

# Worldwide Pollution Control Association

WPCA/LG&E and KU

Coal-fired APC Environmental Seminar

May 23-24, 2017

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A



Visit our website at [www.wpca.info](http://www.wpca.info)



## WPCA-LG&E Seminar

Where is Catalytic Emission Technology  
Going?

May 24, 2017

# Our founder, Dr. Haldor Topsoe, had an infectious passion for science and a determination to prove it could make a difference



We invest in both fundamental research,

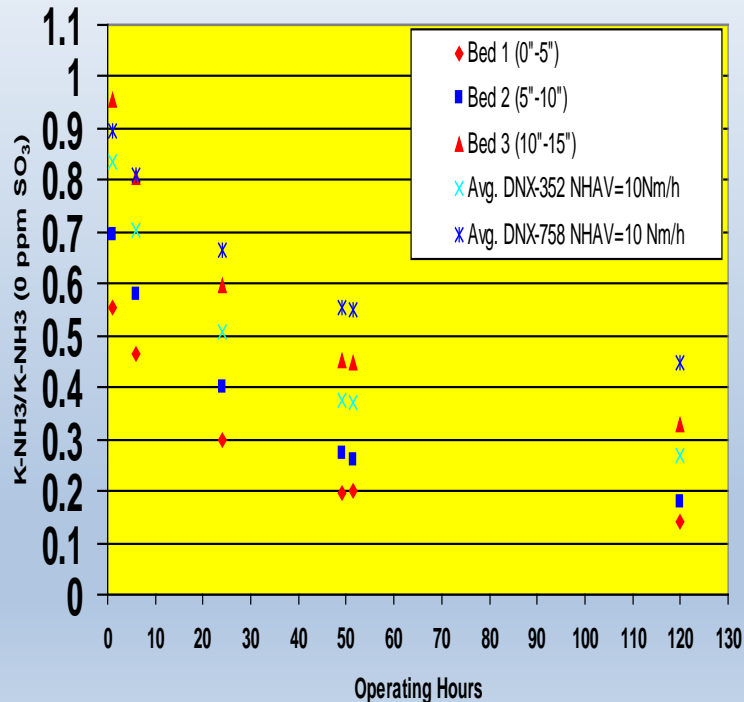
- spending more than 10% of our revenue on R&D,
- we currently have over 50 world-class scientists,
- in collaboration with leading research bodies around the world, including universities in the U.S., Russia, Spain and other research institutes.

All to develop ***Sustainable*** air emissions control ***Technologies*** and ***Catalyst*** products

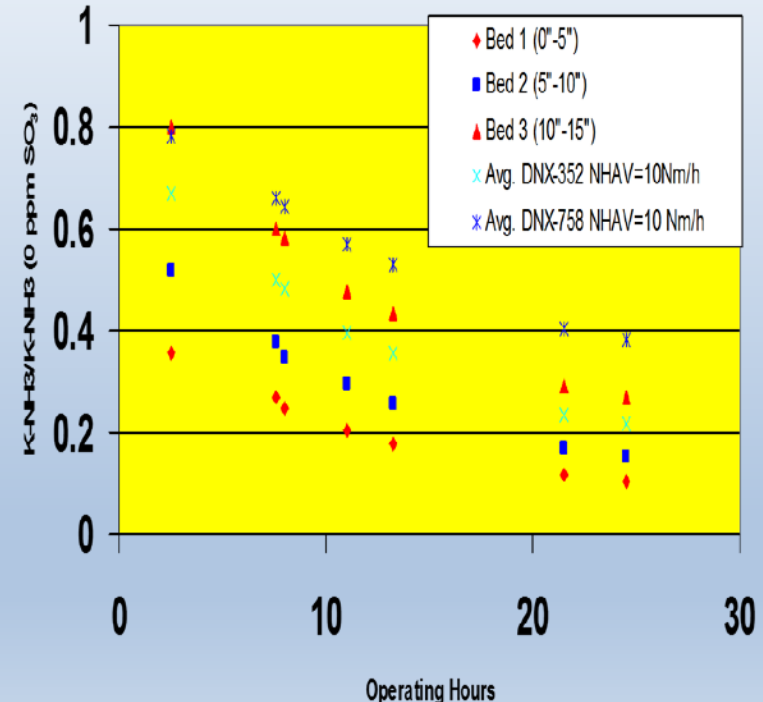
# Environmental Emission Technology

## SCR catalyst operation below the ABS Dew Point

AES Cayuga ABS Inhibition  
at  $T=T_{dew} - 14^{\circ}\text{F}$  ( $576^{\circ}\text{F}$ )



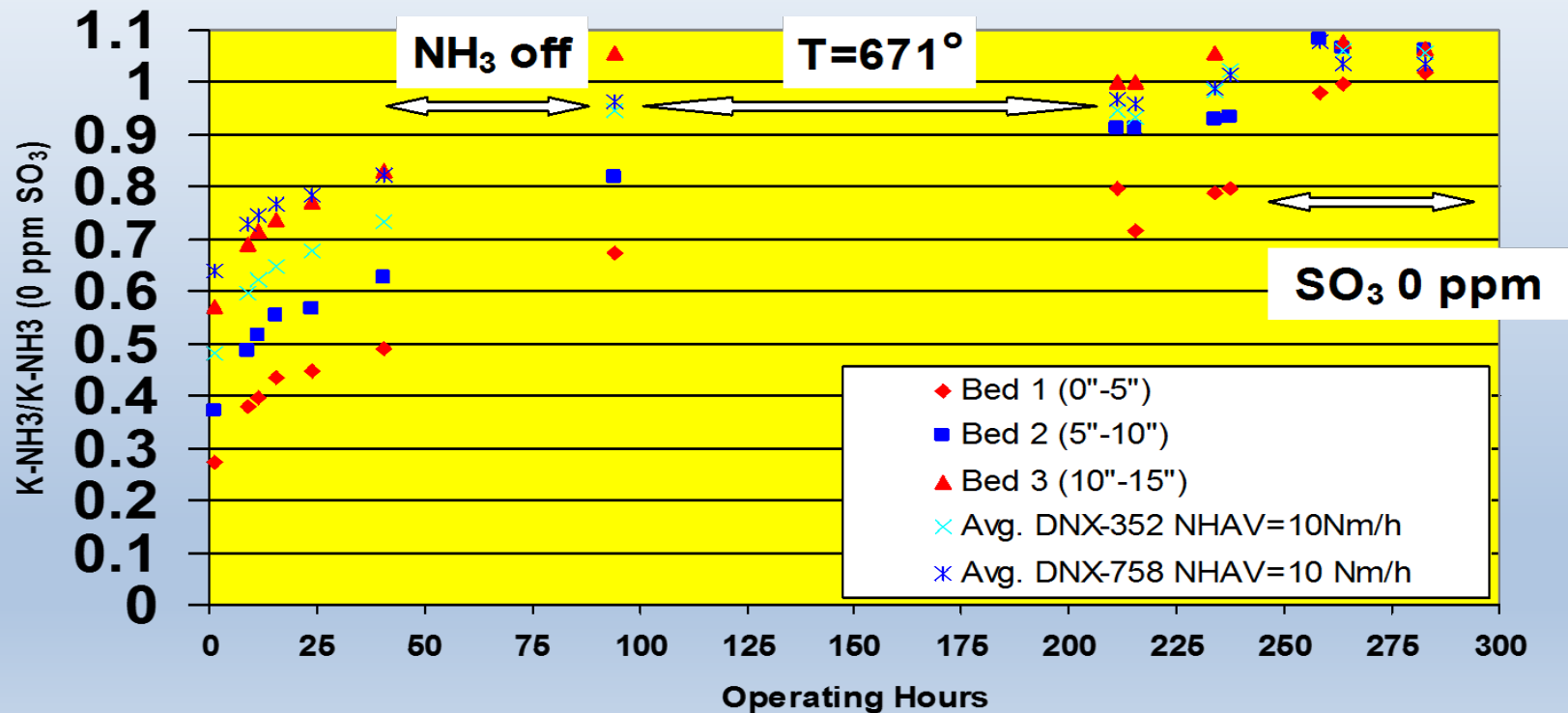
AES Cayuga ABS Inhibition  
at  $T=T_{dew} - 43^{\circ}\text{F}$  ( $547^{\circ}\text{F}$ )



