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Efficiently reducing SO_2 emissions on a smaller plot:

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

2-6 October, 2017

Budapest Hungary

Yves Herssens

REFCOMM® BUDAPEST 2-5 Oct 2017

MECS®

Increasingly stringent SO_2 emission regulations

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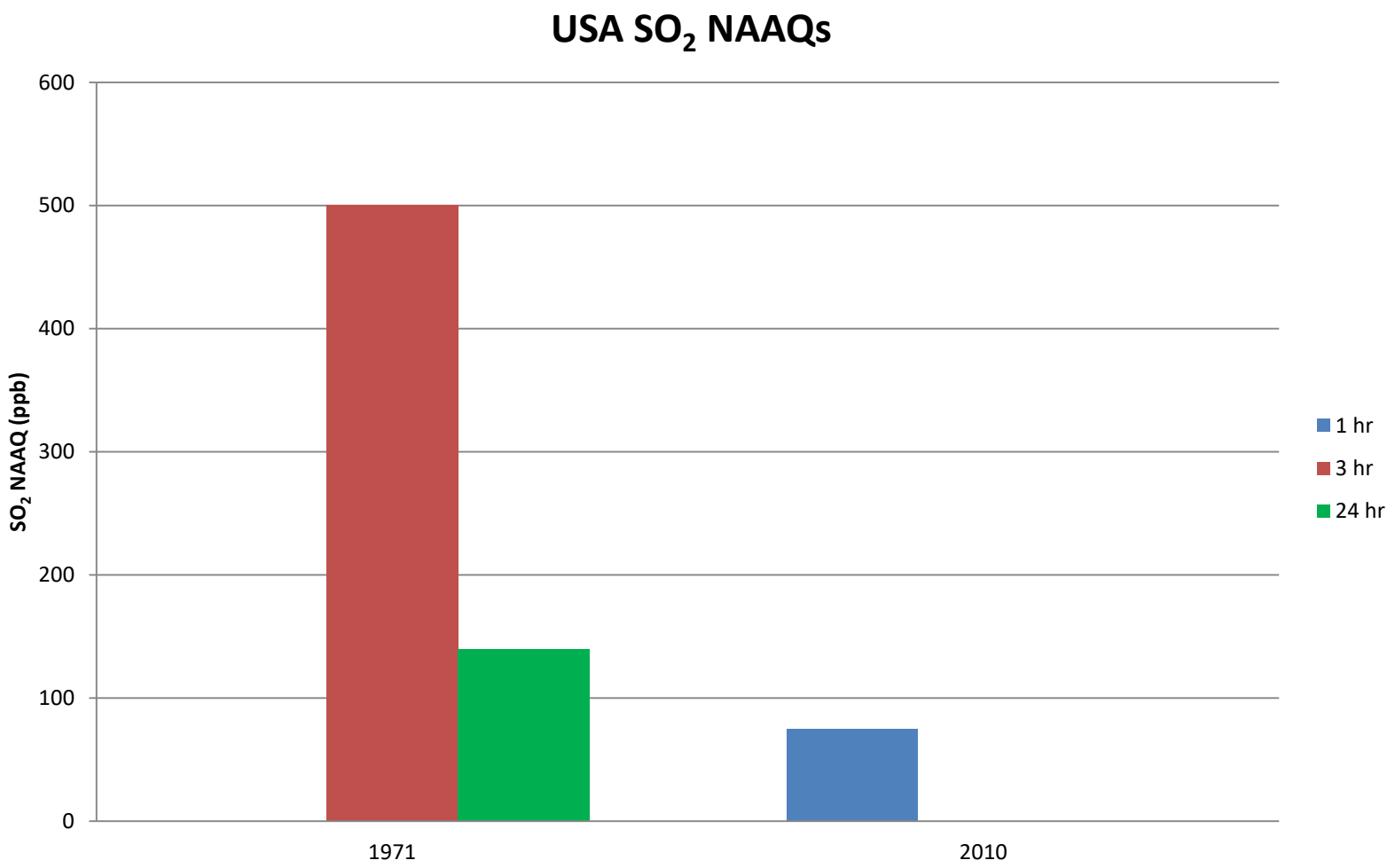
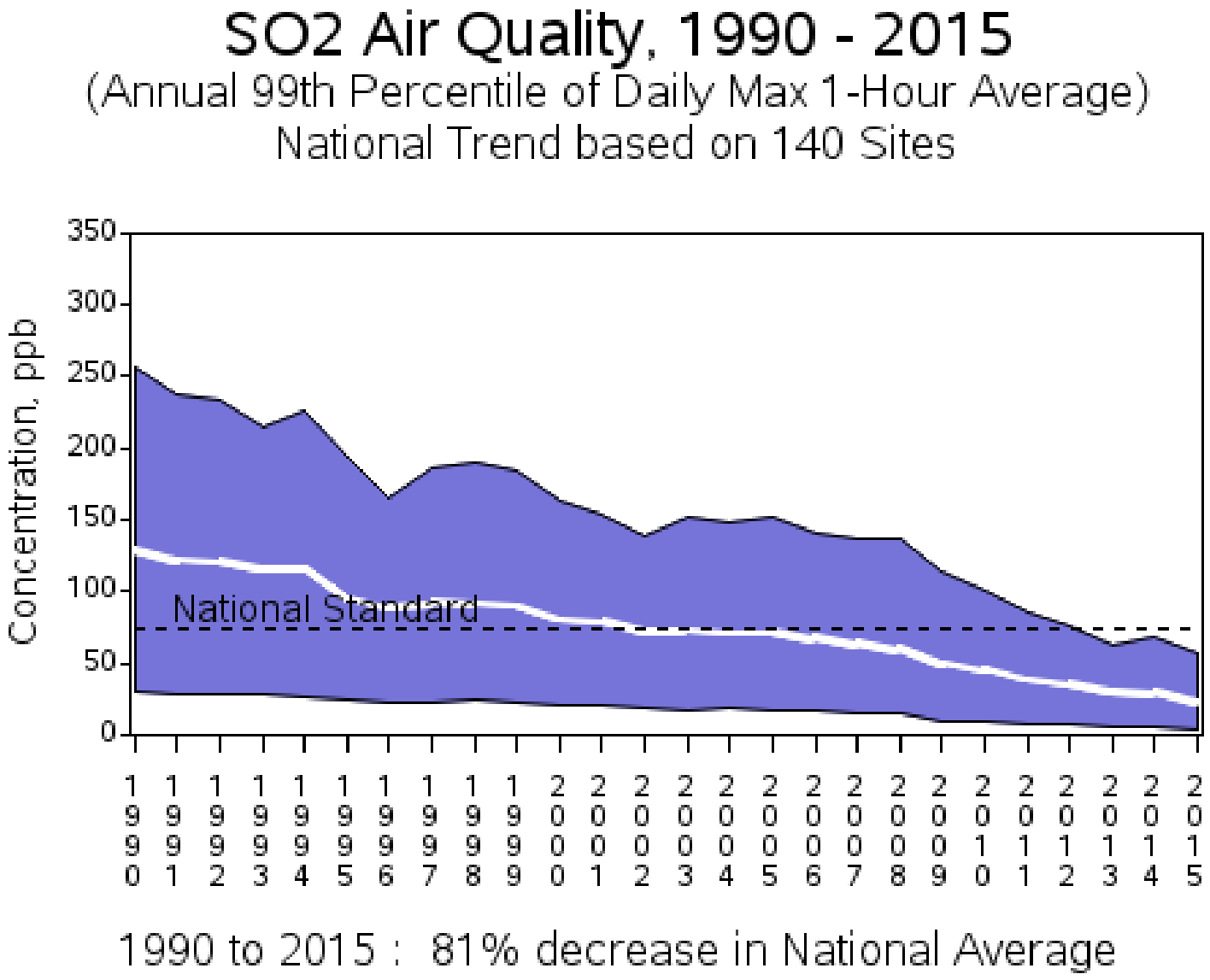
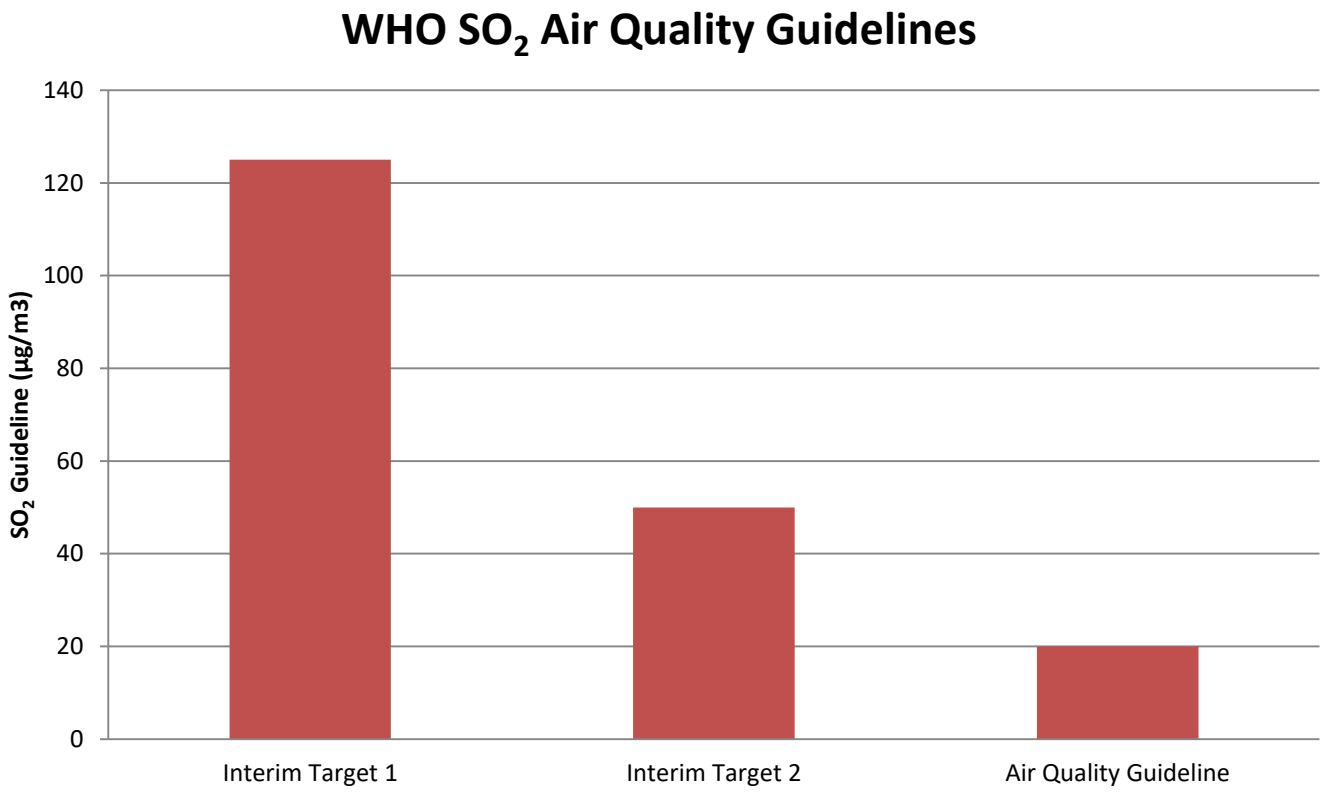


