

Efficiently reducing SO₂ emissions on a smaller plot:

A case study of MECS® DynaWave® technology at CPC Corporation, Taiwan

May 7-11, 2018

Galveston, TX, USA

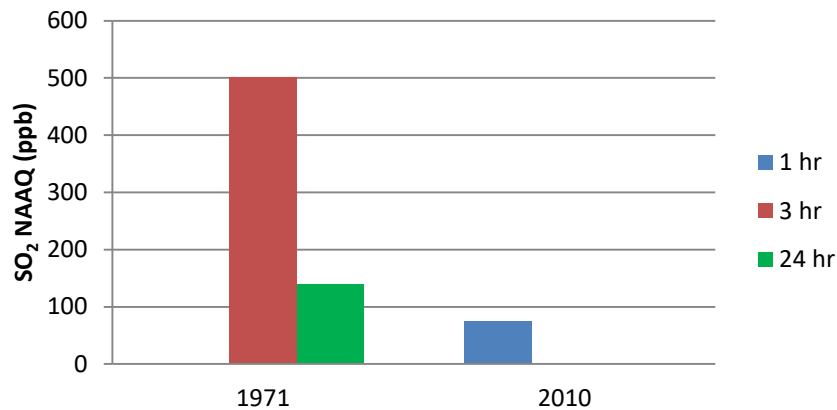
Curt Hassler & Yves Herssens

REFCOMM
GALVESTON
MAY 7-11 2018

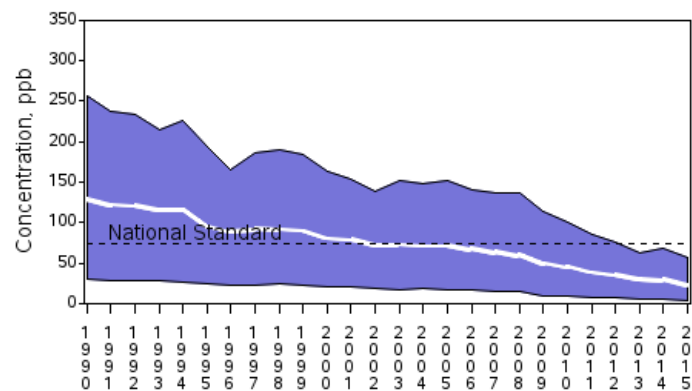
Increasingly stringent SO₂ emission regulations



USA SO₂ NAAQs

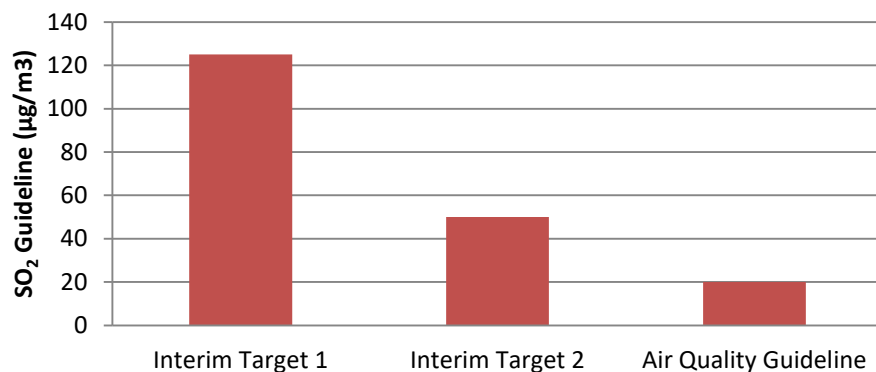


SO₂ Air Quality, 1990 - 2015 (Annual 99th Percentile of Daily Max 1-Hour Average) National Trend based on 140 Sites



1990 to 2015 : 81% decrease in National Average

WHO SO₂ Air Quality Guidelines



World Bank Standards aim to match WHO Guidelines

Increasingly stringent SO₂ emission regulations



- Government regulations
- World Bank Standards
- Company Policies and Objectives
 - Change Company to Company
- Local Considerations
 - Local Governments
 - Plant Location
 - Public Pressure

Regardless of which drivers are in control for a given installation, the trend for all such drivers seems to be increasingly stringent.

Typical approach to reach SRU emission targets



We will have our SRUs comply but.....

