

Acid Gas Scrubber for Multi-Pollutant Reduction

Emission Control and Measurement
Workshop

March 24-25, 2010

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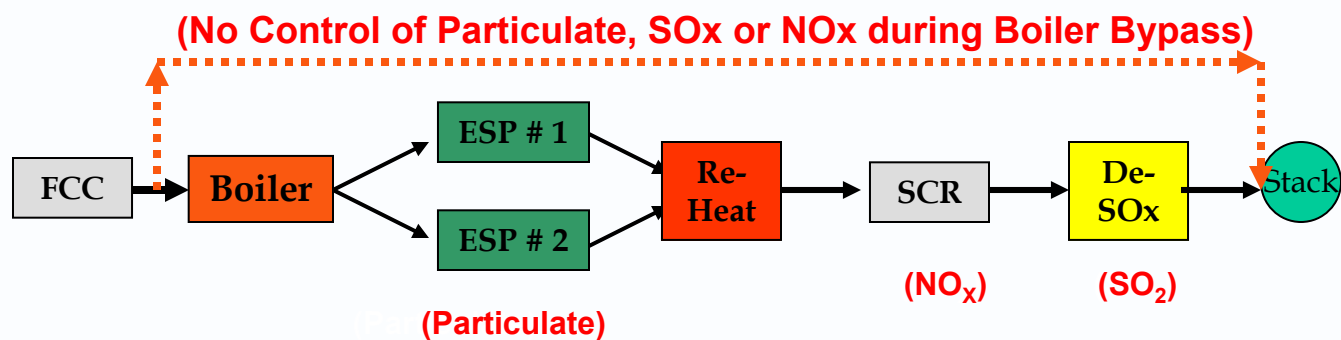
Belco Technologies Corporation



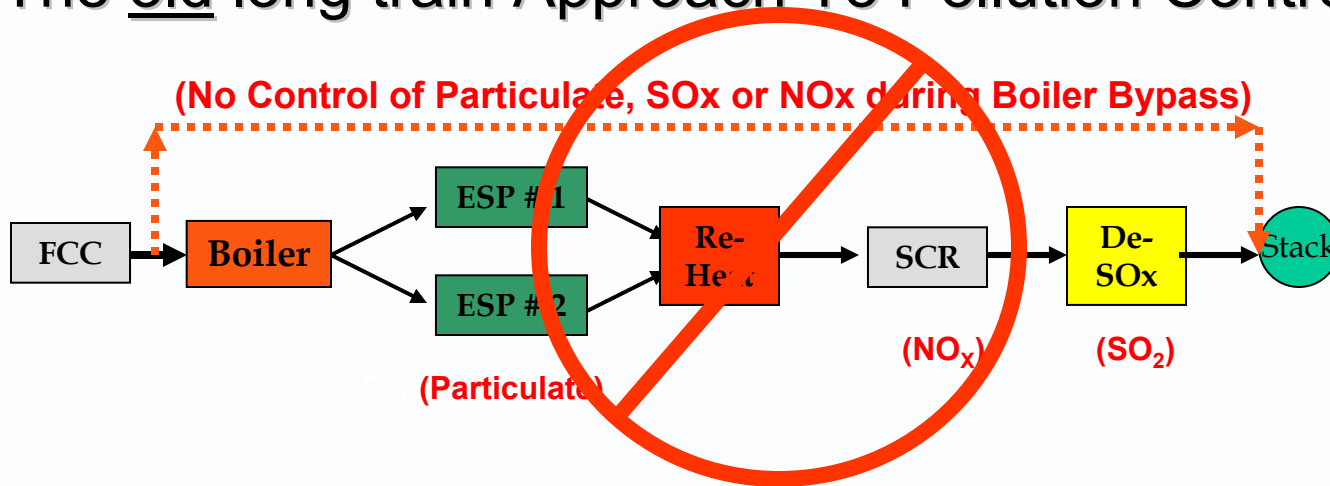
- **Founded in 1968, was part of Foster Wheeler until 1989. Now subsidiary of DuPont.**
- **Located in Parsippany, New Jersey**
- **Employing about 65 people**
- **Worldwide Supplier of Technologies for Controls of Particulate, SO_x and NO_x emissions. Specializing in reduction of Oil Refinery Emissions.**
- **More systems installed and operating than ALL other competitors “COMBINED”**
- **Offering a wide range of solutions to better serve our customers**
- **Certified ISO 9001-2000**

Reducing Particulate, SO_x and NO_x in a single vessel

The old long train Approach To Pollution Controls



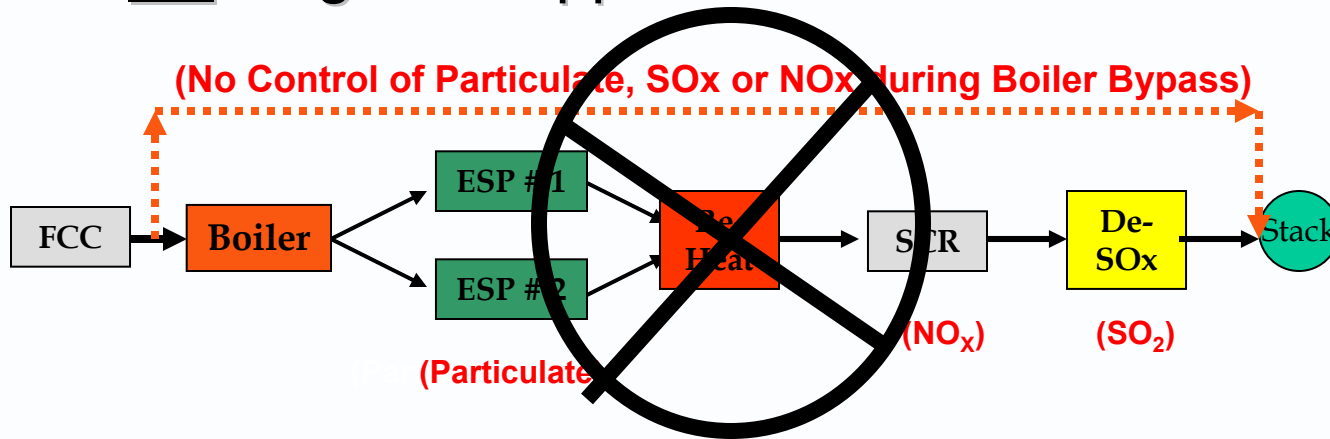
The old long train Approach To Pollution Controls



THE OLD APPROACH IS:

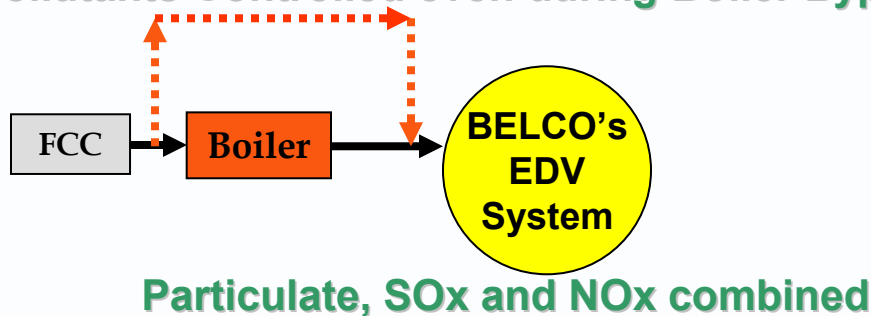
- *COSTLY*
- *USES TOO MUCH PRECIOUS REFINERY SPACE*
- *IS SUBJECT TO TOO MUCH MAINTENANCE AND POSSIBLE DOWN TIME*
- *DOES NOT PROVIDE POLLUTION REDUCTION DURING BOILER BYPASS*

The old long train Approach To Pollution Controls



The Multi-Pollutant Approach To Pollution Controls

(Pollutants Controlled even during Boiler Bypass)



- Less Space Required
- Lower Cost
- Higher Efficiency
- Highest Flexibility
- Higher Reliability
- Full control even during boiler bypass
- Can change with your requirement

EDV[®] Wet Scrubbing System



Reducing Particulate, SO₂, SO₃ and NO_x in a single vessel



EDV[®] Wet Scrubbing Advantages



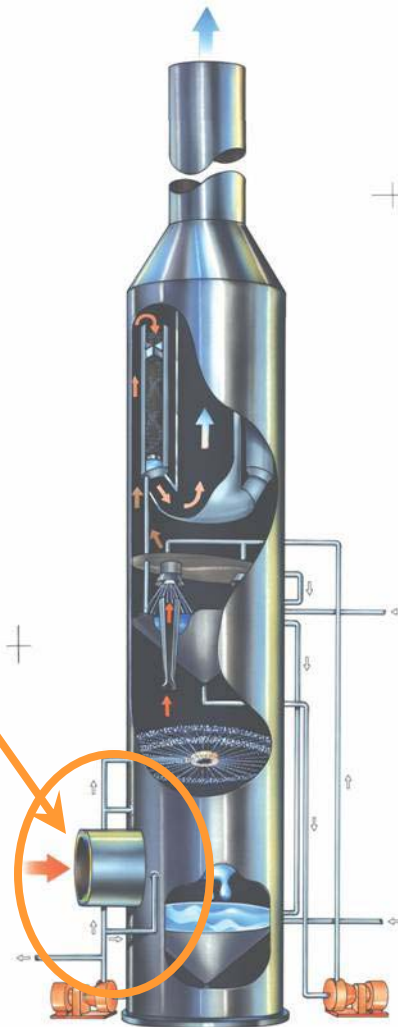
- ◆ No Mist Formation
 - No Demister
 - No Mist Fallout
- ◆ Plot Area
 - Small
 - Flexible
- ◆ Highly Reliable
- ◆ Highly Efficient
- ◆ Can provide Combined Particulate, SO₂, NO_x and SO₃ Control
- ◆ Non Plugging
 - Nozzles, Vessel & Component Design
 - Handles High Dust Loads. Even FCCU Upsets
 - Highly Reliable
- ◆ Modular & Integral
 - Single System for all pollutants
 - Multi-Staged Collection

Step 1 – Flue Gas is quenched and saturated in the Quench Section. Initial reduction of particulate, SO₂ and SO₃ is achieved in this step

