrosion inhibitors and biocides as cooling water preservation chemistry

- Moderate level of chemicals as the key corrosion control program: **save 75% cost**
- Enhanced existing treatment program: enhance the corrosion control and keep sufficient distance from the scaling zone, very stable biocontrol program
- Nitrogen blanket for high floor exchangers that can not fully filled with water during preservation.
- No extra circulation

Key Benefit

- Total lower cost than using Nitrite based preservation and better performance.
- Selected chemistry is compatible with all chemical treatment and discharge limit
- No need to replenish the chemical upon start-up (save water).
- Easy to replenish for water loss in the system
- Be re-used for passivation.

After 30 days – 15/12/20-15/1/21



Mild Steel Coupon – 0.197mpy



Copper Coupon - <0.118mpy

After 60 days – 15/12/20-15/2/21



Mild Steel Coupon – 0.236mpy



Copper Coupon – 0.118mpy

After 90 days – 15/12/20-15/3/21



Mild Steel Coupon – 0.236mpy



Copper Coupon – 0.118mpy

After 90 days – 18/3/21-17/6/21



Mild Steel Coupon

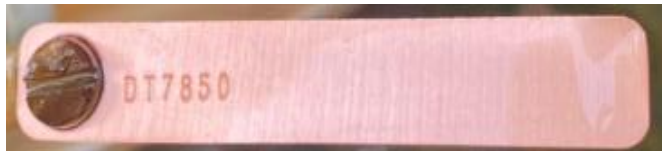


Copper Coupon

Passivation – 2/6/21-4/6/21



Mild Steel Coupon – Pass Copper
Sulphate test



Copper Coupon

Bacteria Count picture

DATE	CWR N	CWR S	SSF	EOEG	C4 INA	PP	LLDPE	LLDPE T	FDPE	SPW
15/12/20										
22/3/20								NA		
29/5/20										

Summary of Performance

- ▲ Achieved overall corrosion rate less than 0.2MPY for all the exchangers
- ▲ zero microbial upset
- ▲ Save **>US\$2mm for electricity** required for regular water circulation
- ▲ Save **>30,000 m³ water** for system re-start
- ▲ save 50% of the time for system re-start.
- ▲ Reduce CO₂ footprint **>10,000 ton**
- ▲ **ROI >300%**

Partnering with Nalco Water

Provide a best protect during challenge time

Prevention is a better approach than remedies

Use TVD approach

Water & Energy saving is much bigger vs chemical cost

Monitoring and Control are the key for success



ECOLAB[®]

| **NALCO** Water