# Environmental Emission Technology

## SCR catalyst operation below the ABS Dew Point

AES Cayuga ABS Regeneration  
from 547°F at T = 613°F



# Environmental Emission Technology

## SCR catalyst operation below the ABS Dew Point

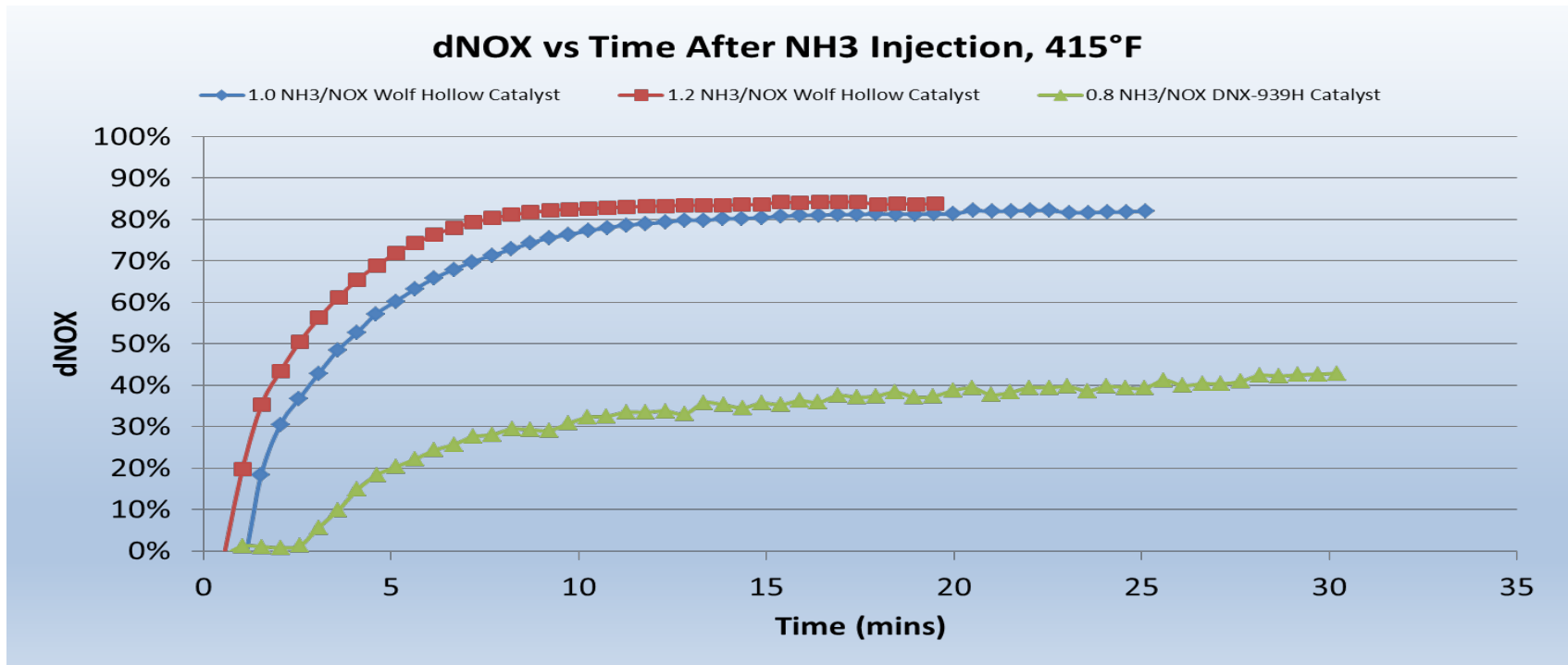
- 2 x 260 MWe, 2 x 300 MWe PC boilers, PRB fired
- Low Dust, Tail End SCR
- Vertical down flow
- NO<sub>x</sub> Inlet, 100 ppm
- NO<sub>x</sub> reduction, 57%
- SCR temperature 490°F
- Service Life – 32,000 Hours
- SCR inlet SO<sub>3</sub>, < 1 ppm (calc. ABS dew point greater than operating temperature)
- Install Date - 2011



# Environmental Emission Technology

## Low temperature SCR operation

- NOx catalyst that *does not form ABS*
- Highly active *low temperature* catalyst



# Environmental Emission Technology

## High dust catalyst strength



- XD & standard plate catalyst placed in unit for eight months
- Unit dust load over *30 grams/Nm<sup>3</sup>*
- EPC found XD catalyst was found to be more than *(4) times stronger* than standard catalyst
- Installed Spring, 2014

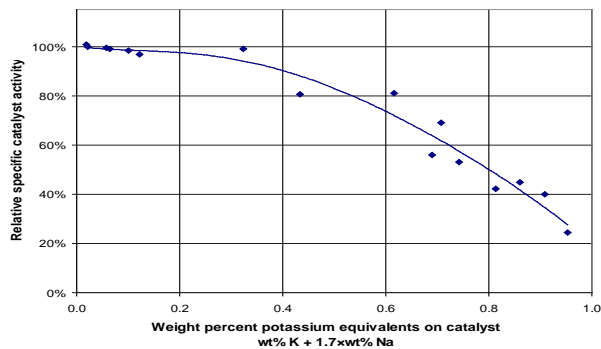


# Environmental Emission Technology

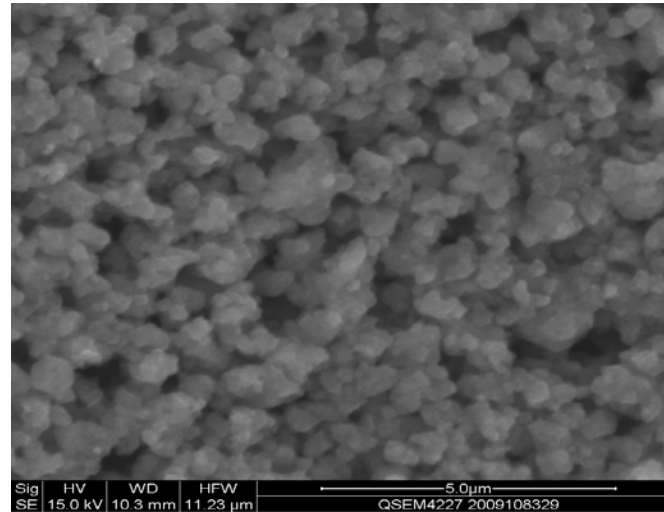
## Catalyst deactivation, higher poison resistance

### Test of sample after 6,500 hrs:

- Activity (k/k<sub>0</sub>): 97% at 482 °F
- Bulk chemical analysis:
  - Potassium:  
0.43% – 1.14% by weight

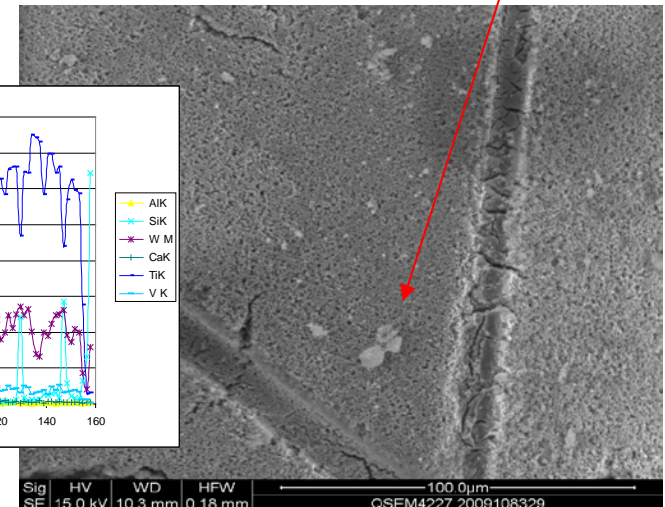
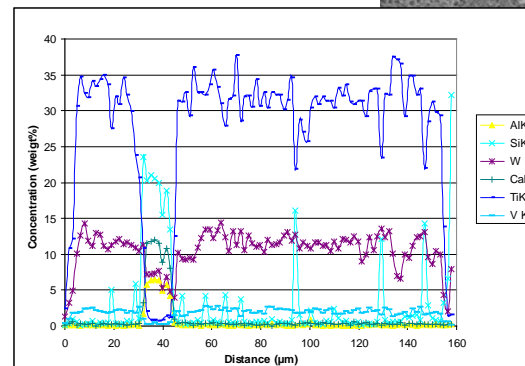