- Minimize CAPEX
- Minimize Maintenance Cost
- Minimize Operator Involvement
- Highest Reliability



Typical approach to reach SRU emission targets



Claus process : 96-98% of S recovered



Traditional Method:

Amine Based TGTU

→ 99.9+% of S recovered



Reliability - emergency shutdowns and startups? Malfunctioning?

Case Study Method:

Installation of a highly flexible Reverse Jet scrubber

- Increase reliability / on-stream time
- Further Minimize CAPEX
- Minimize Maintenance Cost
- Minimize Operator Involvement
- Reduce plot space



CPC Corporation



- Large Taiwanese state-owned refining corporation
- 3 refineries in Taiwan, which had a combined capacity in 2015 of 720,000 bpd:
 - Kaohsiung Refinery – closed end 2015, for environmental reasons.
 - Taoyuan Refinery
 - Talin Refinery
- Output of petroleum products (2015) : 22.4 Billion liters.



CPC Talin Refinery

- Located in Kaohsiung, Taiwan
- Main products: gasoline and diesel
- Increasing capacity from 300,000 bpsd to 350,000 bpsd
- Total sulfur production capacity of 780 MTPD
 - 3 three-stages Claus Units, 4 trains
 - 1 two-stages Claus Unit (SRU #10), 2 trains
- Improved SO₂ removal reliability on SRU #10 simultaneously with capacity increase.

A highly flexible Reverse Jet scrubber



Whatever you do upstream,



at the end, you want to ...



Avoid having the mosquito enter your home.



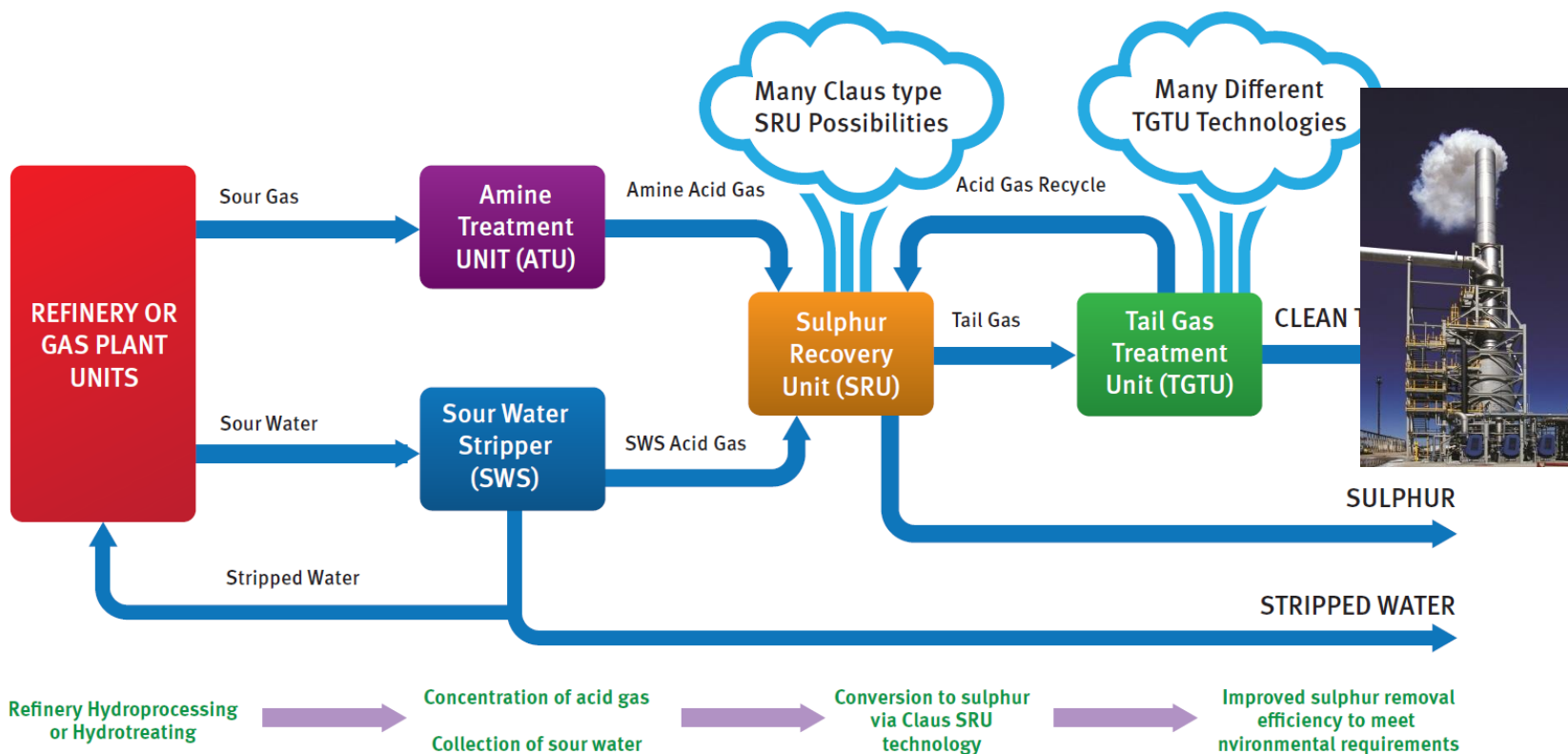
Avoid having the SO_2 enter the atmosphere.