Increasingly stringent SO_2 emission regulations



Increasingly stringent SO_2 emission regulations



World Bank Standards aim to match WHO Guidelines

Increasingly stringent SO_2 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

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We will have our SRUs comply but we want to:

- 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?

Typical approach to reach SRU emission targets

If your emission reduction process is not 100% reliable you run the risk that one day you will have to:

- a. Shutdown the plant during upset conditions
  - Lost production
  - No additional CAPEX
- b. Install a stand-by TGTU
  - No lost production
  - Double the CAPEX

Typical approach to reach SRU emission targets

With the installation of a highly flexible Reverse Jet scrubber, a refinery in Asia, was able to:

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

Presentation of CPC and the Ta-Lin refinery

Presentation of CPC and the Talin Refinery

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.

Presentation of CPC and the Talin Refinery

CPC Talin Refinery

- Located in Kaohsiung, Taiwan
- Main products: gasoline and diesel
- Increasing capacity from 300,000 bpsd to 350,000 bpsd
- Total sulfur prodution capacity of 780 MTPD
  - 3 three-stages Claus Units, 4 trains
  - 1 two-stages Claus Unit (SRU #10), 2 trains
- Improved SO_2 removal reliability on SRU #10 simultaneously with capacity increase.

A highly flexible Reverse Jet scrubber

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Whatever you do upstream,

at the end, you want to …

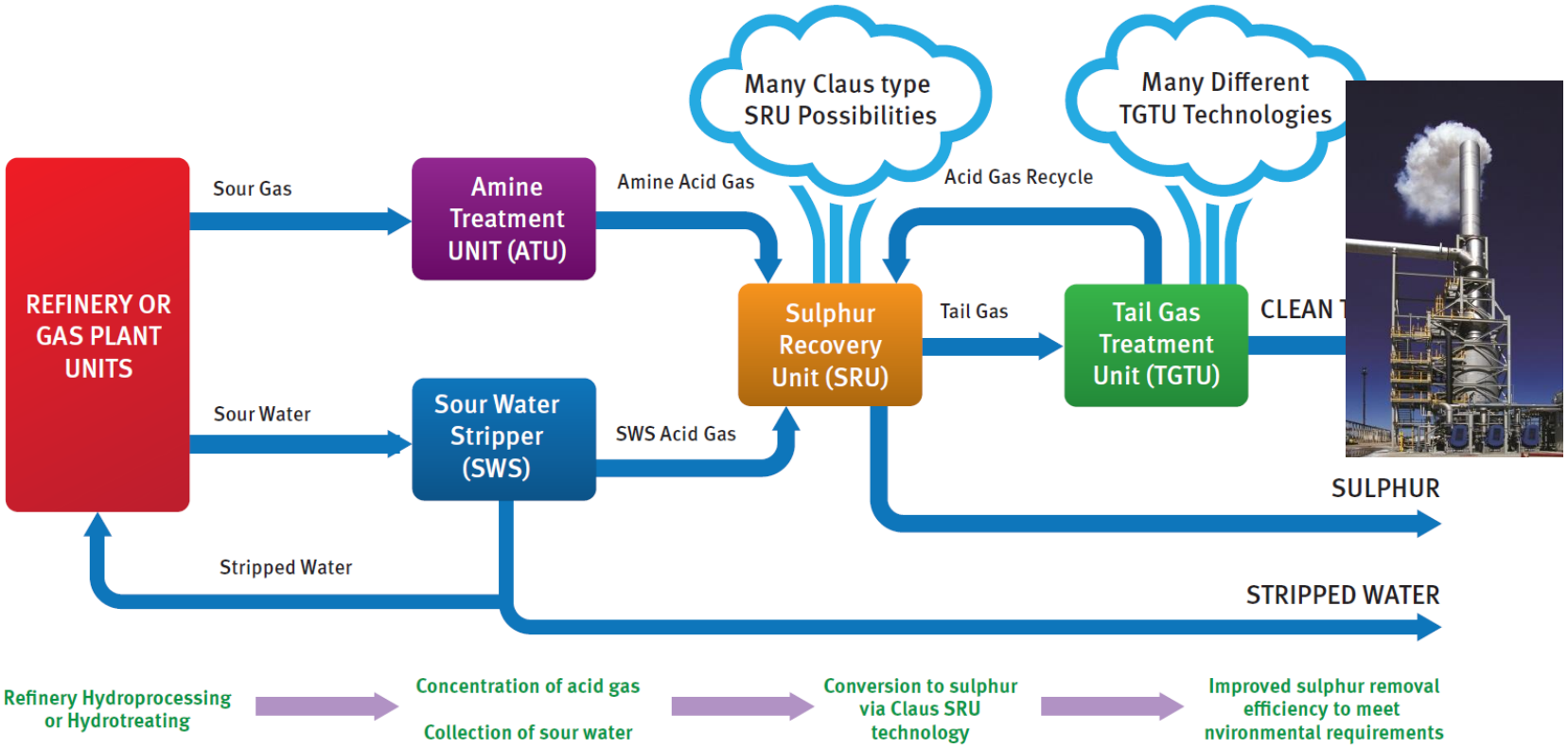
Avoid having the mosquito enter your home.