The EDV[®] Quench Section



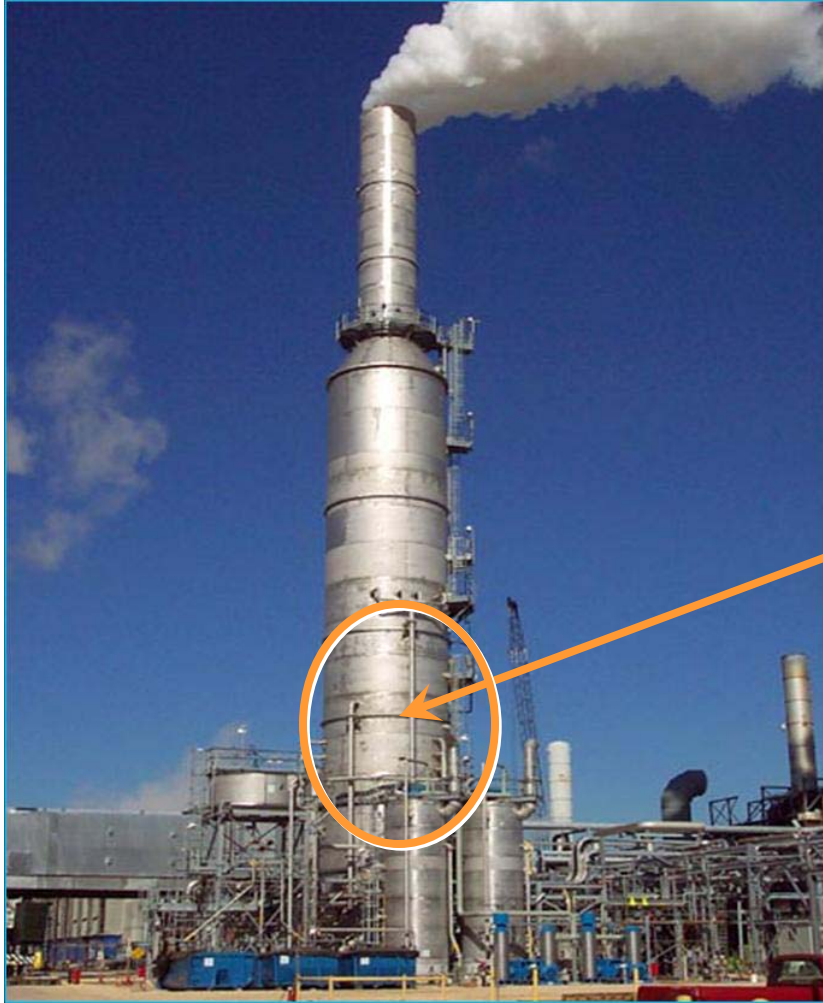
Quench Section



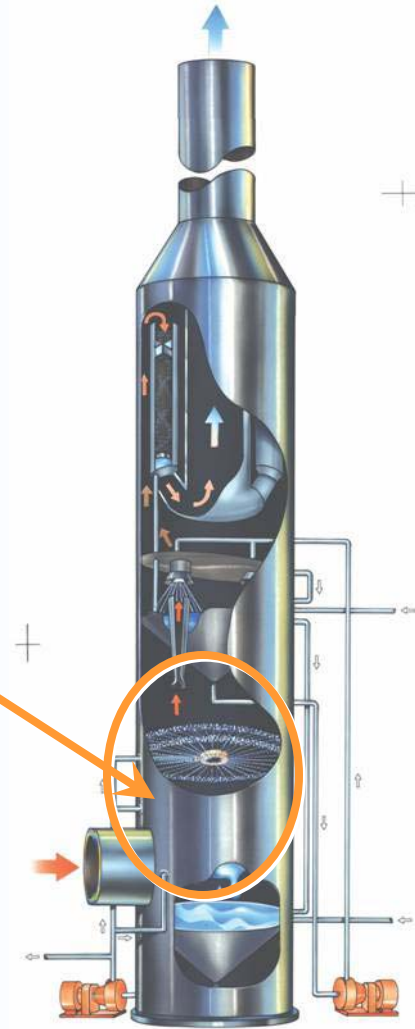
- Designed to fully saturate gas
- Unique design minimizes Wet/Dry interface
- Can be designed to allow the full regenerator temperatures

Step 2 – Reduction of SO₂ and Primary Particulate Control is achieved in the Absorber Section

The EDV[®] Absorber Section



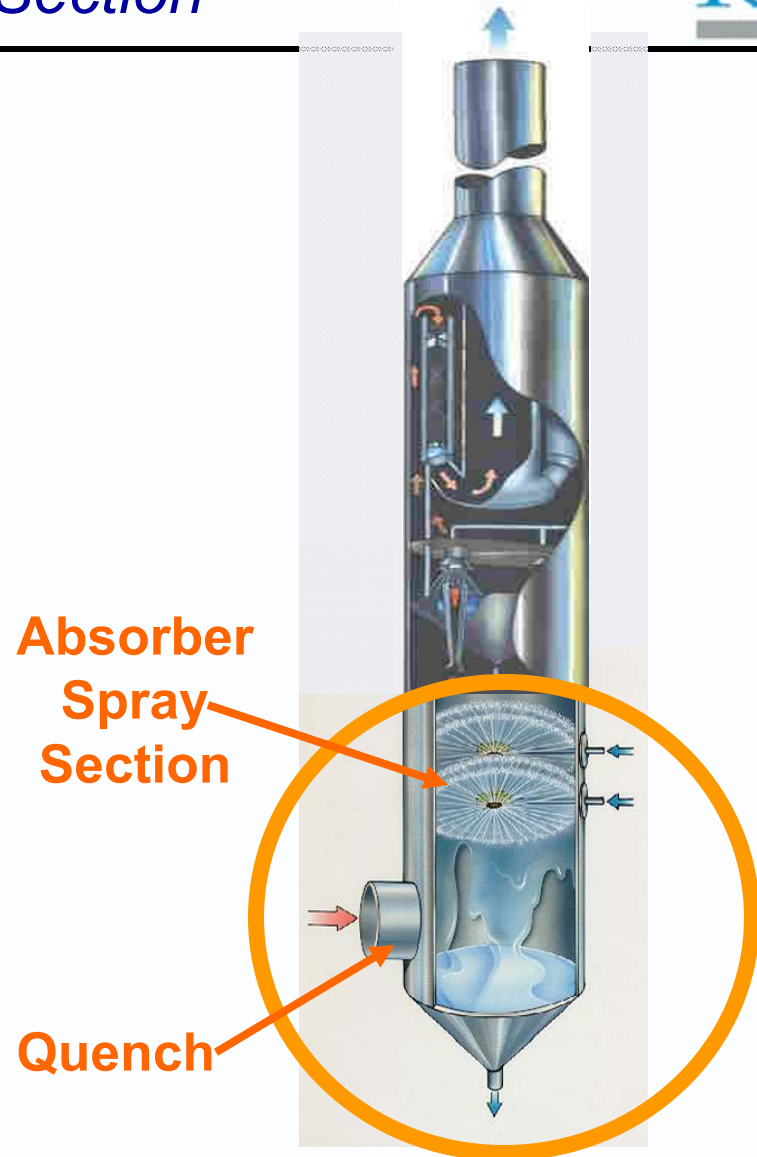
Absorber Section



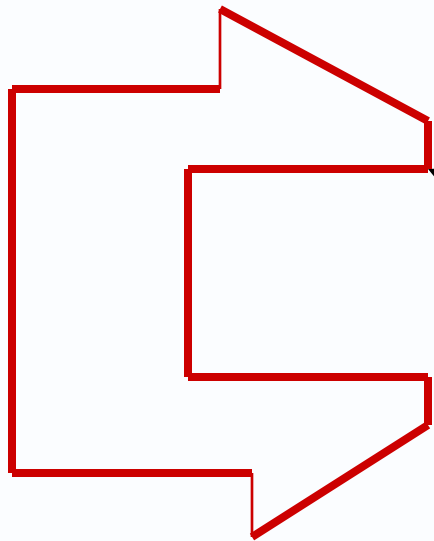
The EDV® Absorber Spray Section

Absorber Spray Section

- **SO₂ & PM Removal**
 - Liquid / Gas Contact
 - Staged Approach
- **Open Tower Design**
- **Self Cleaning**
- **No Mist Formation**
- **Low Pressure Drop**

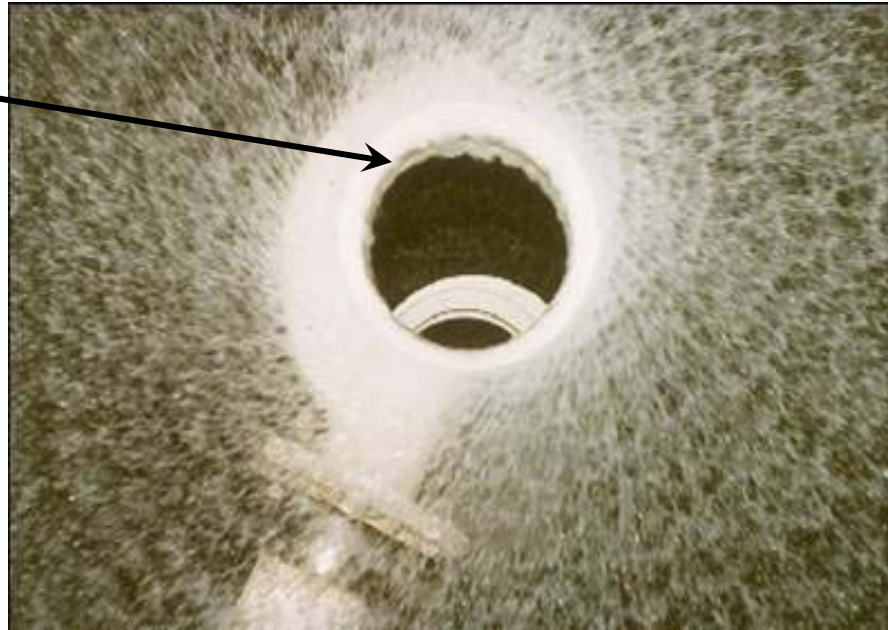
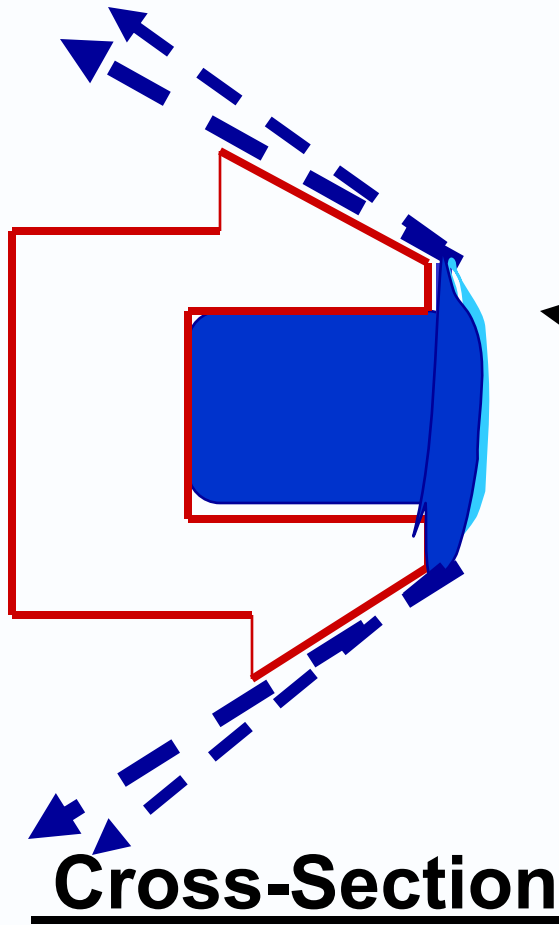