- Phosphorous:  
0.21% - 0.28% by weight
- No potassium in QSEM profile



Surface appears clean

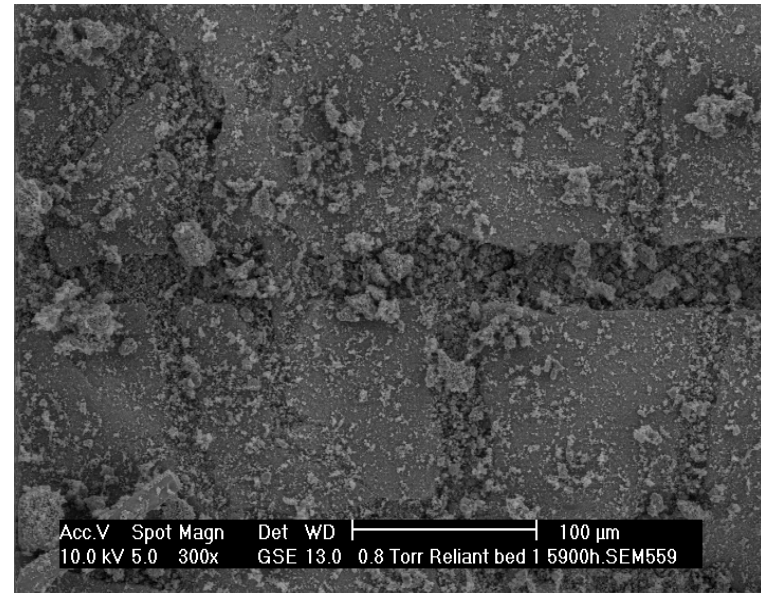
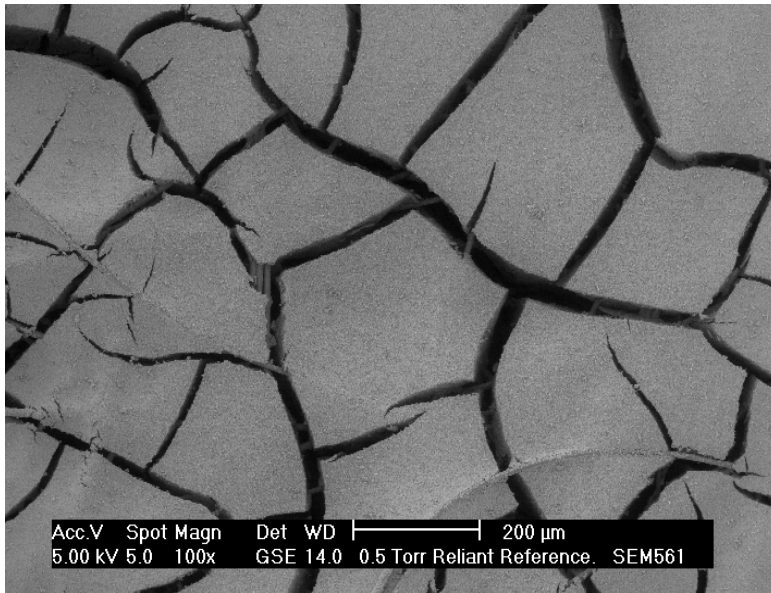
SEM:  
K-rich particles



# Environmental Emission Technology

## Catalyst deactivation, higher poison resistance

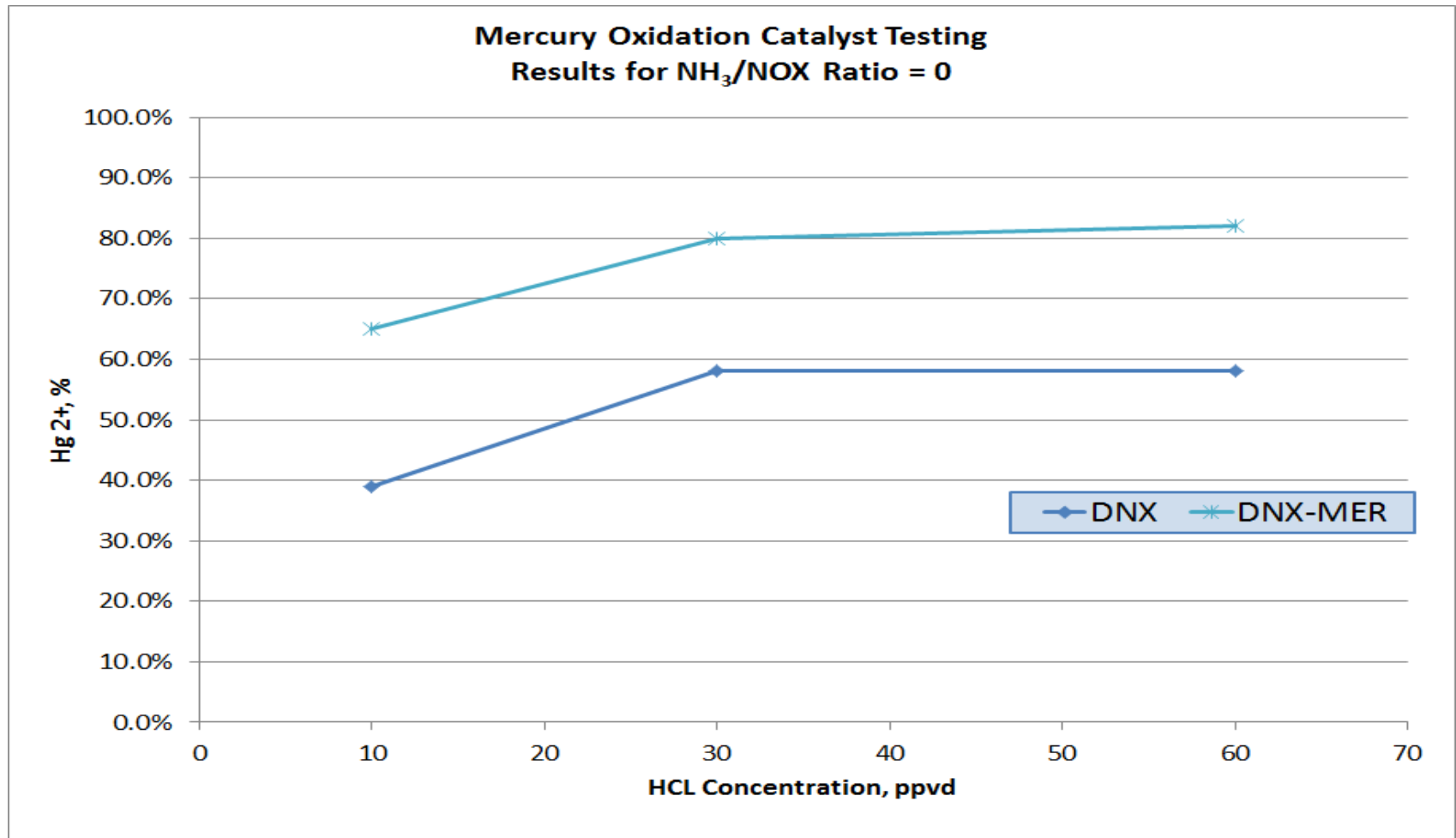
Activity, Nm/h	Fresh	7,500 h	15,500 h
DNX-664 HD	1.0	n.a.	0.83
DNX-664 XD	1.0	1.0	0.98