A highly flexible Reverse Jet scrubber



Whatever you do upstream,

at the end, you want to ...



Avoid having the SO₂ enter the atmosphere.

A highly flexible Reverse Jet scrubber



The challenges of an SRU/TGTU scrubbing solution :

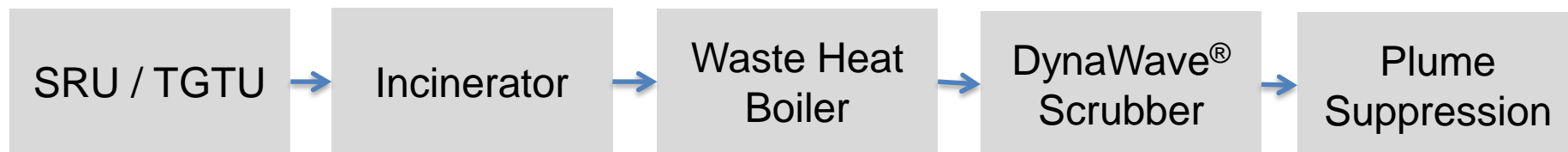
- Guarantee low SO₂ emissions at all times (no lost production and low CAPEX)
 - Ability to handle a wide range of inlet SO₂ loadings
 - A high turndown required
 - Reliability and proven experience
- This opens extra opportunities:
 - Potentially save on stack height.
 - Operate a more cost-effective SRU/TGTU process, as final SO₂ is captured anyhow before emitting to the stack.

A little background on the technology

- Developed by DuPont in the 1970s for TiO_2
- Used extensively in harsh environments
 - MECS sulfuric acid plants
 - Incineration tail gas treatment
- Installed and proven experience
 - Over 400 DynaWave installations globally
 - ~ 200 Refinery scrubbing references by Dupont Clean Technologies, including several at CPC in the last 10 years.