The EDV[®] G[®] Nozzle



Cross-Section

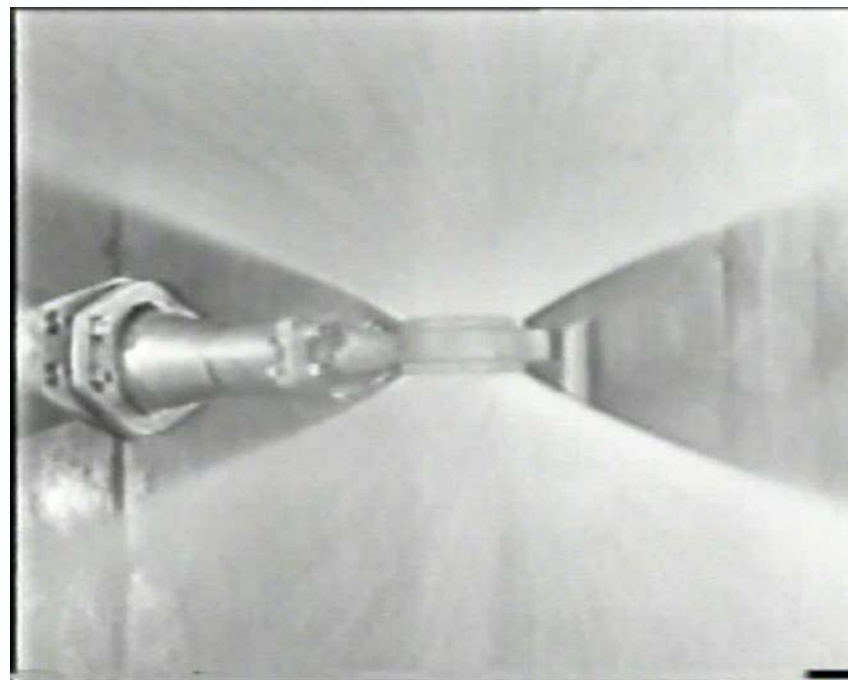
The EDV[®] G[®] Nozzle



Plan View



Side View



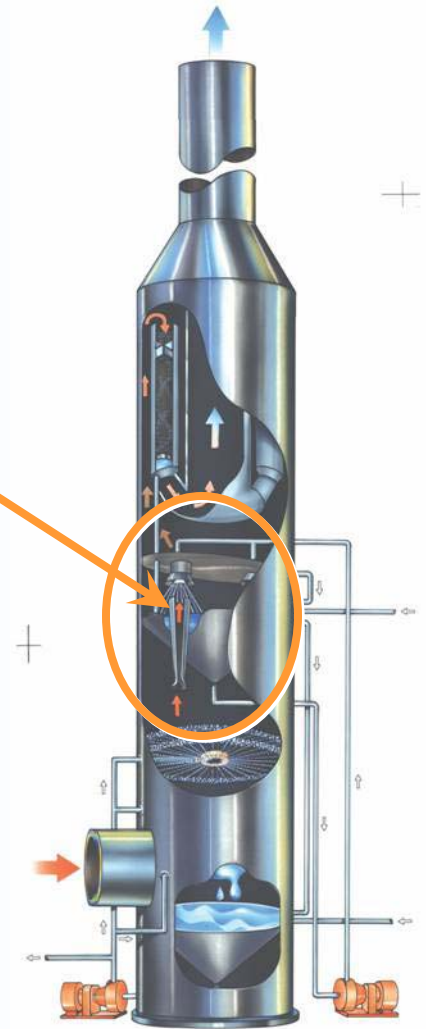
Step 3 – Further reduction of fine particulate (PM 2.5 and below) and further reduction of SO₂ / and SO₃ is achieved in Filtering Modules

EDV[®] Wet Scrubbing System



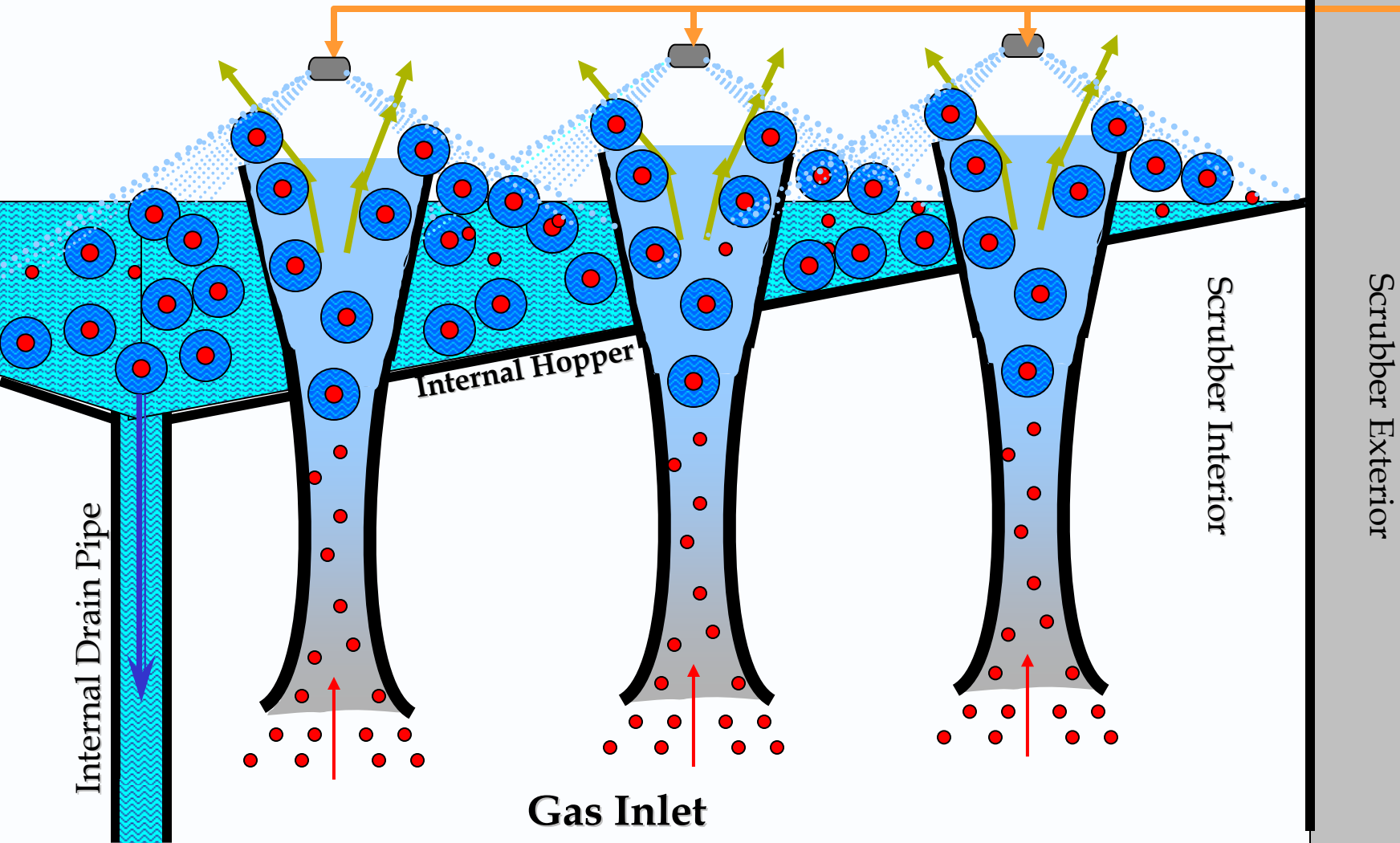
Filtering Modules

(FM's are applicable only to EDV 5000 and 6000 models)



Multiple Modules in Each Scrubber

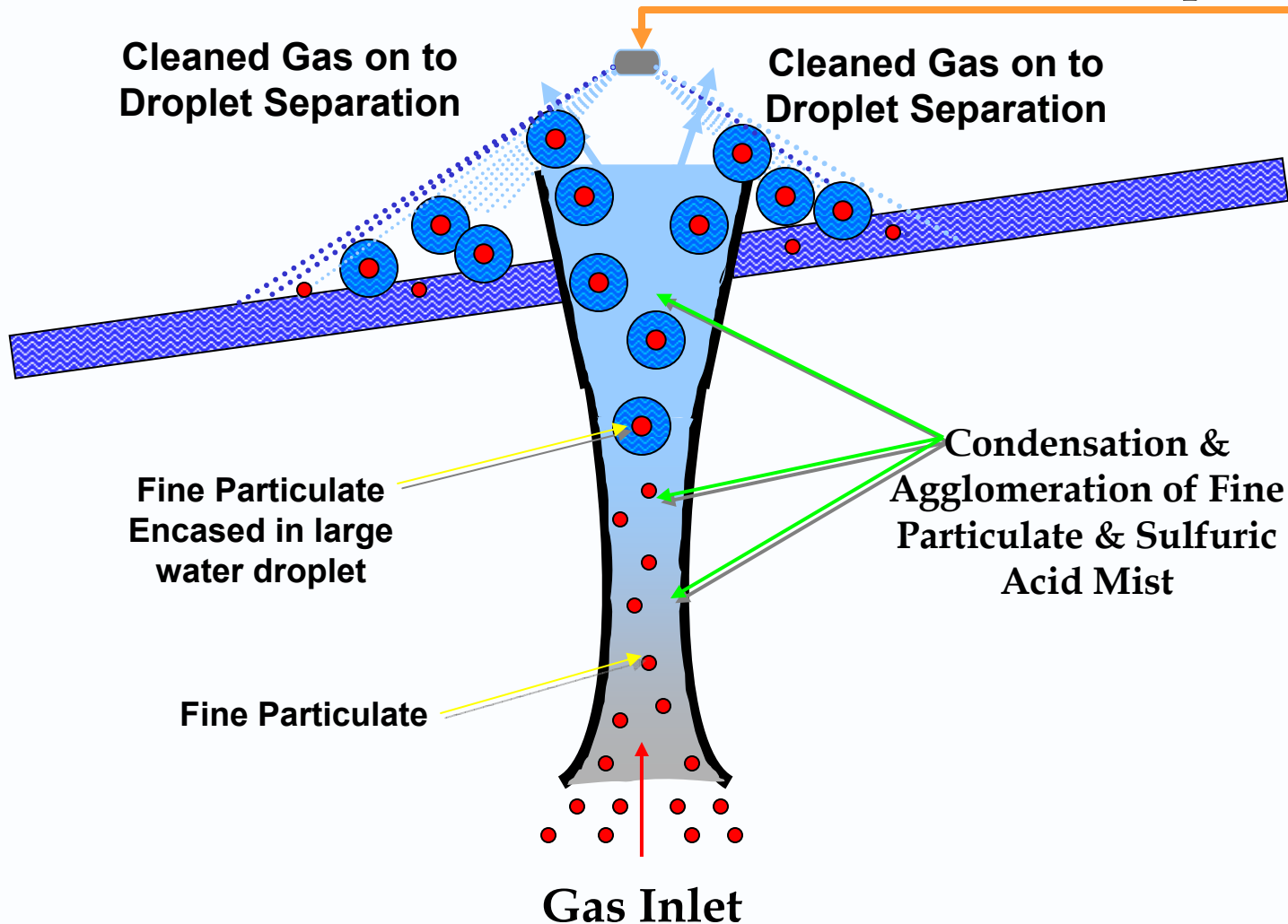
Efficient and Reliable Fine Particulate Control