Catalyst installed in both the U.S. and Europe

# Environmental Emission Technology

## Catalyst Hg oxidation

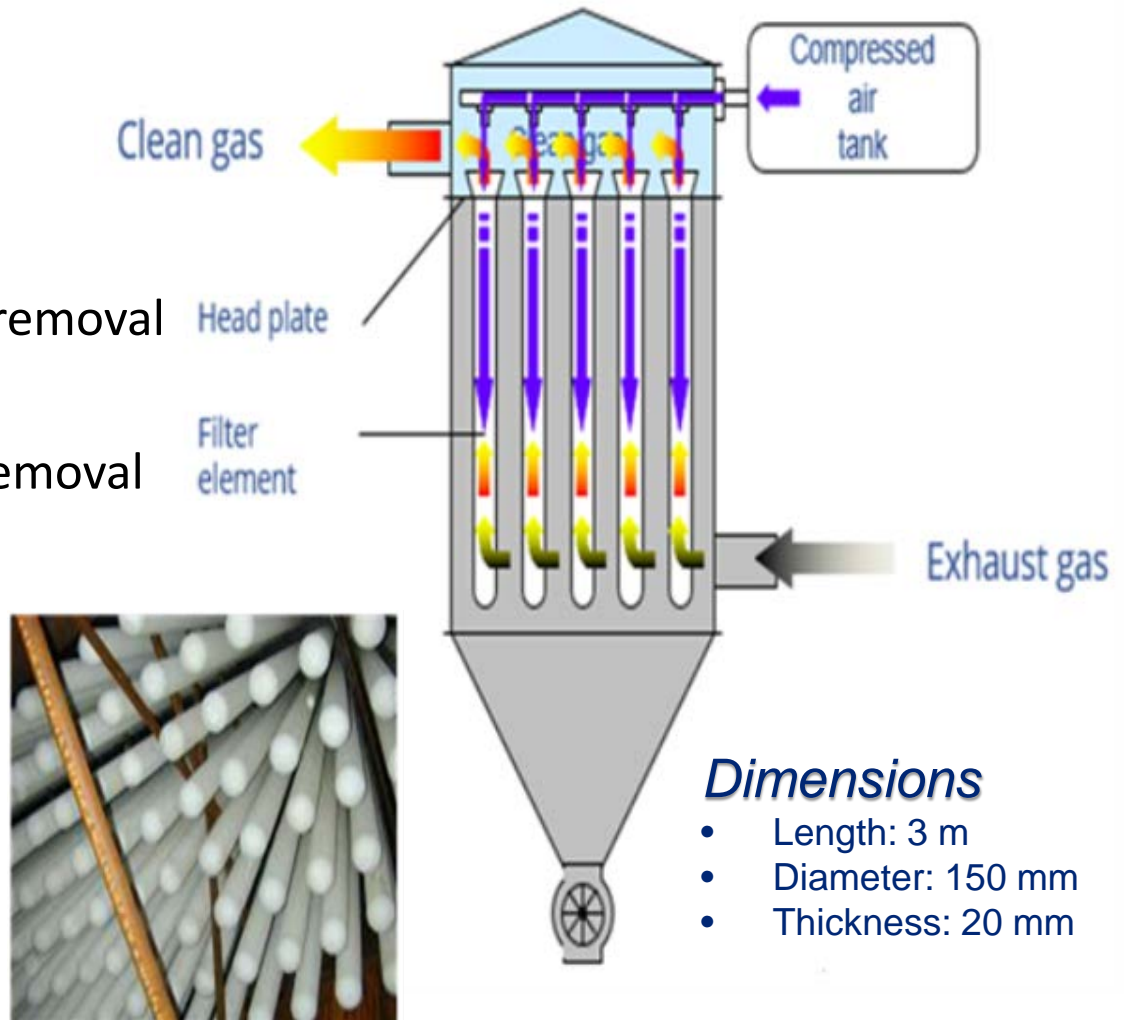


# Environmental Emission Technology

## Multi-pollutant, TopFrax™ catalytic filters

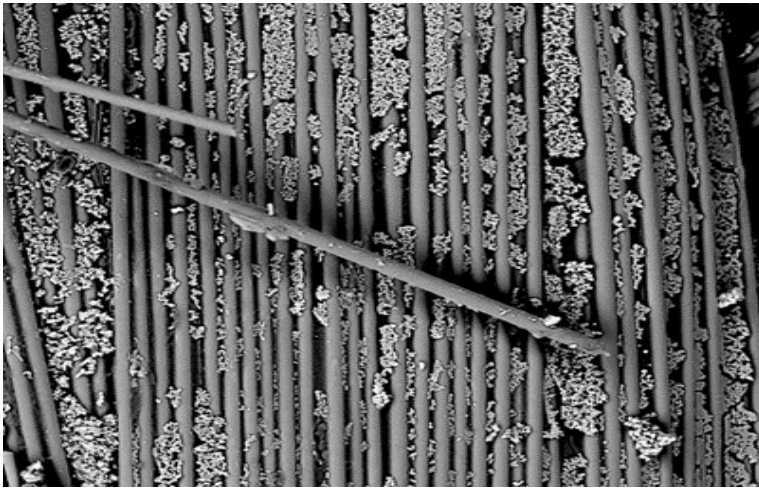
### Performance

- up to 800 deg. F
- < 2mg/Nm<sup>3</sup> dust
- up to 98% HCL, SO<sub>3</sub>, & HF removal
- up to 95% SO<sub>2</sub> removal
- up to 98% NO<sub>x</sub>, CO, VOC removal
- > 99% dioxin removal
- Hg removal



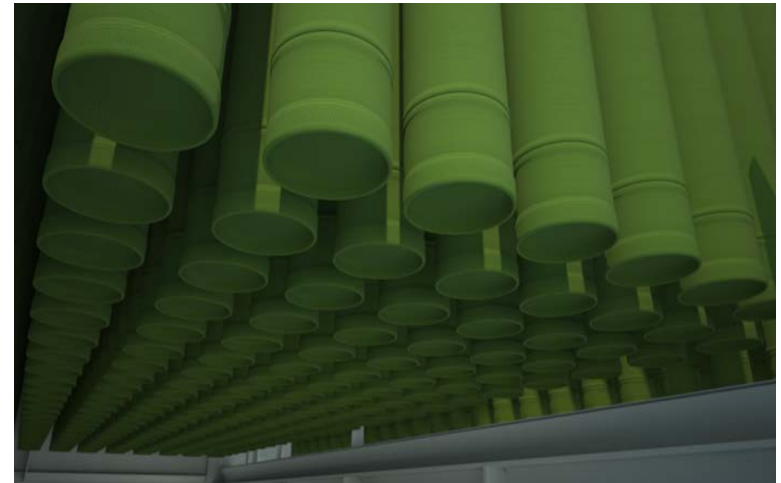
# Environmental Emission Technology

## Multi-pollutant, CataFlex™ catalytic bags



- ✓ Each bag consist of one, two or three impregnated layers with little impact to draft loss,
- ✓ High filtration efficiency,
- ✓ Up to 90% NO<sub>x</sub> reduction
- ✓ Filter bag up to 464 F (240 deg. C)

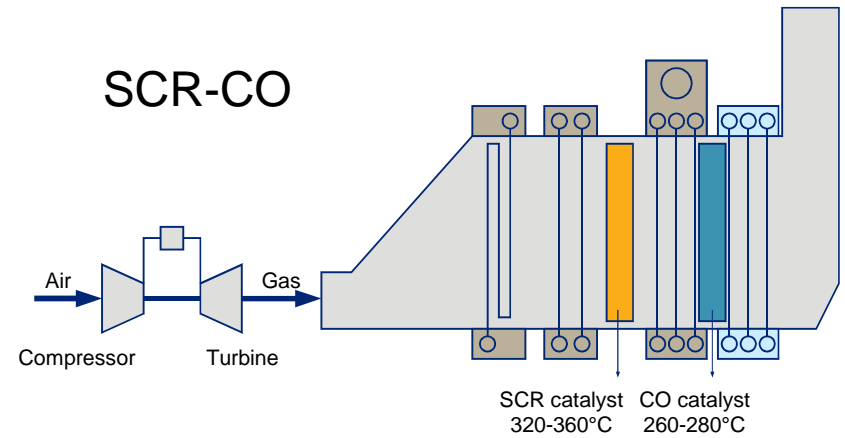
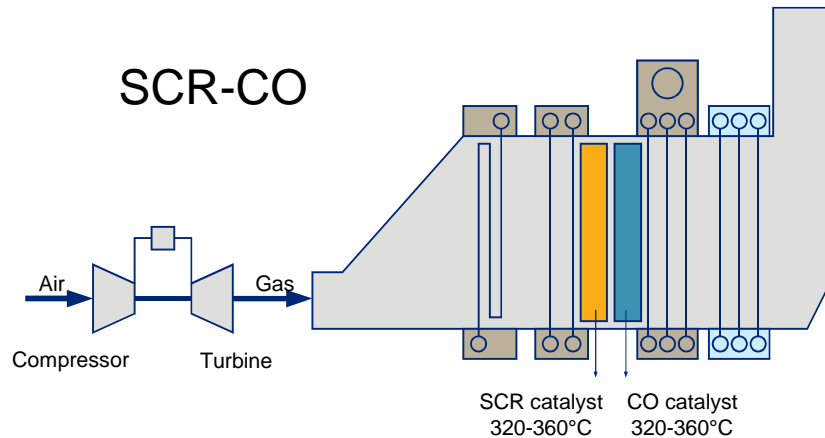
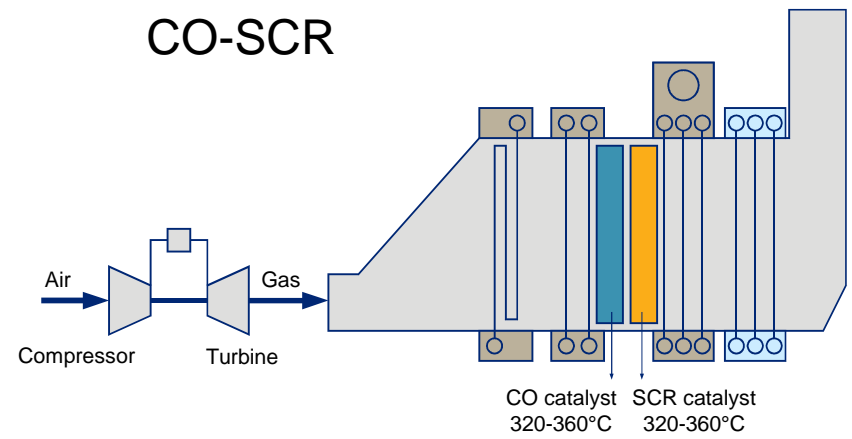
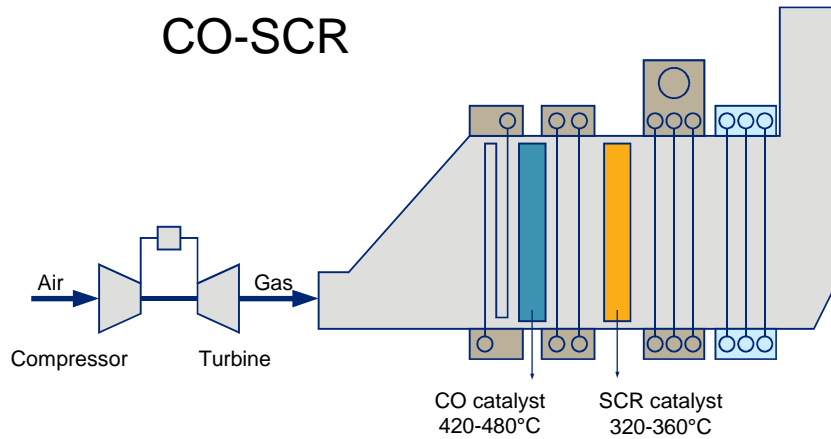
- ✓ Multiple pollution removal - NO<sub>x</sub>, CO, VOC, ammonia, SO<sub>x</sub>, dioxins, furans and others capable across one back end system
- ✓ No poisoning of catalyst



