Worldwide Pollution Control Association

WPCA/TVA

Coal & Gas Seminar

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DELTA WING / MIXER DISCUSSION

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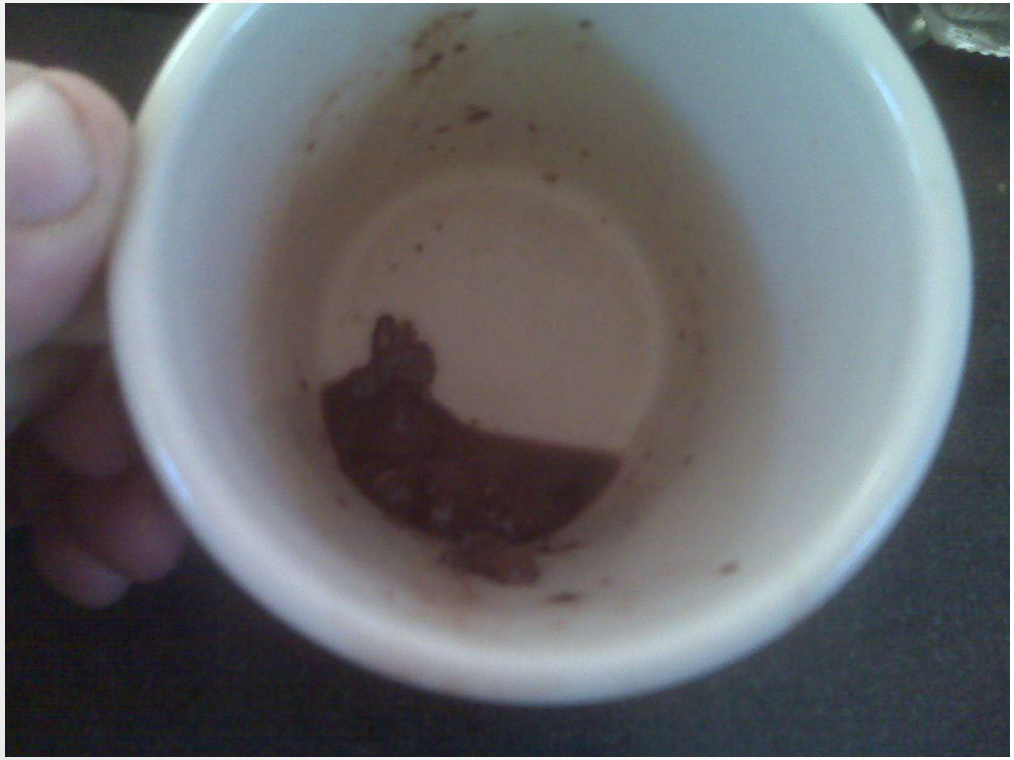
OOPS.. FORGOT TO SHOVEL THE DRIVEWAY

JOB WELL DONE

REFRESHMENT AFTER ALL THAT "WORK"

- HOT Chocolate (good to the last drop)

BUT IS IT ALWAYS?



JUST AS IN HOT COCO THE KEY TO EFFICIENT NOX REMOVAL IS ….

- MIXING
- MIXING
- MIXING
- MIXING

WHAT IS INLET MIXING?

A system of flow modification devices that displace or straighten the flue gas to assure the appropriate mixture of NOx and NH_3 at the face of the SCR catalyst.

WHERE TO START?

- Conditions to mixing system.
- NOx Profile Testing (load range and mill change stability)
- Temperature and flow profiles.
- Check for evidence of LPA (Entry to Air Heaters)

WHAT ARE THE GOALS OF YOUR SCR?