EDV[®] 5000 Filtering Module

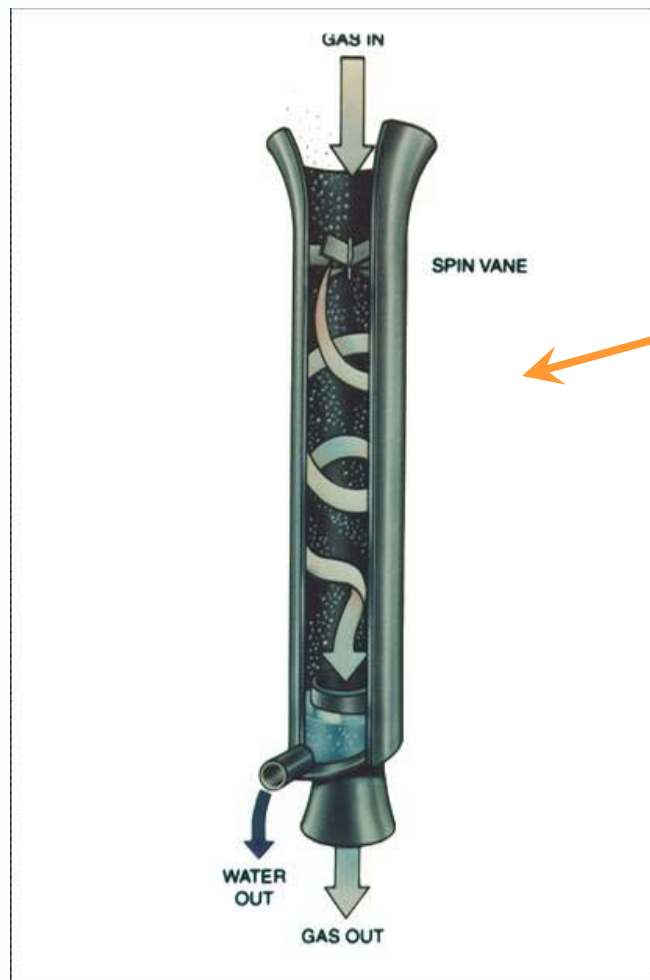
Efficient Fine Particulate Control

Liquid to Spray

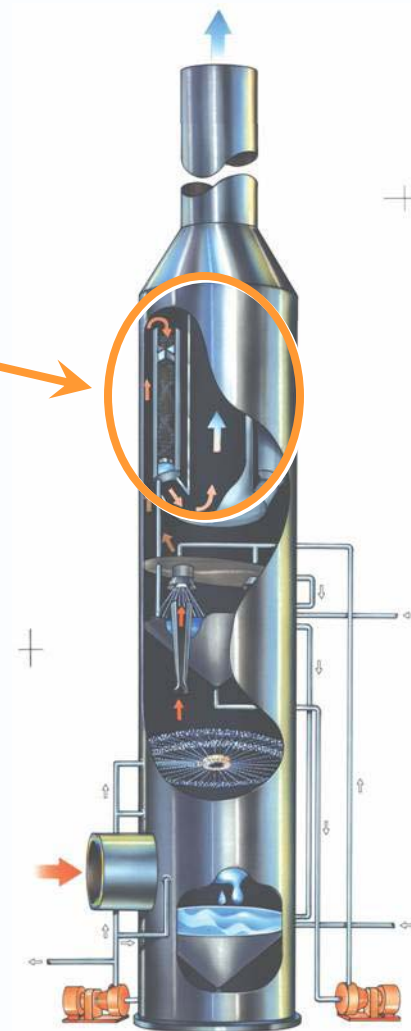


Step 4 – Removal of entrained droplets
prior to exit through stack

EDV[®] Wet Scrubbing System

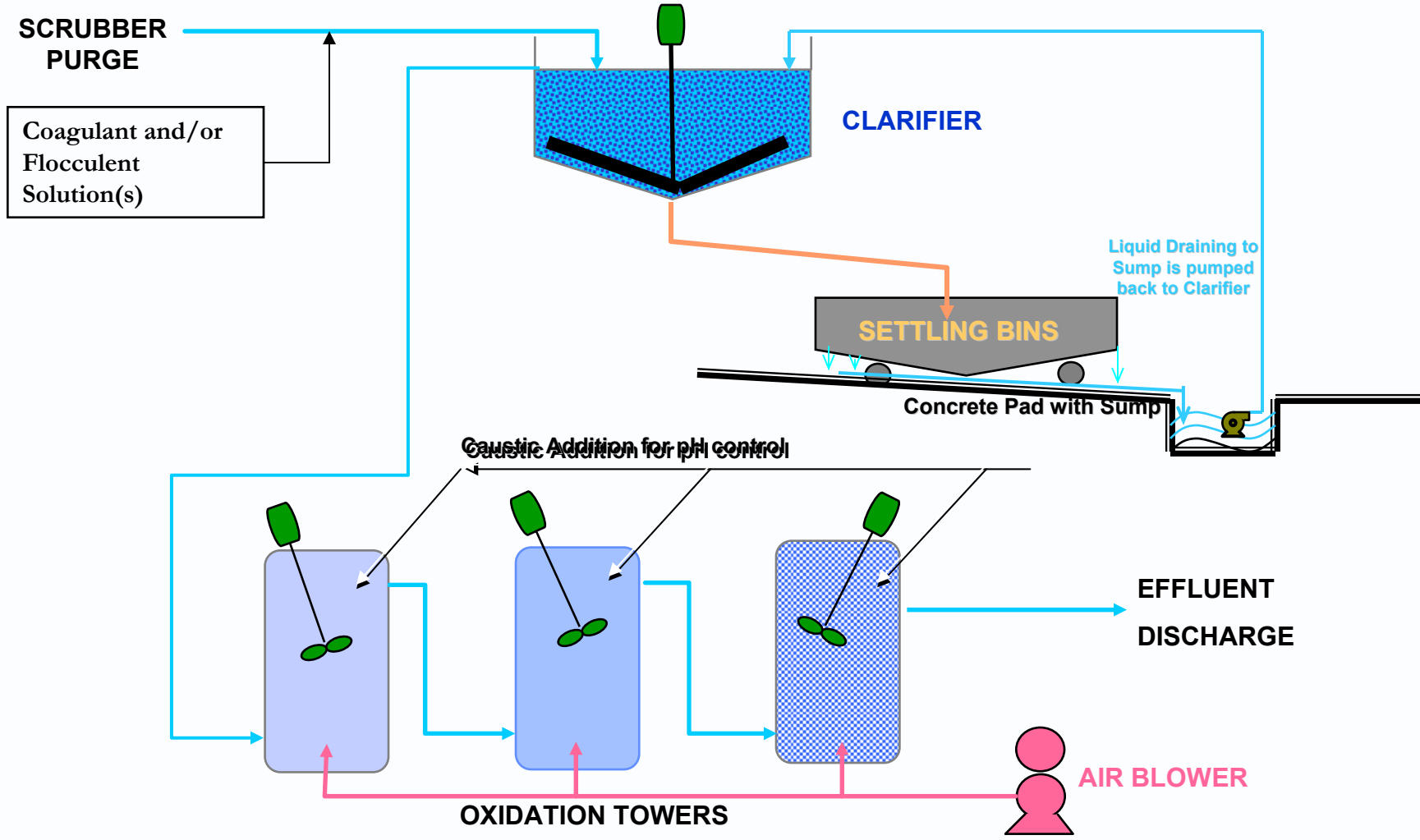


Droplet Separators

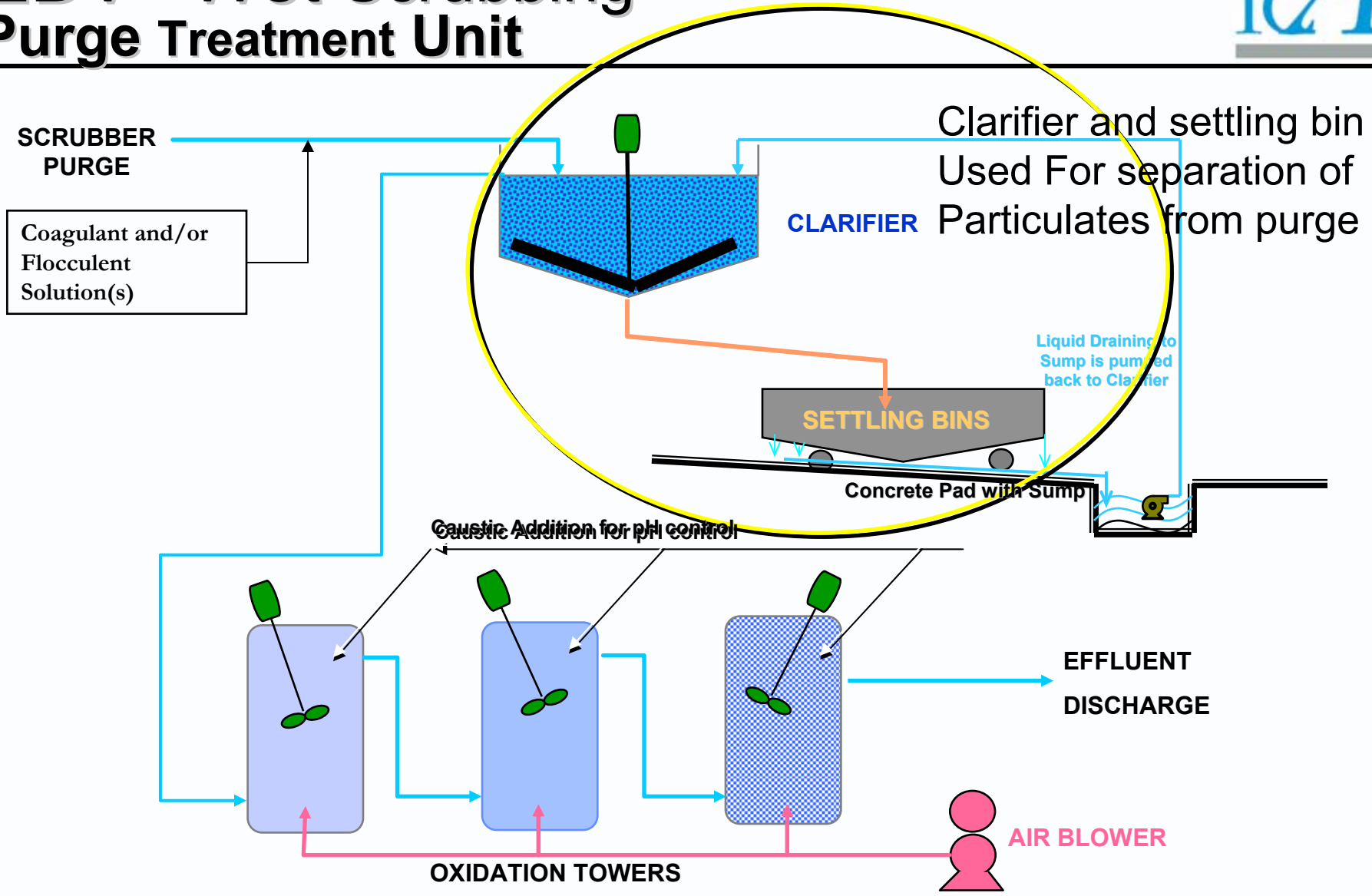


Step 5 – Treatment of Scrubber Purge in Purge Treatment Plant (PTU)

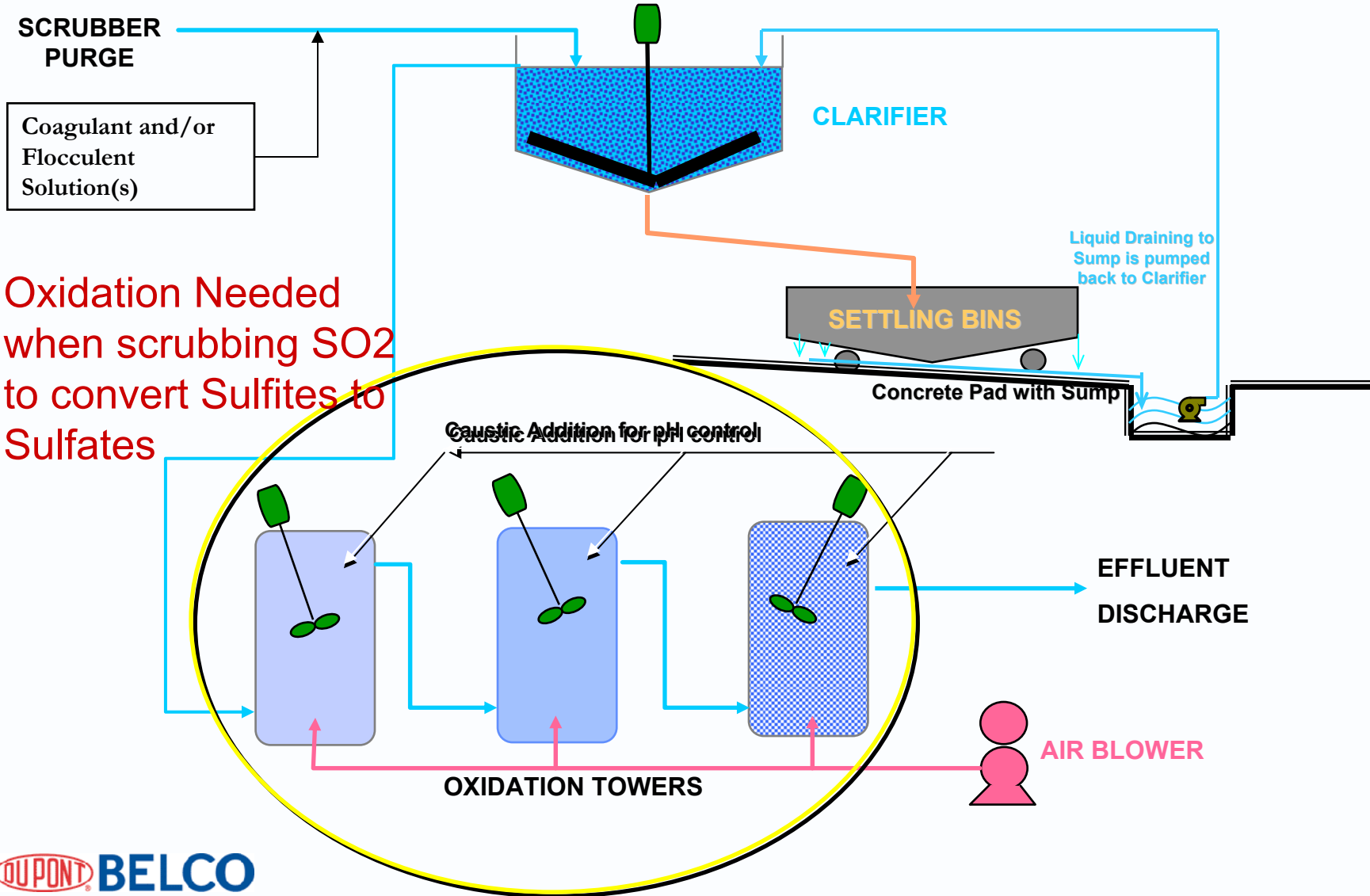
EDV[®] Wet Scrubbing Purge Treatment Unit