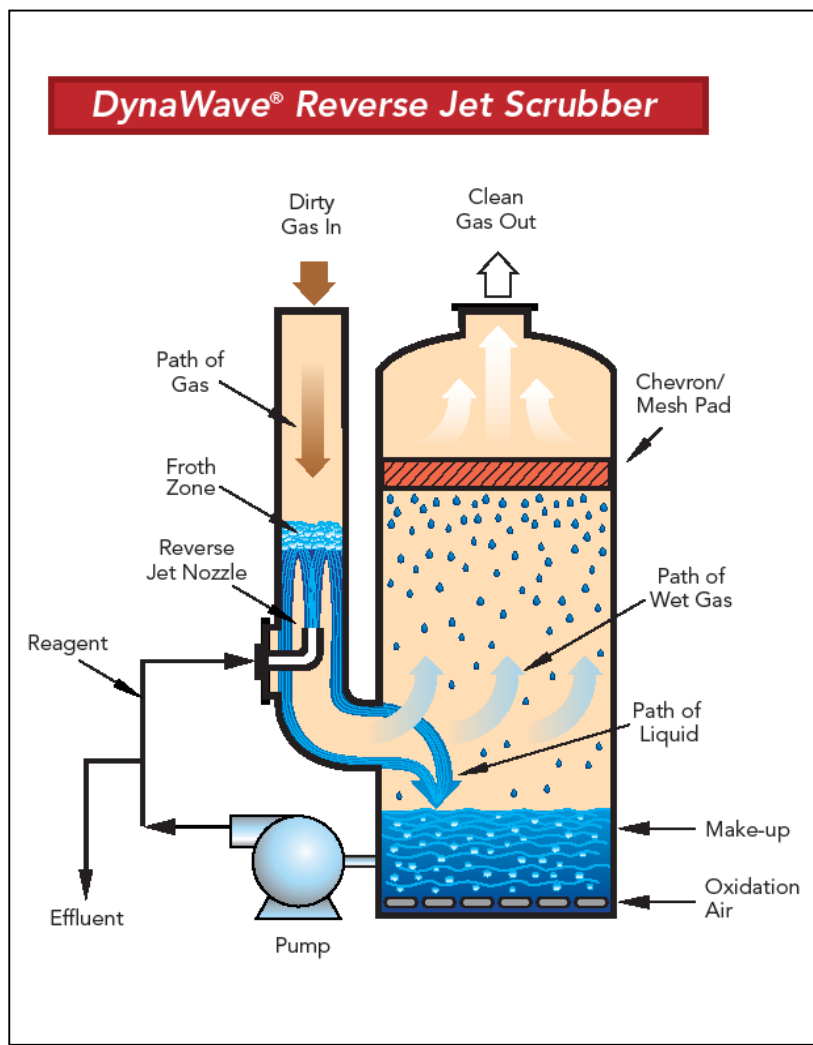
DynaWave® Technology at CPC



- Custom designed for CPC, based on specific design inlet conditions
- DynaWave technology allows to combine functions all in one vessel:
 - Quench the gas from the WHB
 - Eliminate particulates
 - SO₂ to <30ppmv (d)
 - SO₃ to <30ppmv (w)
- Additional plume suppression system for visual optimization.