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 SO_2 enter the atmosphere.

A highly flexible Reverse Jet scrubber

The challenges of an SRU/TGTU scrubbing solution :

- Guarantee low SO_2 emissions at all times (no lost production and low CAPEX)
  - Ability to handle a wide range of inlet SO_2 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 SO_2 is captured anyhow before emitting to the stack.

DynaWave® Technology at CPC

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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

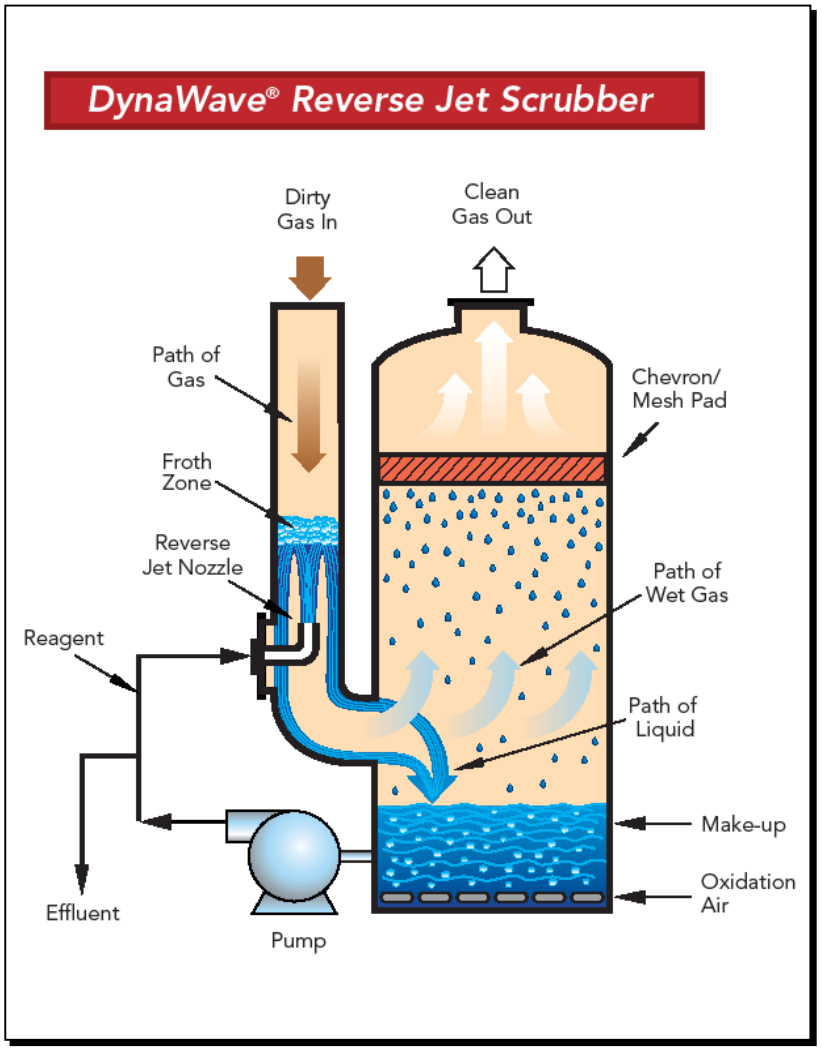
- Installed and proven experience
  - Over 400 DynaWave installations globally
  - Over 100 Refinery scrubbing references by Dupont Clean Technologies, including several at CPC in the last 10 years.