EDV[®] Wet Scrubbing Purge Treatment Unit

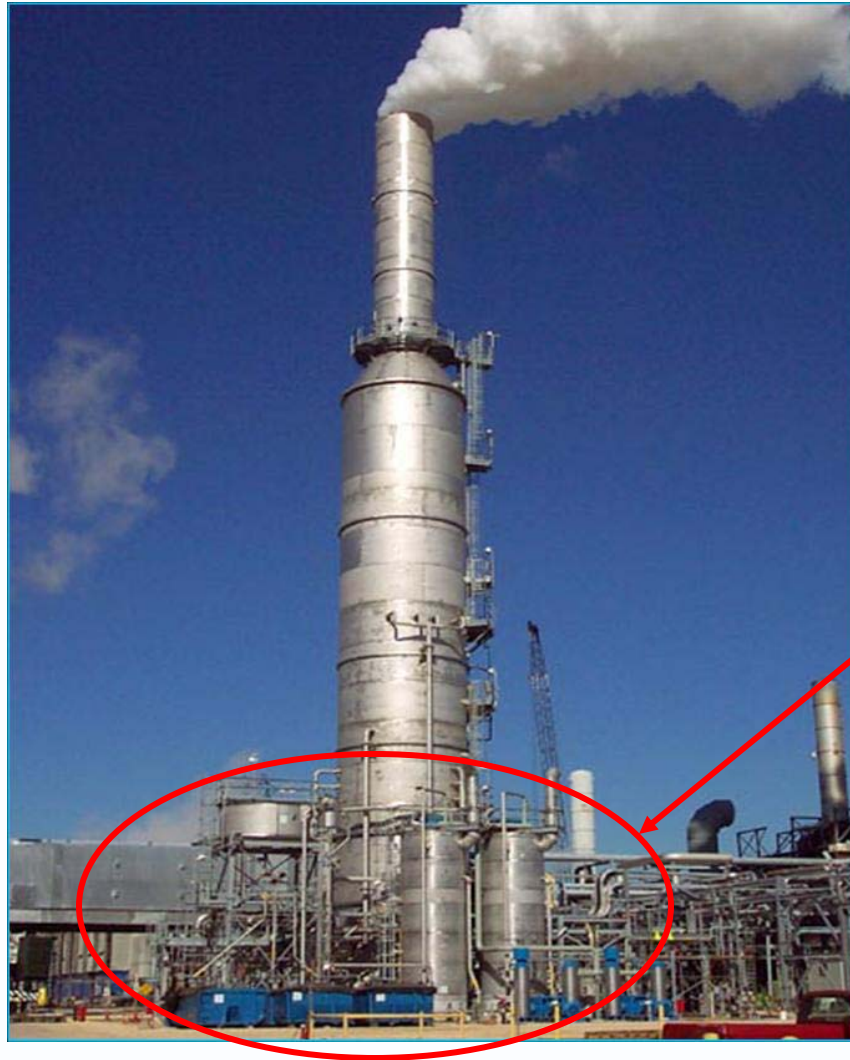


EDV[®] Wet Scrubbing Purge Treatment Unit



Oxidation Needed when scrubbing SO₂ to convert Sulfites to Sulfates

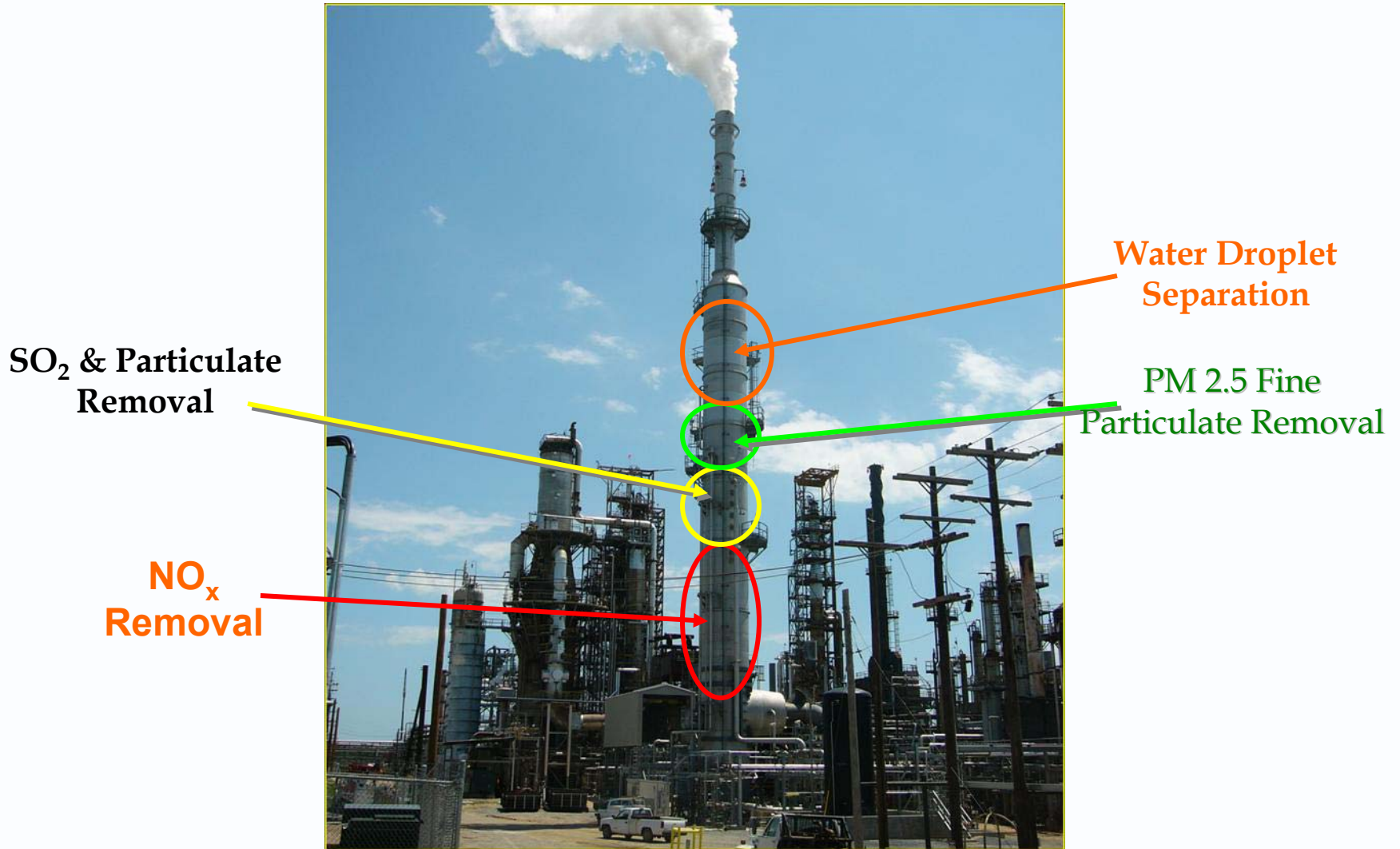
EDV[®] Purge Treatment Unit (PTU)



**Purge
Treatment
Unit**

NO_x Reduction with EDV[®] + LoTOx[™] **-- Low Temperature Oxidation --**

EDV[®] Wet Scrubber with LoTO_x[™] on FCCU

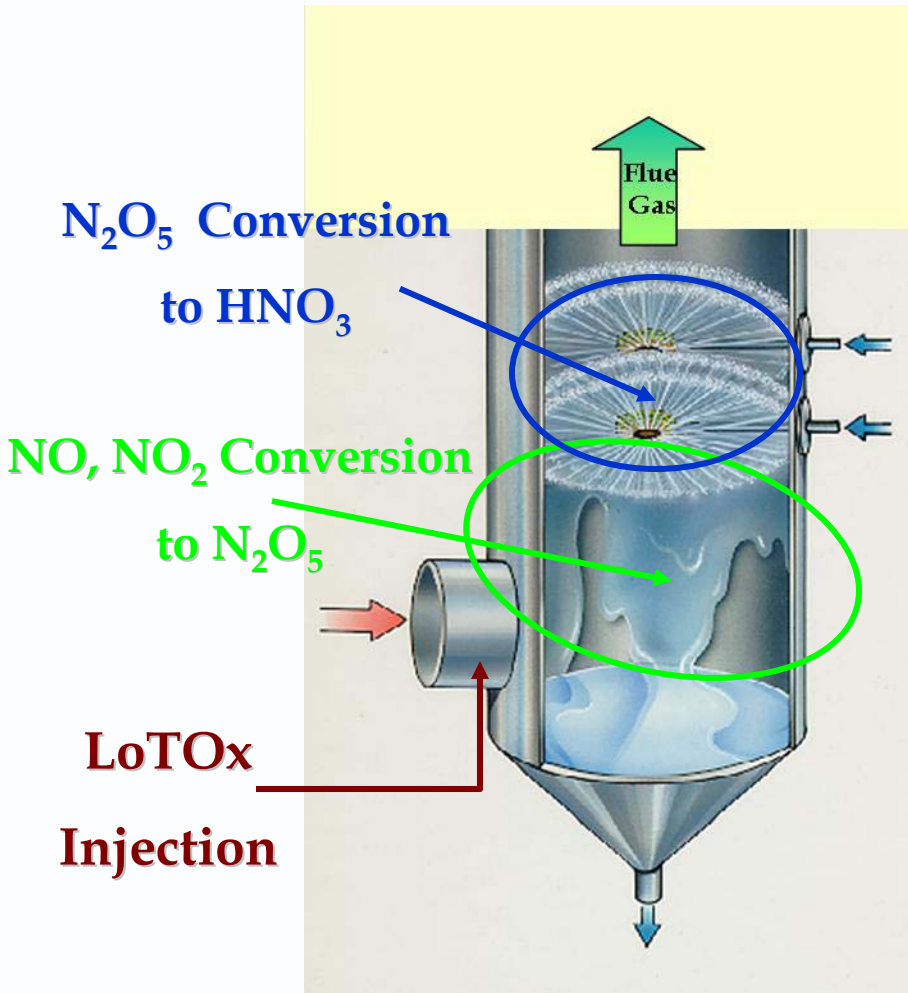


LoTOx™ NO_x Reduction Technology



- LoTOx™ is sold to refineries worldwide by BELCO® under license from The BOC Group
- Patented Process of Injecting Ozone into gas stream to control NO_x. Applied following Quench in EDV® Scrubbing System
- At Saturation Temperature and with proper mixing and residence time Ozone Reacts with NO_x to Form N₂O₅
- Contact with liquid droplets Forms Nitric Acid
- Nitric Acid is Stabilized with Caustic to Form Sodium Nitrate
- **Greater than 90% reduction of NO_x is achieved**
- Commercialized in refinery applications. First commercial FCCU application was in May 2006. Many installations since then.
- Successfully applied to refinery FCCU and many other processes
- NOT susceptible to plugging, poisoning, masking or deactivation