Dimension: standard diameter, length up to 40 feet

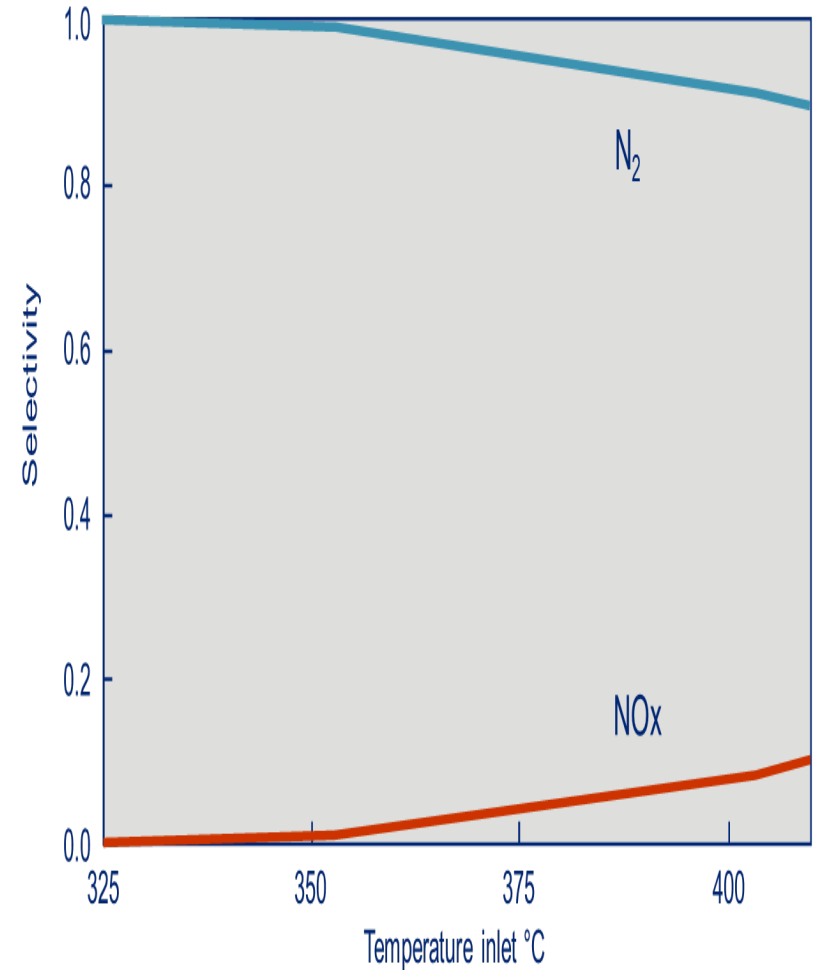
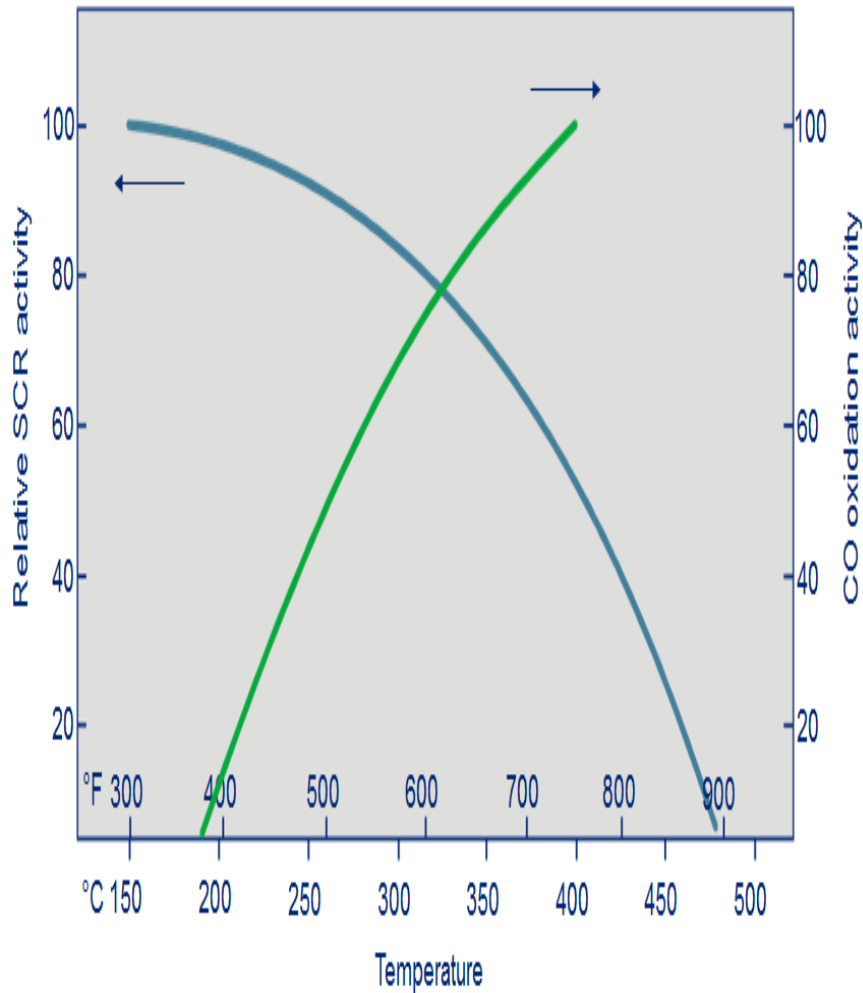
# Environmental Emission Technology