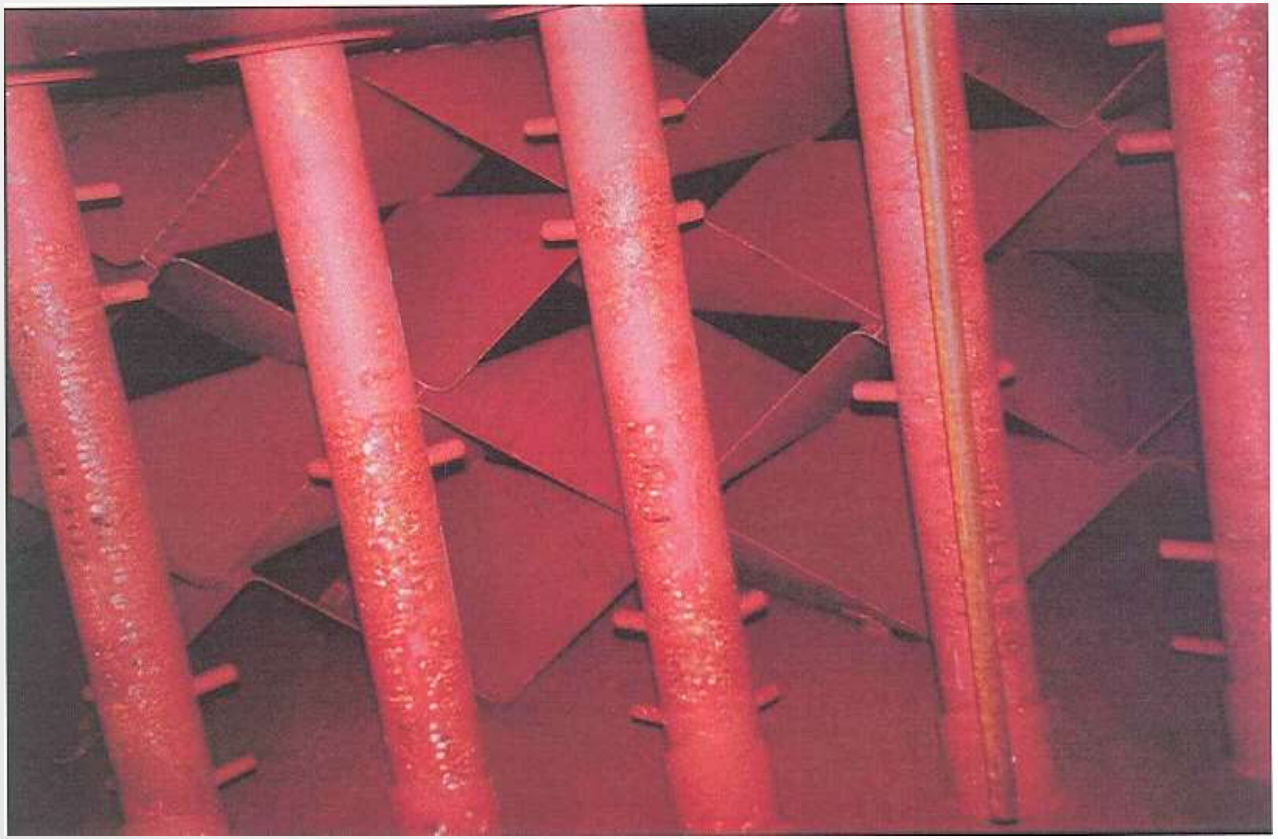
- To meet target NOx levels
- Highest potential for removal of NOx
- Consistent profiles across load range for turn down

TYPES OF MIXING SYSTEMS

Straight Line – Devices straighten flow, intensive grid to match NOx profile

Shifting Mixers – Devices alternately shift gases horizontally and vertically, NH_3 injected through one or more multi-nozzled header.

SULZER MIXER



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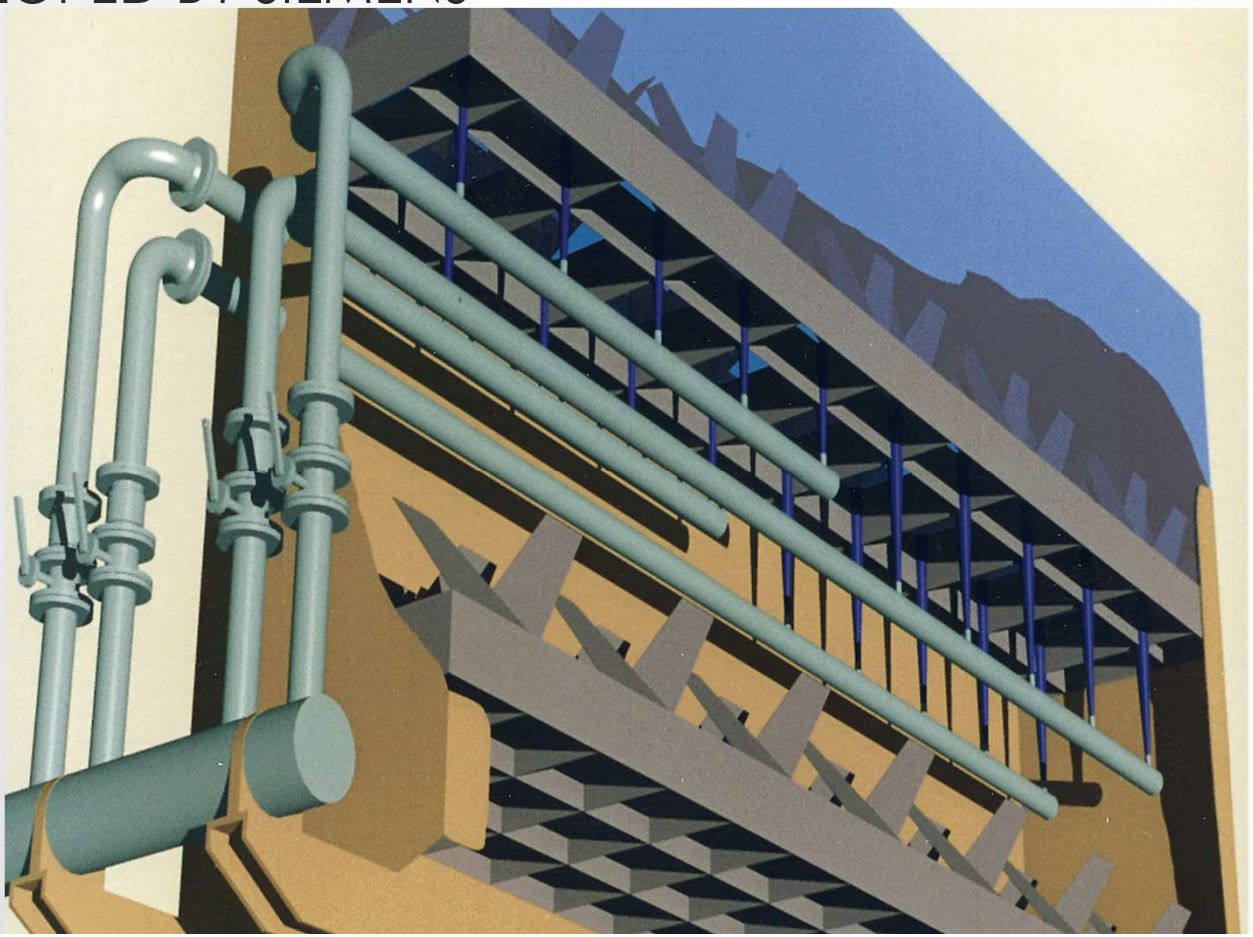
Zonal Mixers - Devices divide duct into zones with intensive mixing, NH_3 adjusted for each zone.