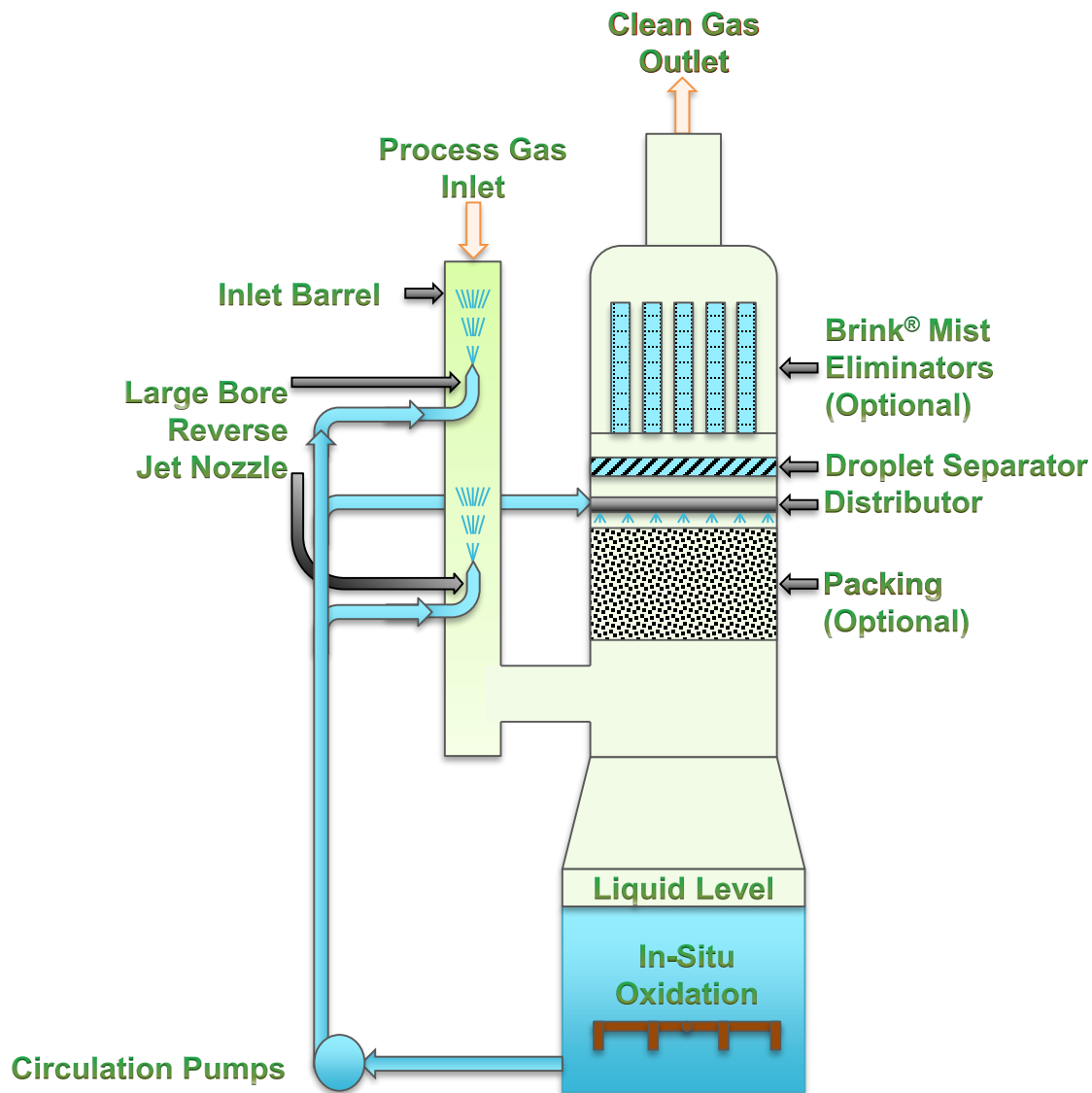
DynaWave® Technology at CPC



DynaWave® Technology at CPC



DynaWave® Technology at CPC



Benefits noted at CPC Talin Refinery



■ SO₂ emission reduction in **normal operation mode** - above expectations:

- Before DynaWave was installed: 1000 ppmv
- Guaranteed by DynaWave: < 30 ppmv
- Achieved by DynaWave:
 - » Train 1 : 9.15 ppmv
 - » Train 2 : 0.23 ppmv

■ In **bypass operation mode** :

- Before : 7000/8000 ppmv
- After : < 10 ppmv



Benefits noted at CPC Talin Refinery



- DynaWave has allowed CPC to operate a more cost-effective TGTU process.



→ Fewer pieces of equipment needed, resulted in a **smaller overall footprint** and significantly less complexity(*).



→ Overall, CPC estimates a **30% TIC savings**(*).

(*) compared to a traditional amine based TGTU.

- **Additional reliability**, compared to a traditional amine based TGTU only.

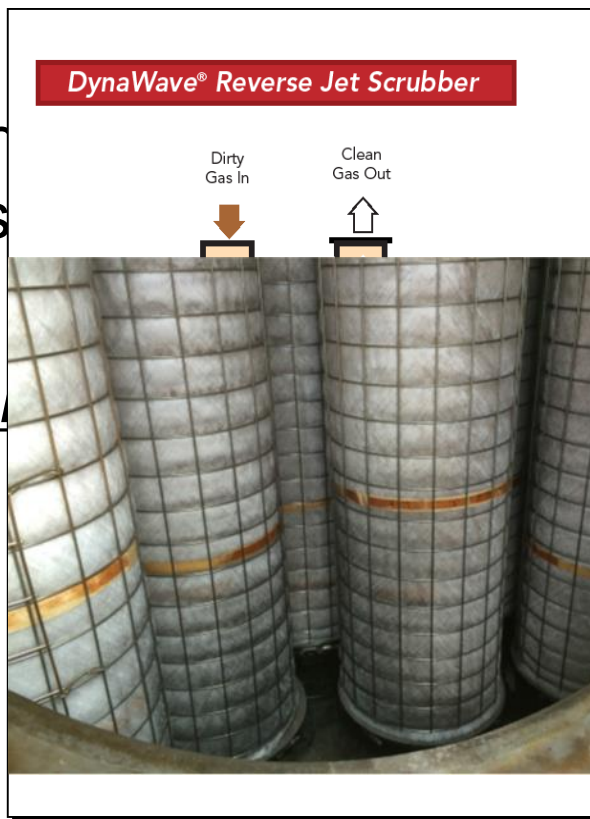


Benefits noted at CPC Talin Refinery



- Little operator attention required:
 - Very **easy** system to operate
 - **Maintenance free** system (unpluggable nozzles)

■ Guaranteed process



■ **No vis**



Ending remarks



- Increased reliability: 24/7 low SO_x emissions
- Significant CAPEX savings
- Minimal operator attention
- Smaller footprint
- No visible plume, which is appreciated by the surrounding community.



« If we have the opportunity to use the DynaWave® scrubber technology for other SRU plants in the company's refining complexes, we will recommend it »



Mr Jinn-Kuen Lu, head of technical service sub-section at CPC