## Combined Cycle - NO<sub>x</sub>, CO catalyst layout



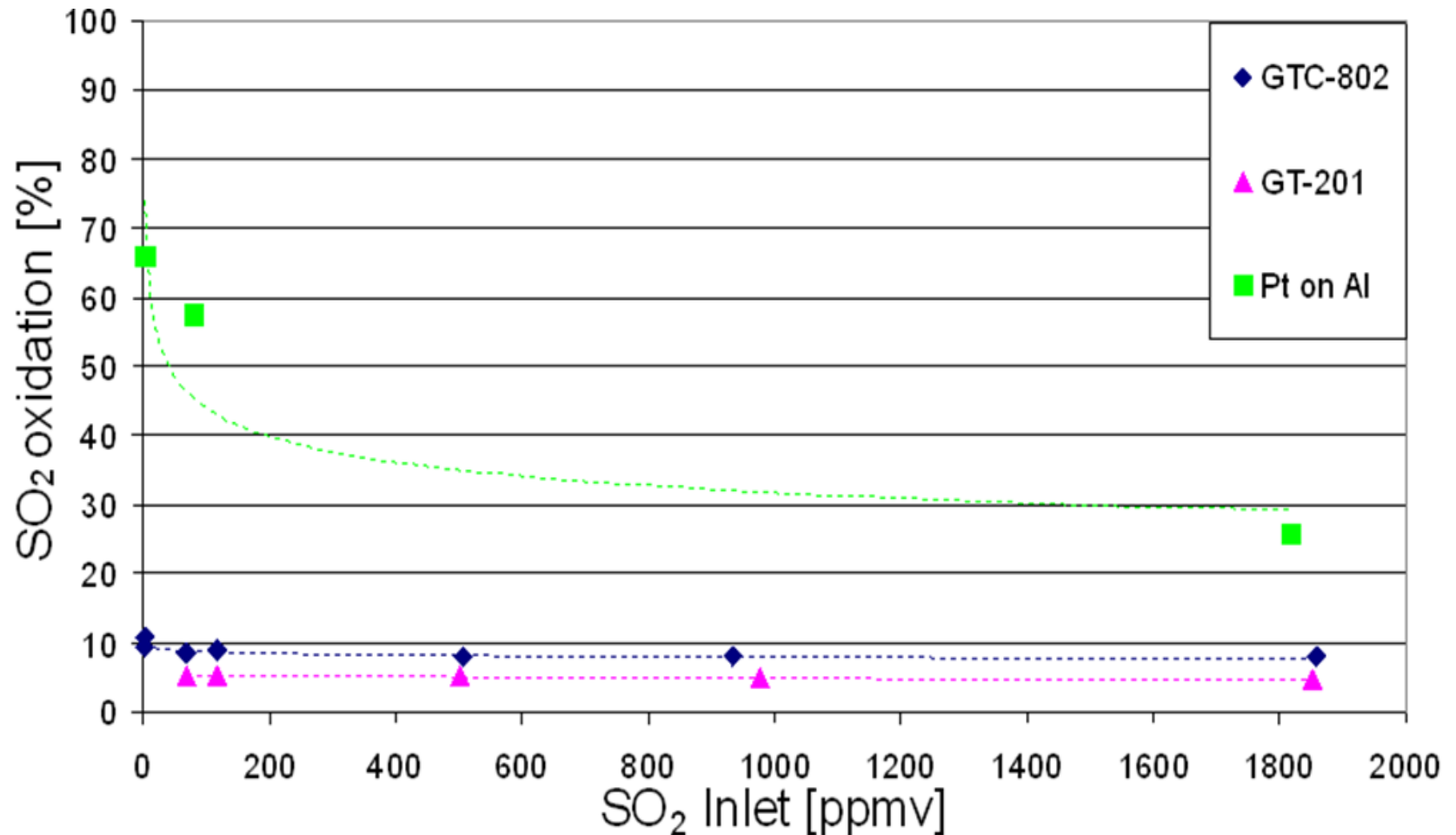
# Environmental Emission Technology

NO<sub>x</sub>, CO, VOC simultaneous reduction, GTC™ catalyst



# Environmental Emission Technology

## GTC™ catalyst series – SO<sub>2</sub> oxidation



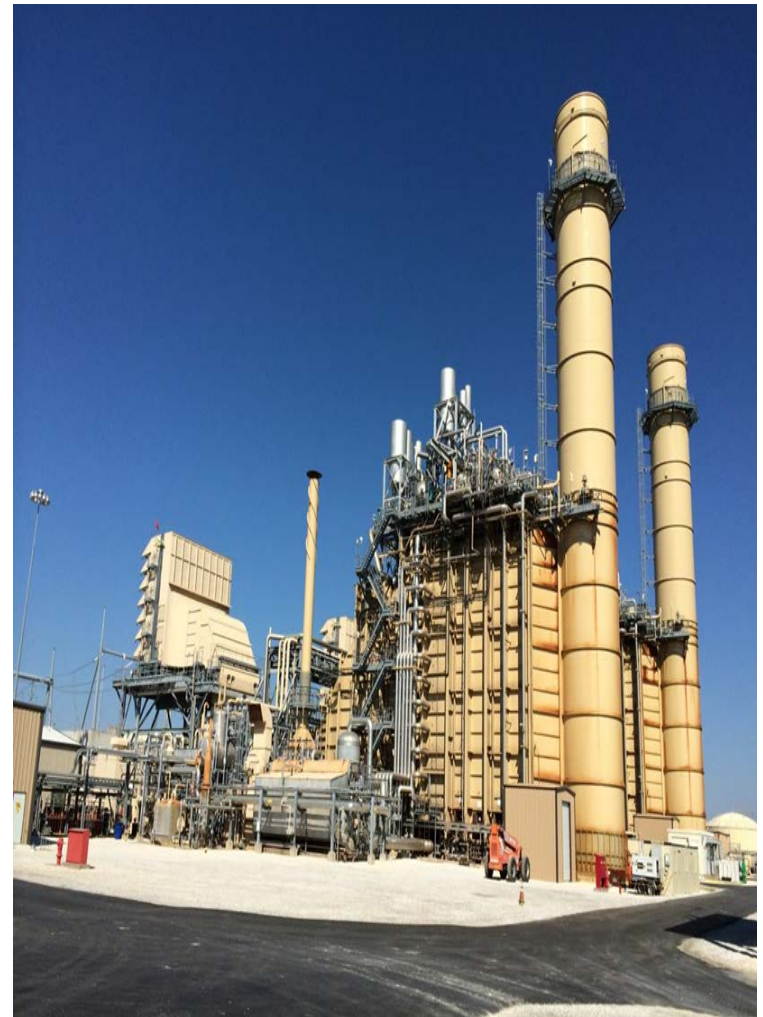
# Environmental Emission Technology

NO<sub>x</sub>, CO, VOC simultaneous reduction, GTC™ catalyst

- Exelon Generation, Wolf Hollow Units 1 & 2, October 2014
- Westinghouse 501G unit combustion turbines (~725 Mwe)

January 15, 2016

Condition No	I	II	III	IV
Load	90	130	Maximum	Max. with duct burners I/S
NO <sub>x</sub> removal, %	77.0	78.2	86.7	87.3
CO oxidation, %	96.1	96.4	~100	~100
NO <sub>x</sub> as NO <sub>2</sub> , %	3.1	~0	~0	~0
Ammonia slip, ppmvd @ 15% O <sub>2</sub>	N/A	1.9	4.9	5.3



# Environmental Emission Technology

NO<sub>x</sub>, CO, VOC simultaneous reduction, GTC™ catalyst

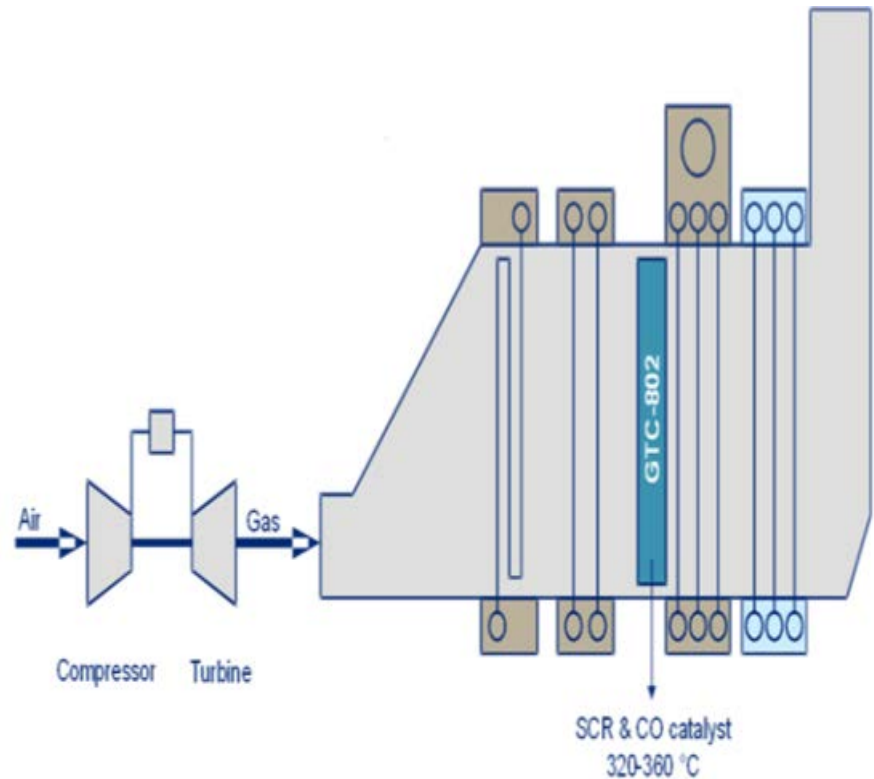
Optimized design, Dual Function Arrangement