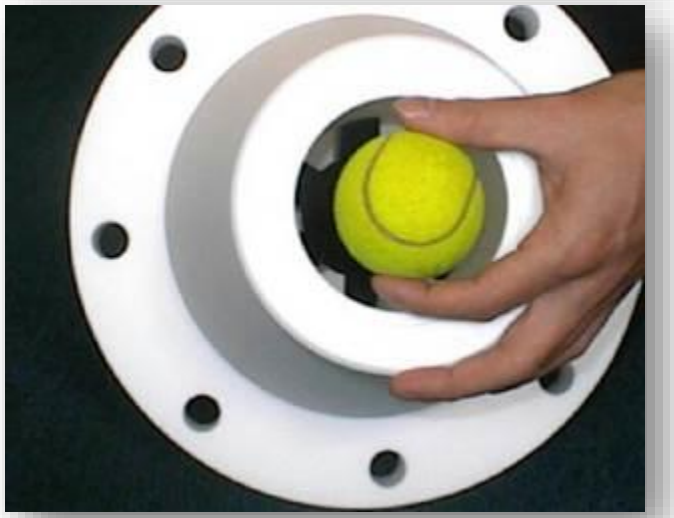
DynaWave® Technology at CPC

SRU / TGTU → Incinerator → Waste Heat Boiler → DynaWave® Scrubber → Plume Suppression

- 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
  - SO_2 to <30ppmv (d)
  - SO_3 to <30ppmv (w)
- Additional plume suppression system for visual optimization.

DynaWave® Technology at CPC





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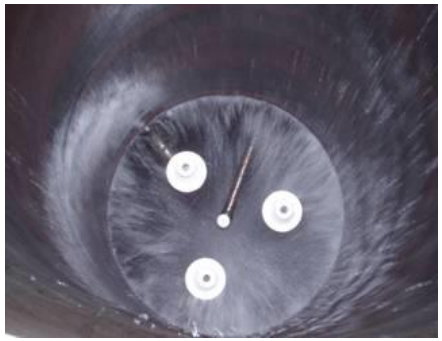