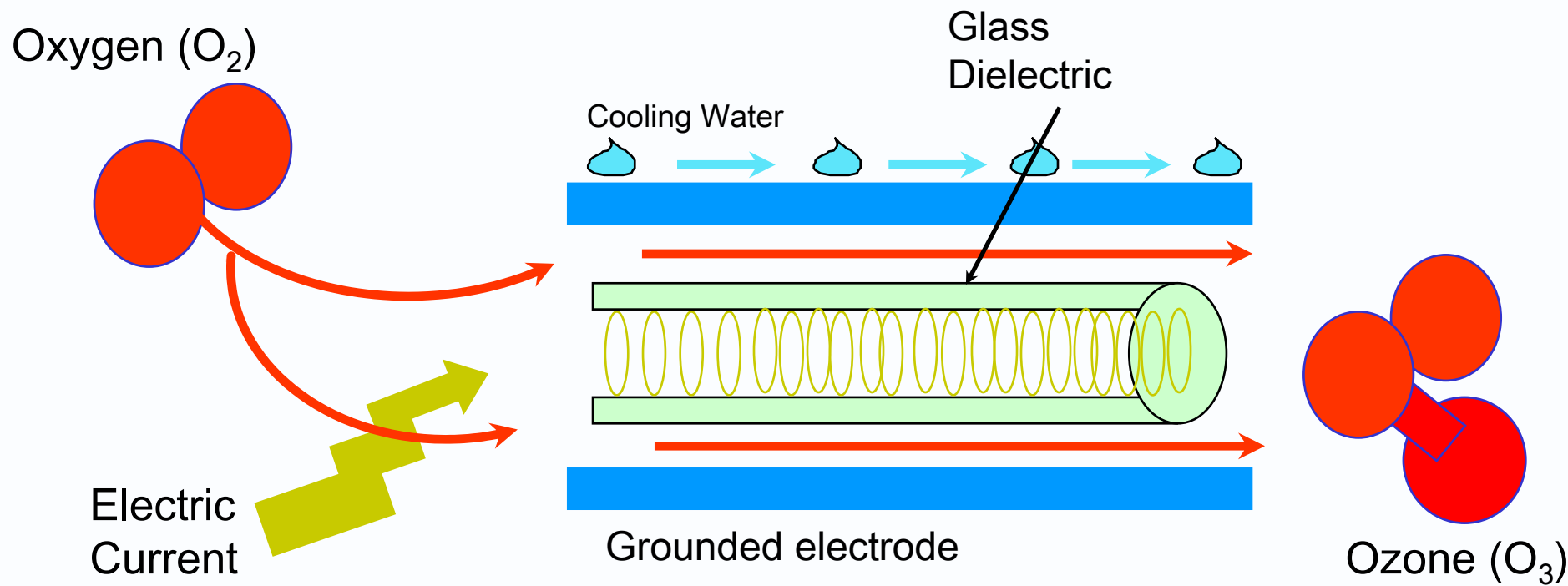
EDV[®] Wet Scrubbing Spray Tower for LoTO_x[™]



- **Ozone Injection after Quench**
- **Conversion to N₂O₅**
- **Conversion to Nitric Acid**
- **Conversion to Sodium Nitrate**
- **More than 90% NO_x reduction is achieved**
- **No problems such as SCR catalyst poisoning, deactivation, sintering and no SO₂ to SO₃ conversion**
- **Able to operate all the time even during boiler bypass**

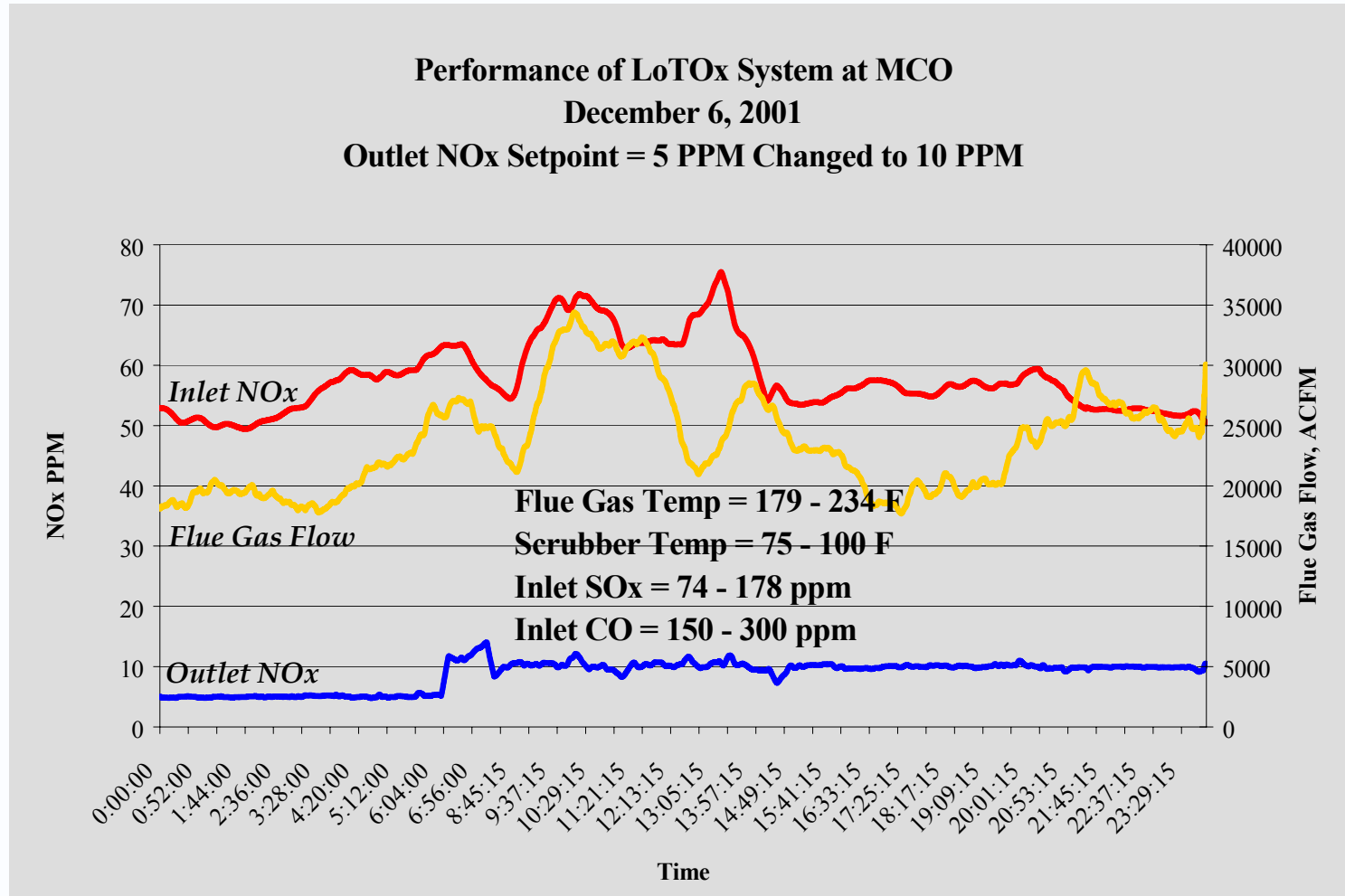
LoTO_x[™] is sold to refineries worldwide by BELCO[®] under license from The BOC Group