## O & M side

- Lower system pressure drop
- Lower SO<sub>2</sub> oxidation
- Easy of installation
- Lower ammonia slip

## Capital side

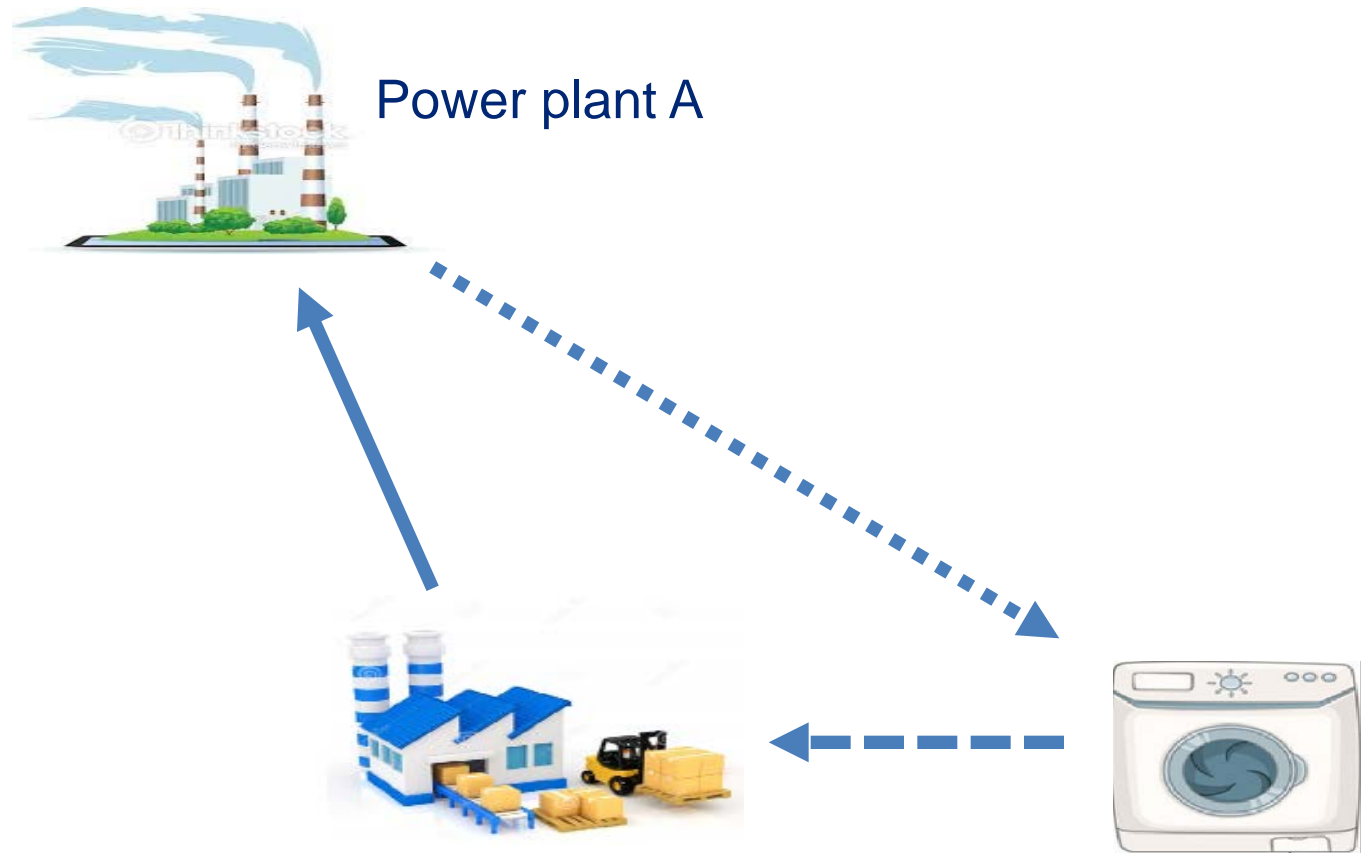
- Reduced unit foot print
- One or no catalyst support structure



Over 50 references including gas turbines, industrial boilers, engines, and industrial applications.

# Environmental Emission Technology

Options for catalyst disposal, what if ????