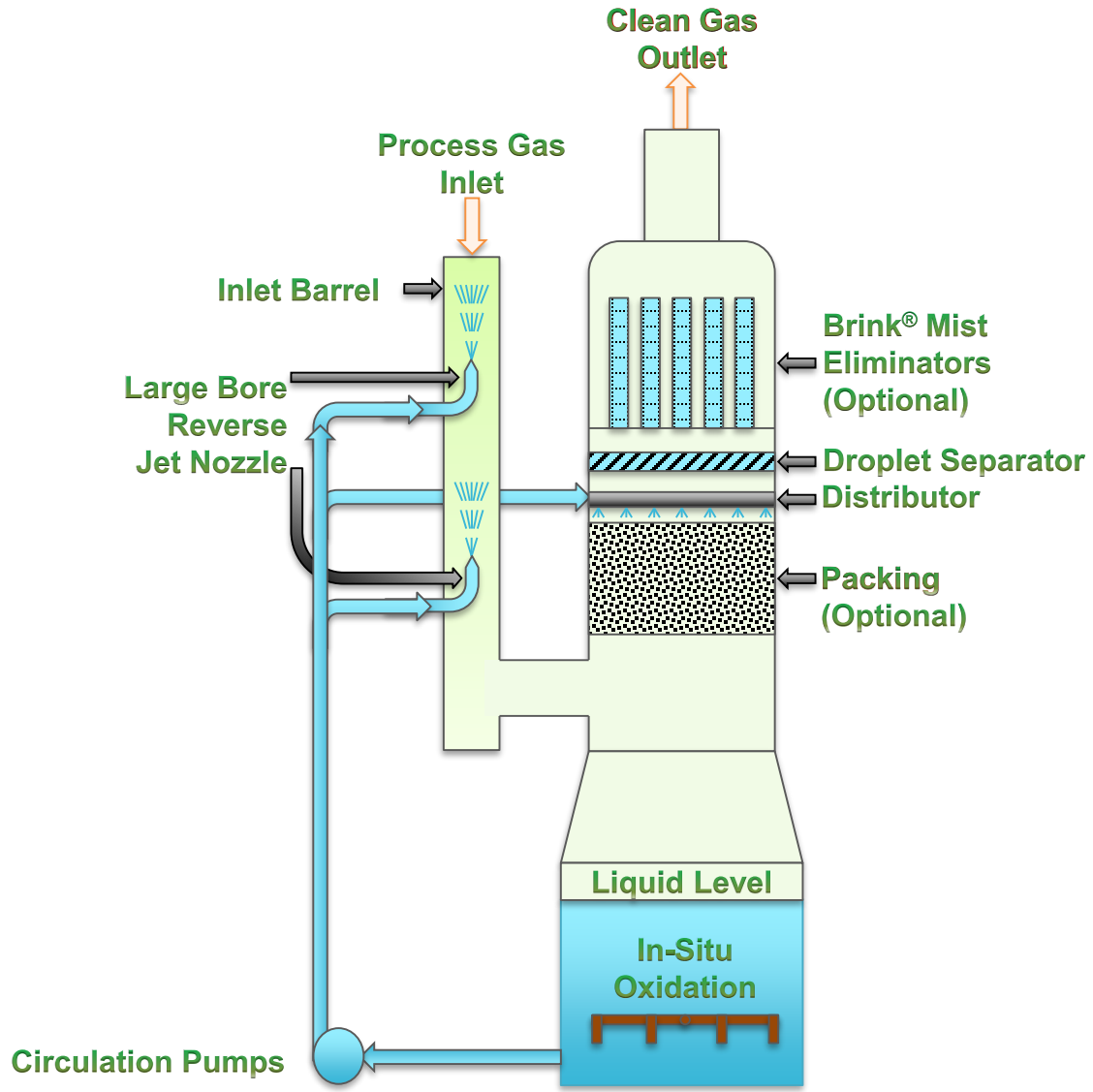

Benefits noted at CPC Talin Refinery

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- SO_2 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 ***<u>smaller overall footprint</u>*** and significantly less complexity(*).

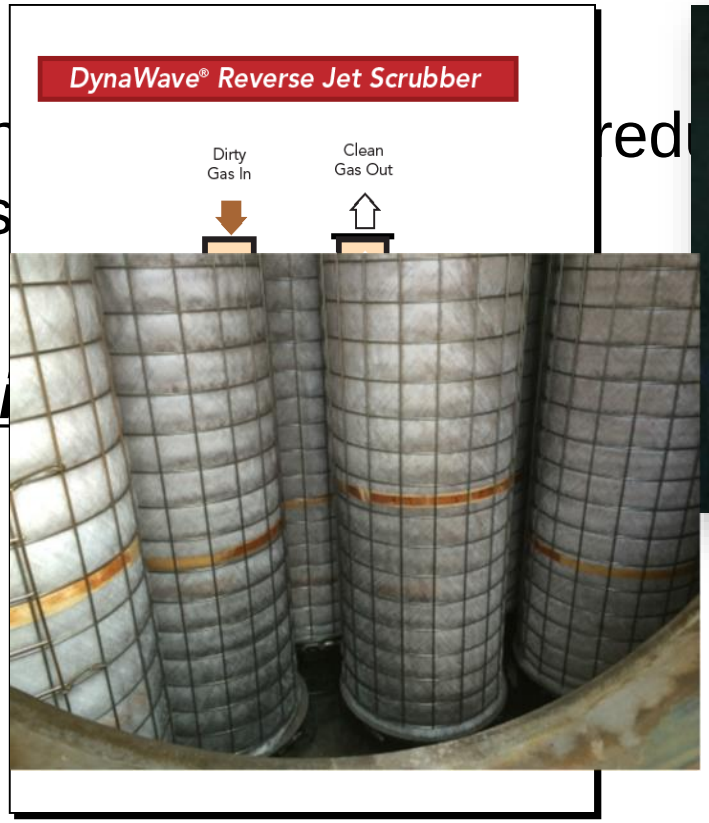
→Overall, CPC estimates a ***<u>30% TIC savings</u>***(*).

(*) compared to a traditional amine based TGTU.

- **<u>Additional reliability</u>**, 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)
- Guaran… …redu… process…
- ***No visi…***



Ending remarks

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- 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.

Ending remarks

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

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

Ending remarks

SPECIAL THANKS TO:

- Mr Jinn-Kuen Lu, Head of the technical service sub-section, CPC Corporation, Taiwan
- Mr Wei-Chen Ke, No.10 SRU Superintendent at the Ta-Lin refinery of CPC Corporation, Taiwan
- Mr William Lam, Senior Business Development Manager, MECS, Hong Kong