Cross-Section of Single Ozone Generator Cell

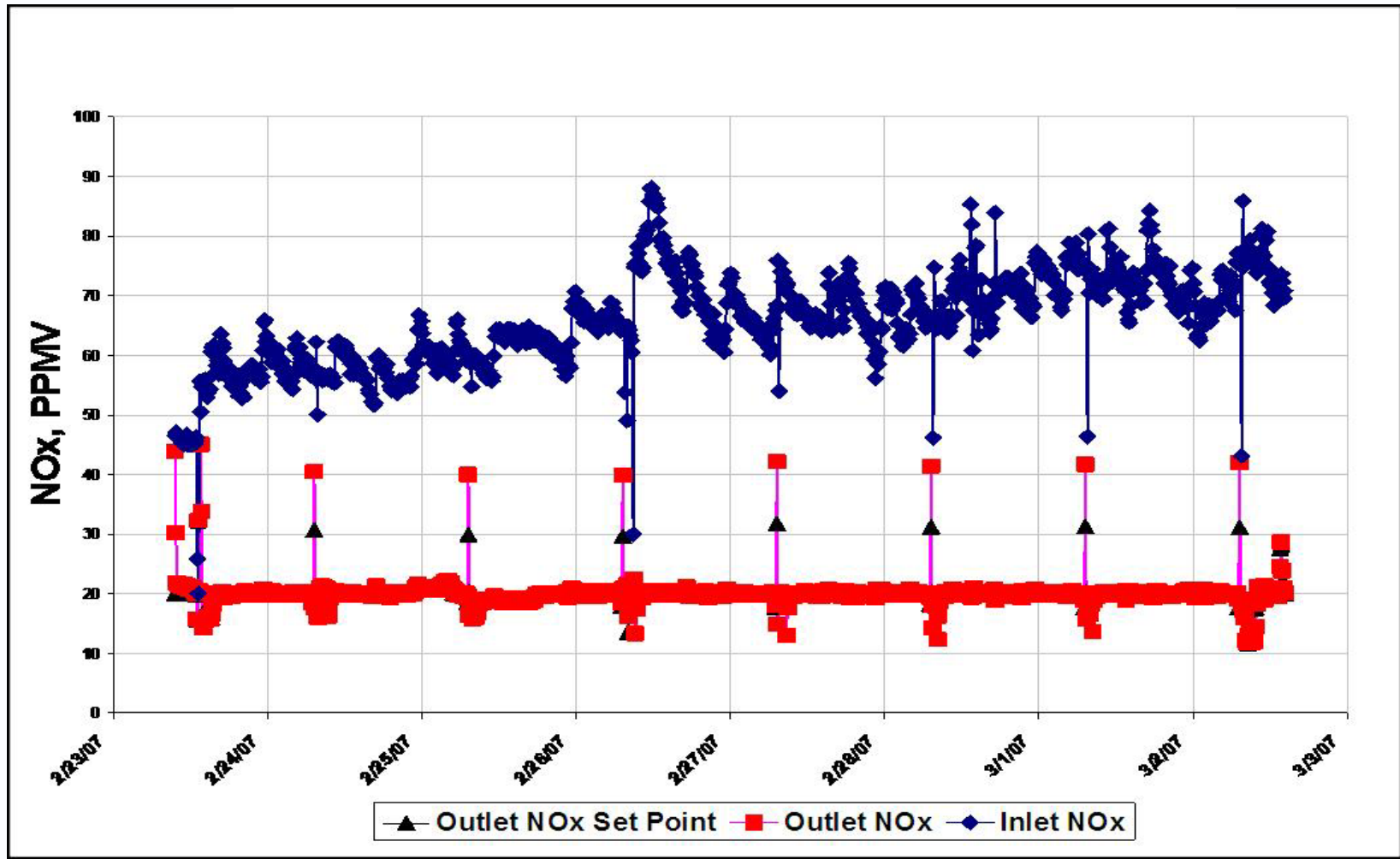


LoTOx™ Ozone Generator

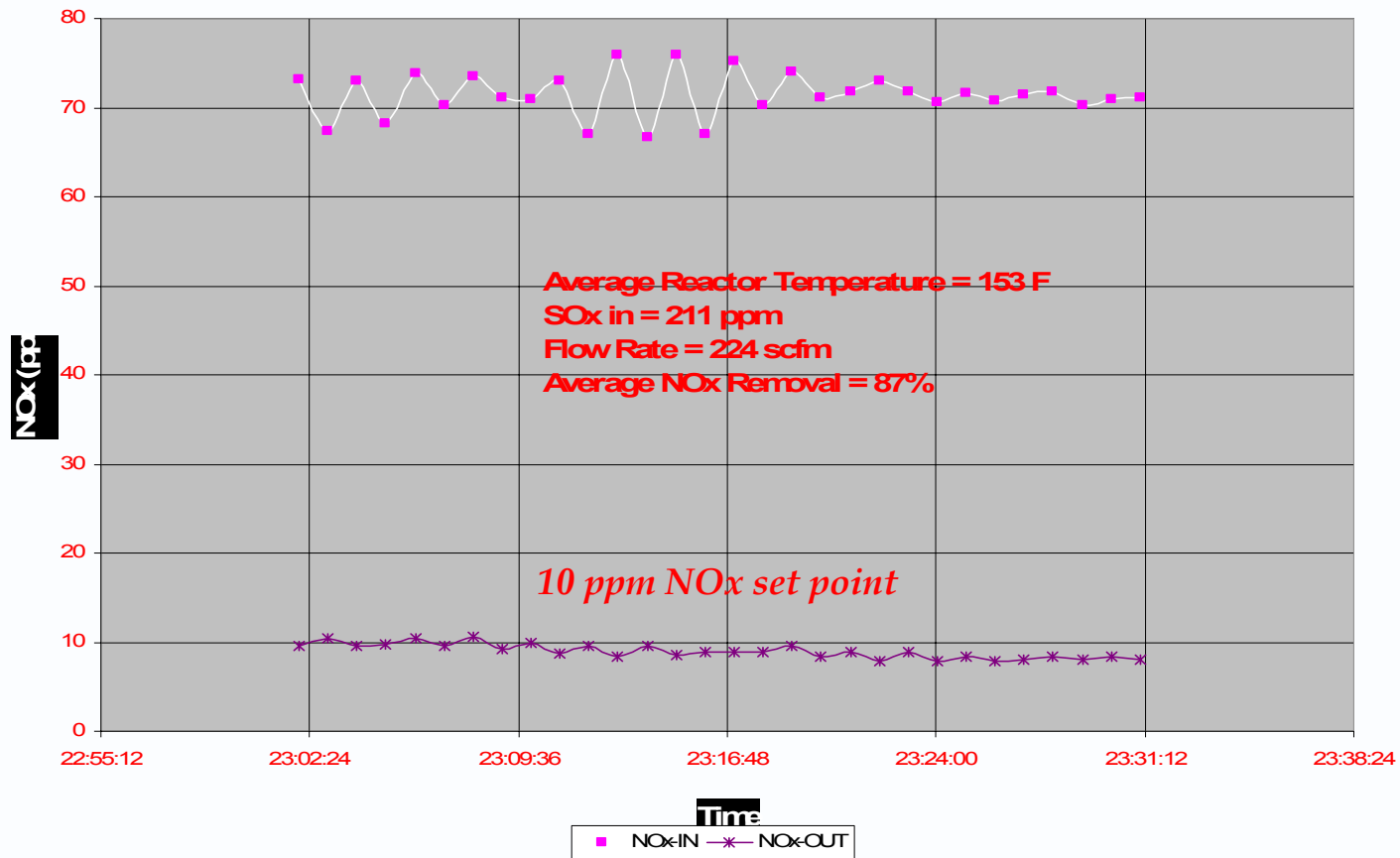




LoTOx™ data – Refinery FCCU



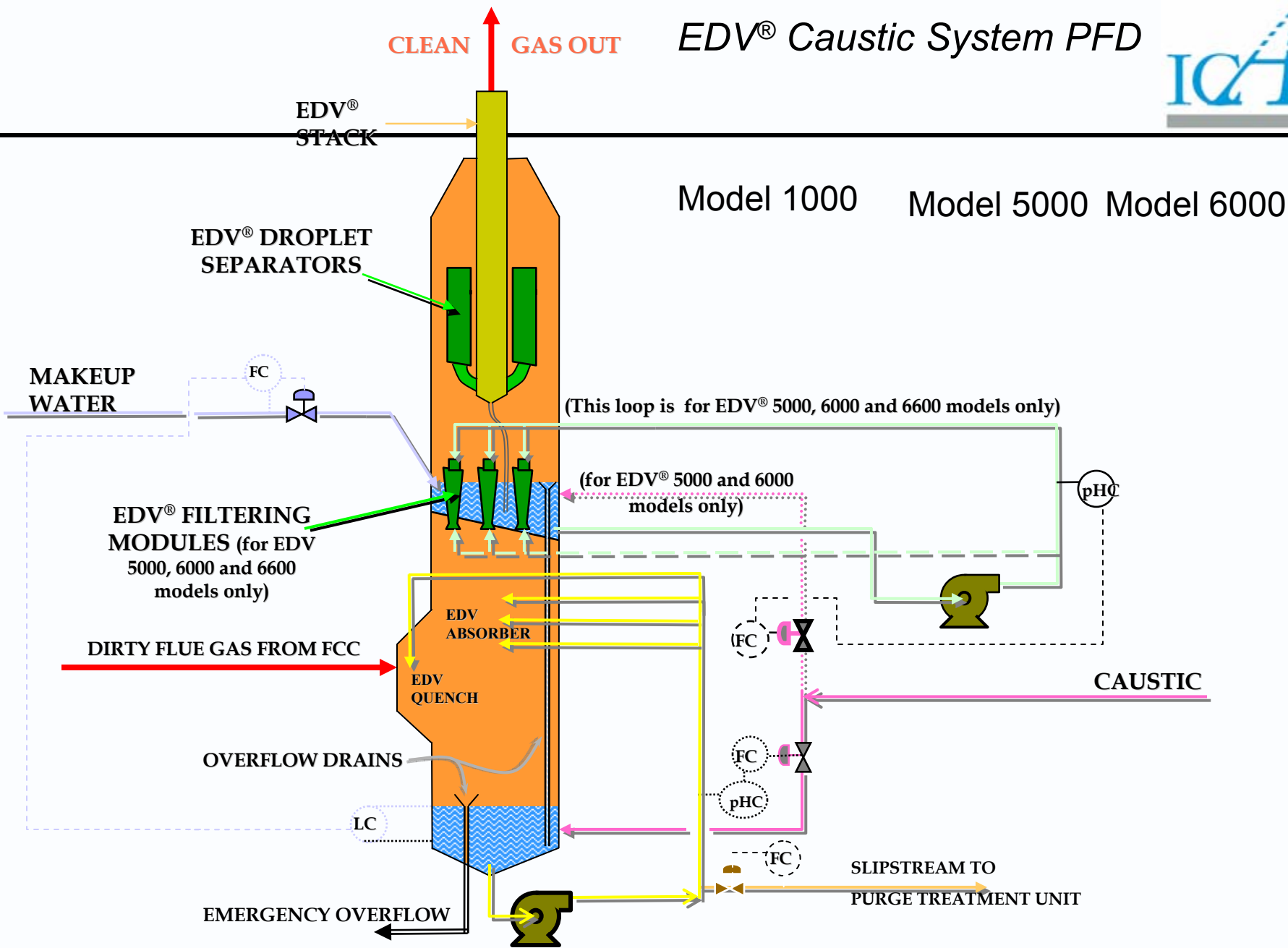
Demonstrated Performance



Simplified PFD

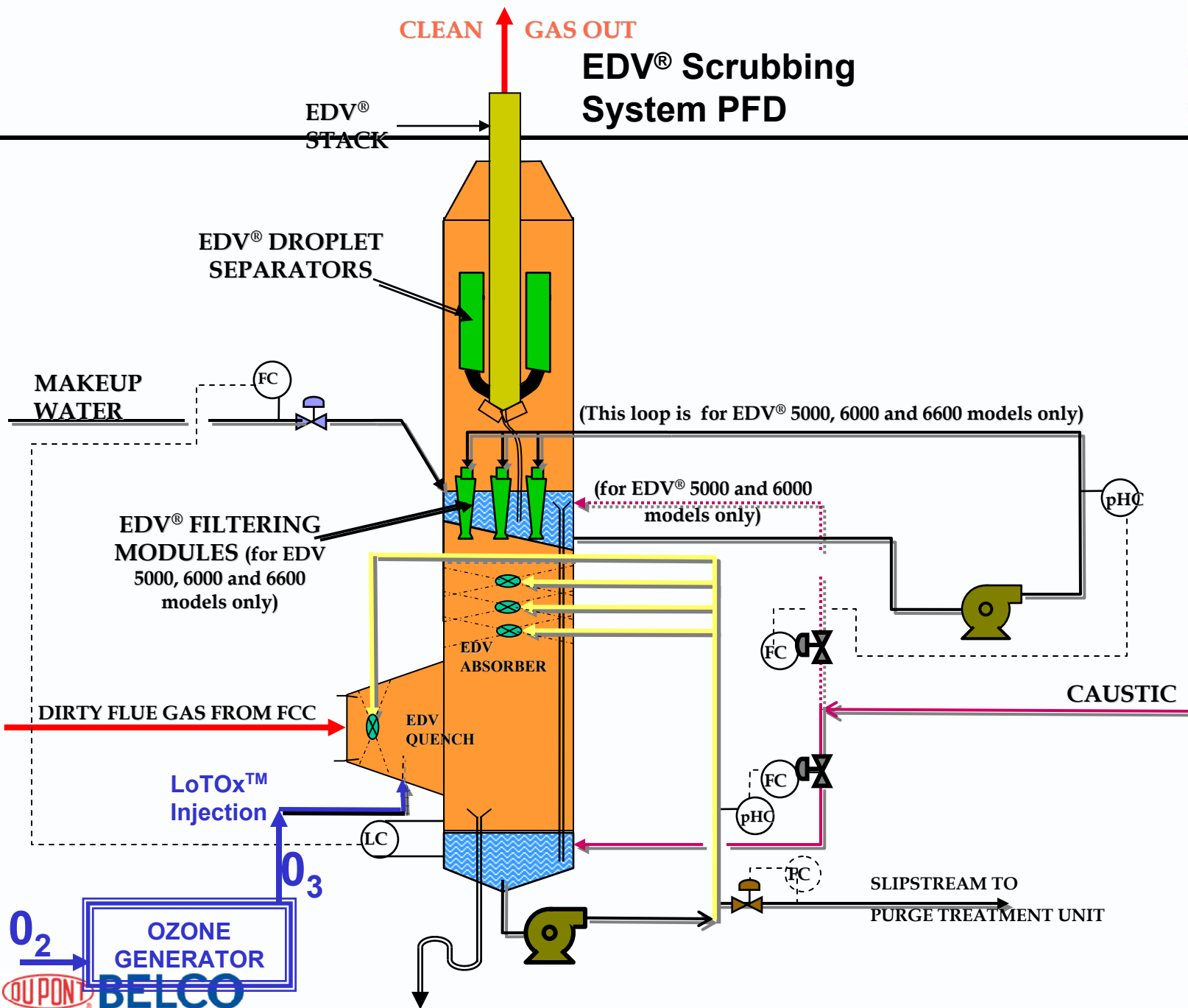
EDV[®] Caustic System PFD

CLEAN GAS OUT



CLEAN GAS OUT

EDV® Scrubbing System PFD



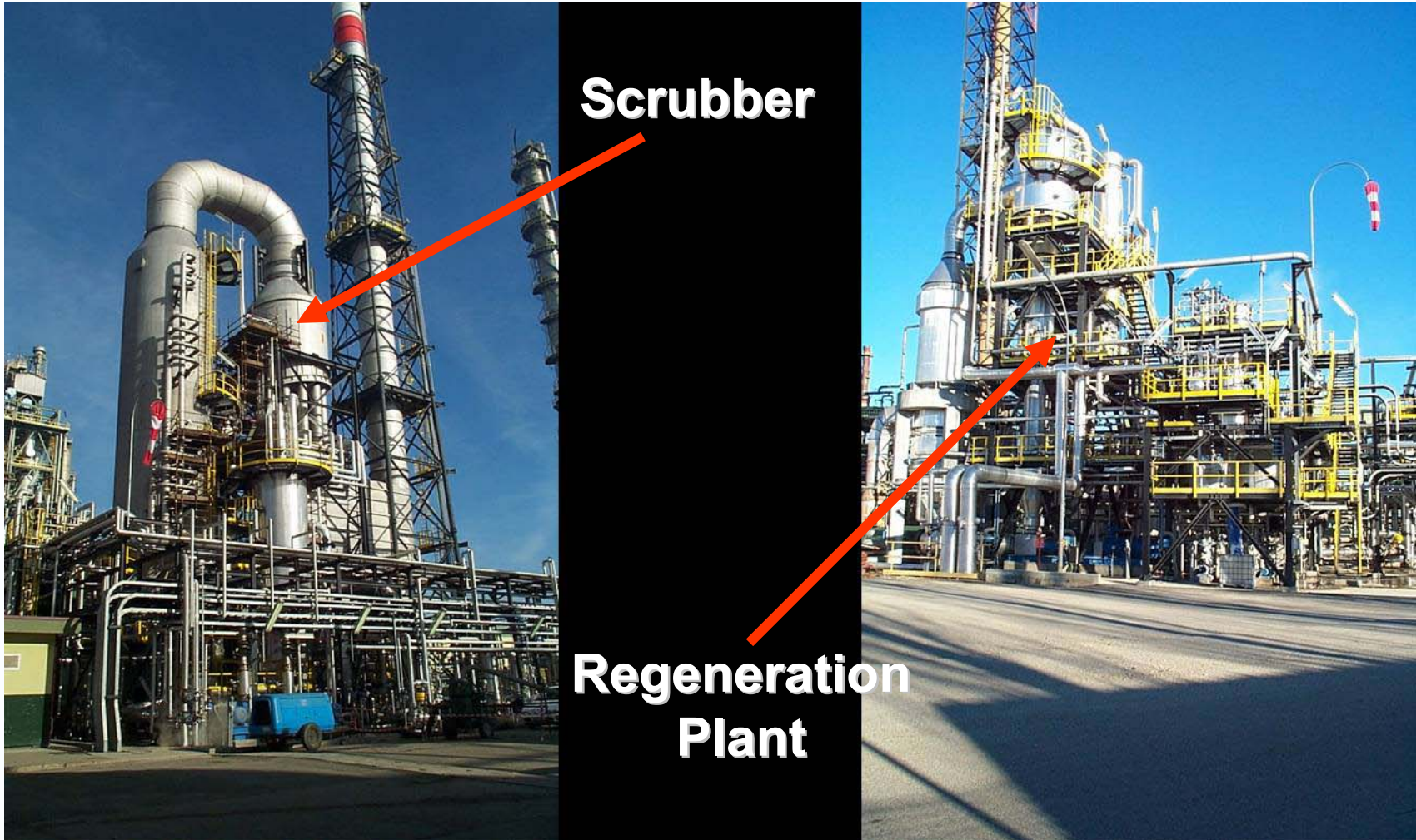
EDV[®] scrubbing with LoTOx[™] Process

Ozone Injection Grid in Quench Section



Liquid Discharge elimination using the **BELCO LABSORB™ System**

LABSORB™ Regenerative SO₂ Scrubbing System



Scrubber

**Regeneration
Plant**

- **Sodium Phosphate Solution (“buffer”) used to absorb SO₂**
- **Buffer is Regenerated and sent back to the absorber to scrub SO₂**