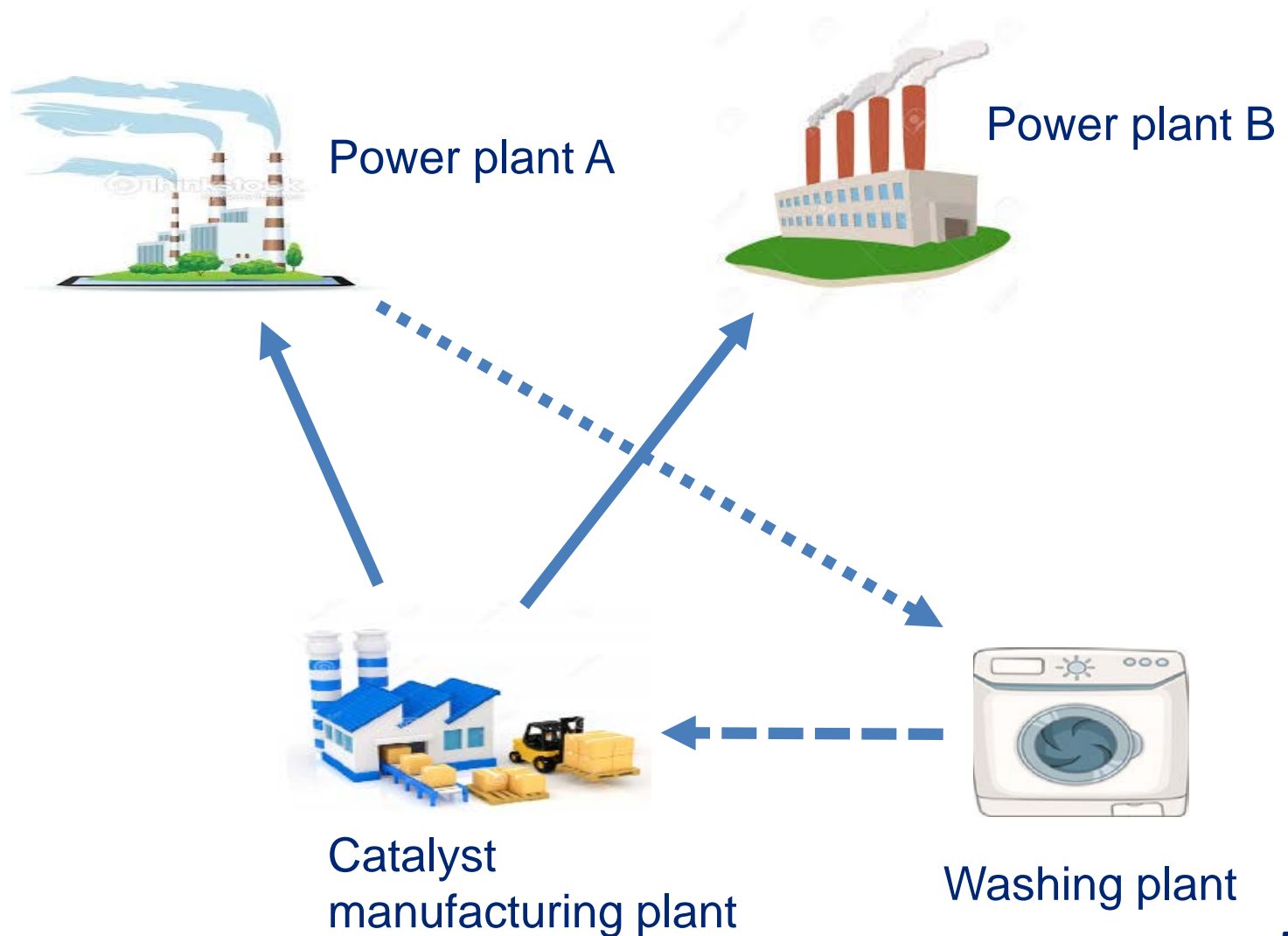


Catalyst  
manufacturing plant

Washing plant

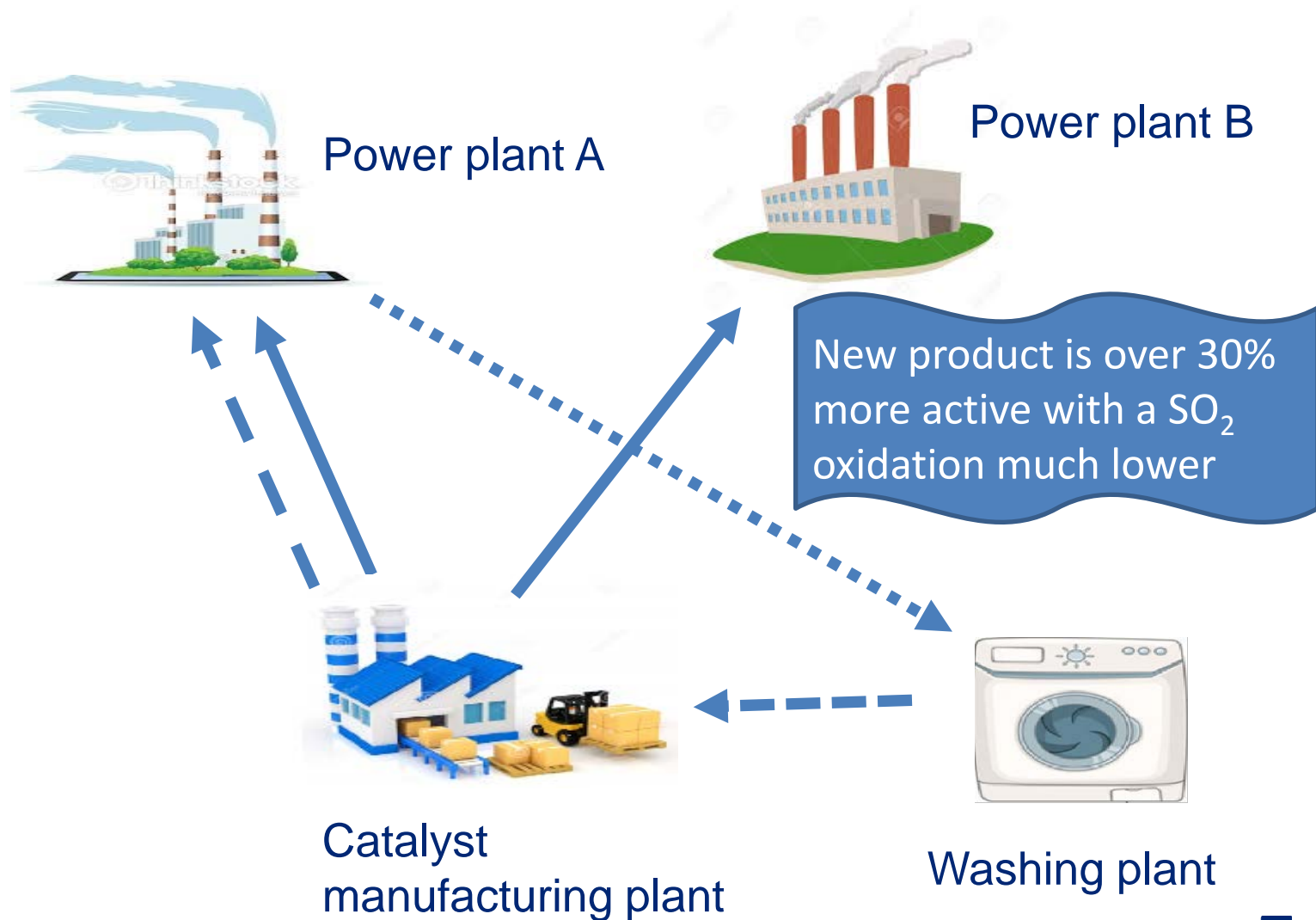
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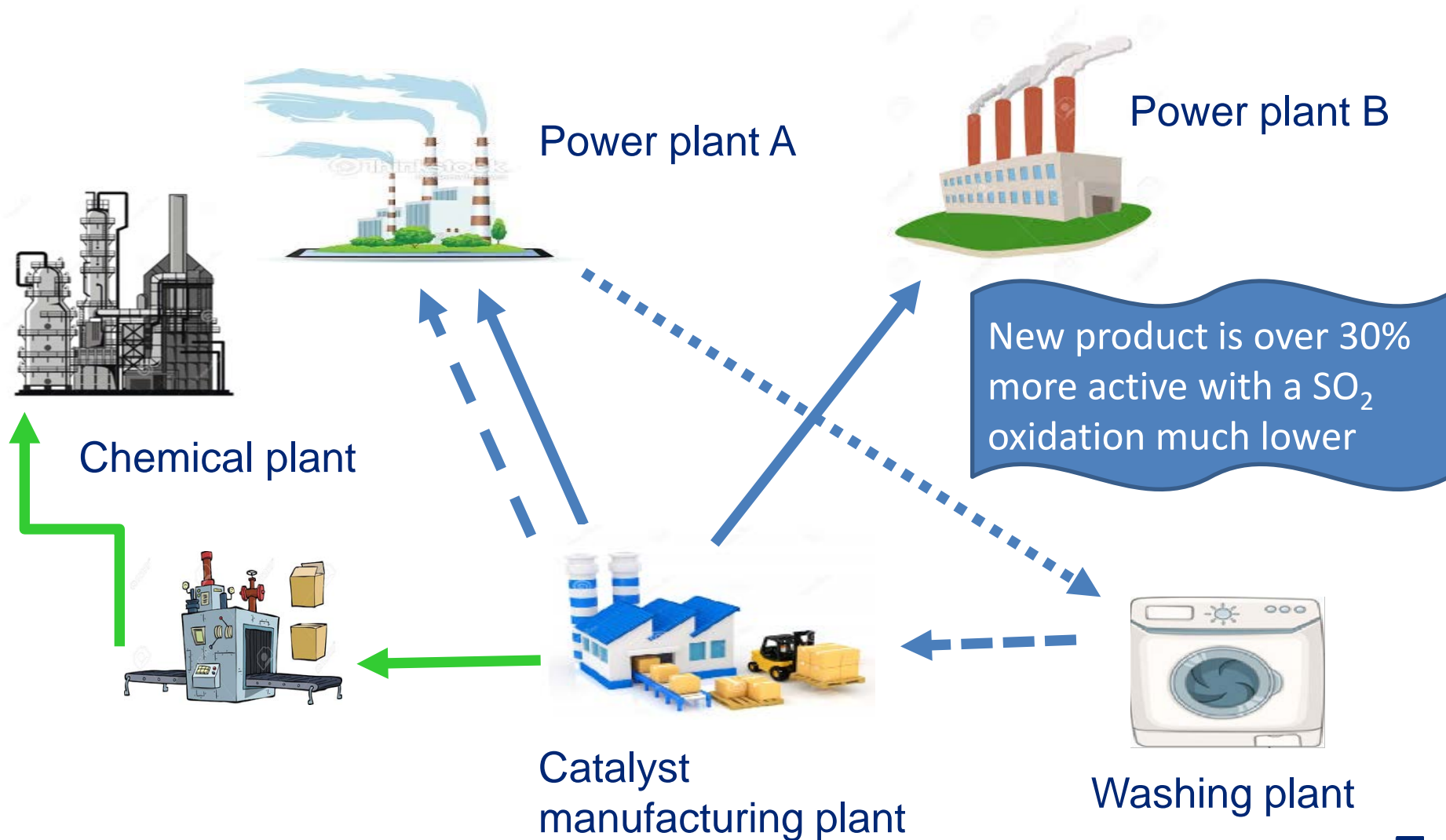
# Environmental Emission Technology

Options for catalyst disposal, what if????



# Environmental Emission Technology

Options for catalyst disposal, what if????



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