- **Only product from regeneration is a concentrated SO₂ stream that is then converted to elemental sulfur or sulfuric acid**
- **Reduces load on Waste Water Treatment Plant**
- **Reduced Reagent Cost (Caustic)**
- **Enhanced Recovery (Sulfur)**

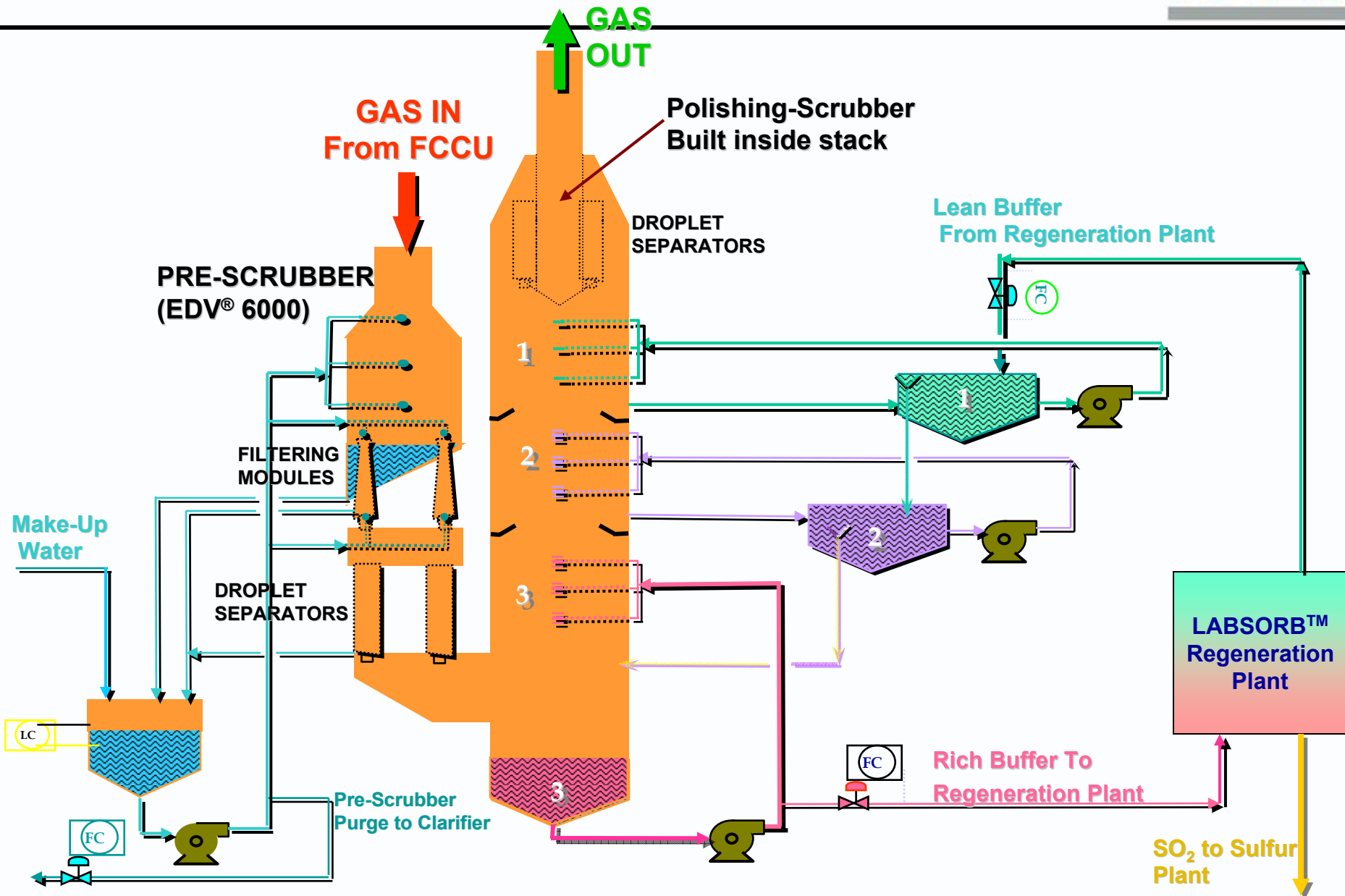
Basics - Regeneration Side

- *Buffer Regenerated using Evaporation with low pressure steam*
- *Sulfates and heat stable salts formed from SO_3 and oxidation of SO_2 are removed as a solid by a patented process*
- *Less than 3% buffer loss*

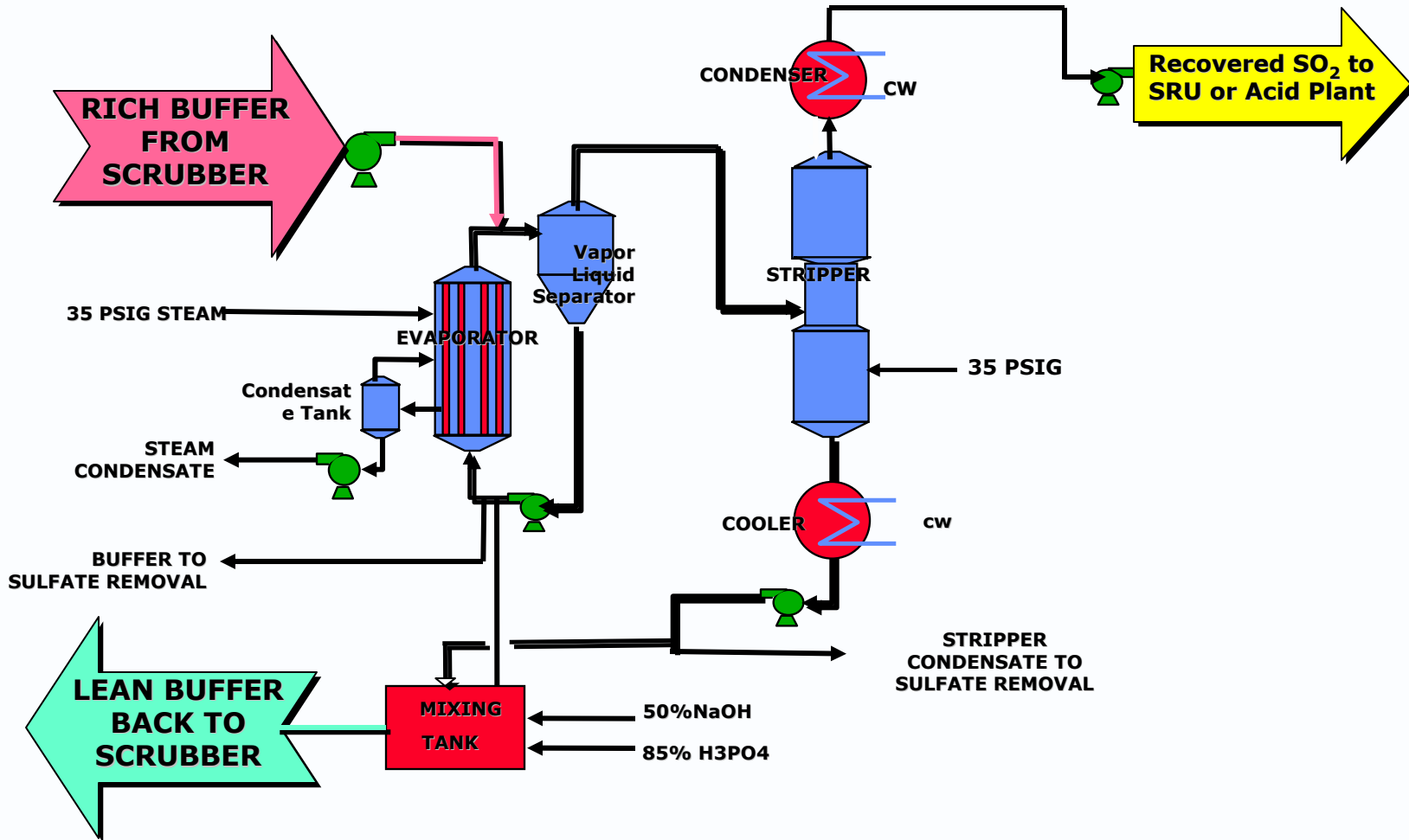
- Installed 9 years ago as SRU tail gas treater at a Refinery in Europe
- Operating on a 40,000 bpsd FCCU in Italy since June 2003
- Operating on a 60,000 bpsd FCCU in the USA since October 2004



LABSORB™ Absorber and Full Pre-scrubber



LABSORB™ Regeneration Plant (simplified) “SINGLE EFFECT” EVAPORATION



QUESTIONS?



The miracles of science™