PARMIX & TURBOMIX
DEVELOPED BY SIEMENS



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Shifting Mixers – Devices alternately shift gases horizontally and vertically, NH_3 injected through one or more multi-nozzled header.

Zonal Mixers - Devices divide duct into zones with intensive mixing, NH_3 adjusted for each zone.

Vortex Mixers - Devices create vortices throughout duct, NH_3 injected into a voertex device.

DELTA WING® MIXING FROM BABCOCK POWER

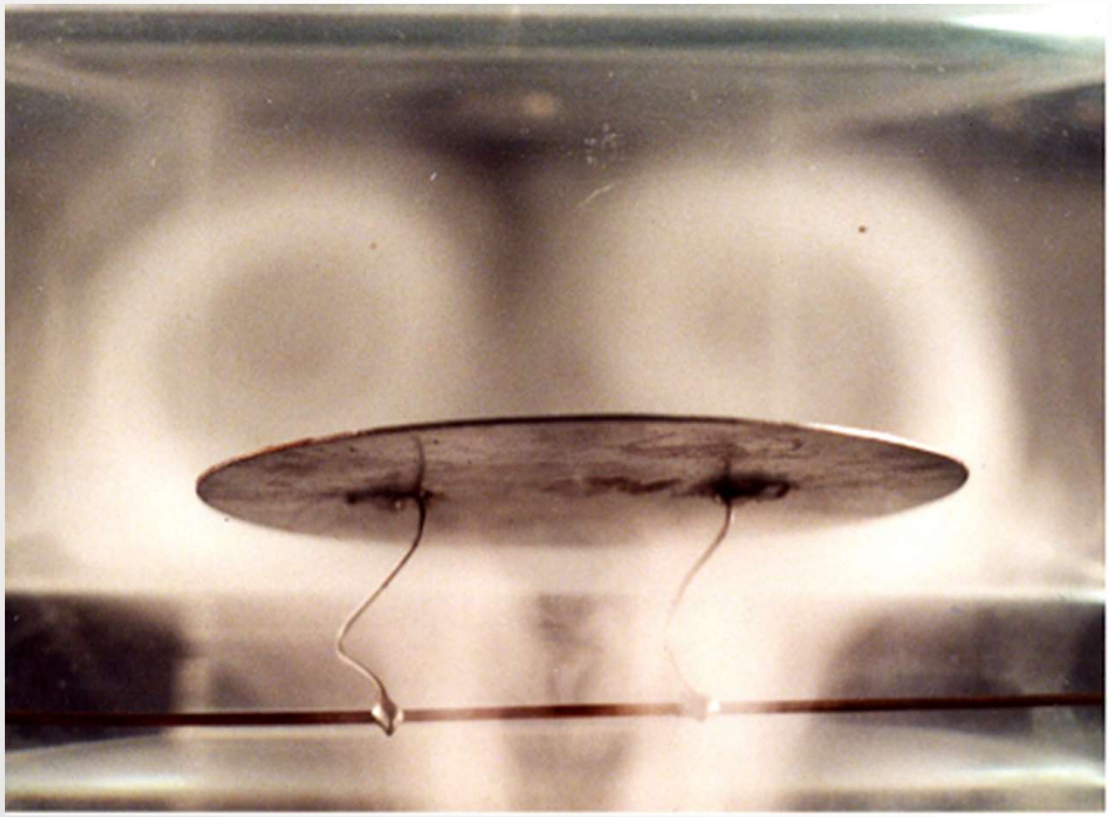


Photo Courtesy of Balcke-Dürr GmbH, Germany

MODELING

- Whether CFD or scale the most important thing to remember is the model output is only as good as its input.

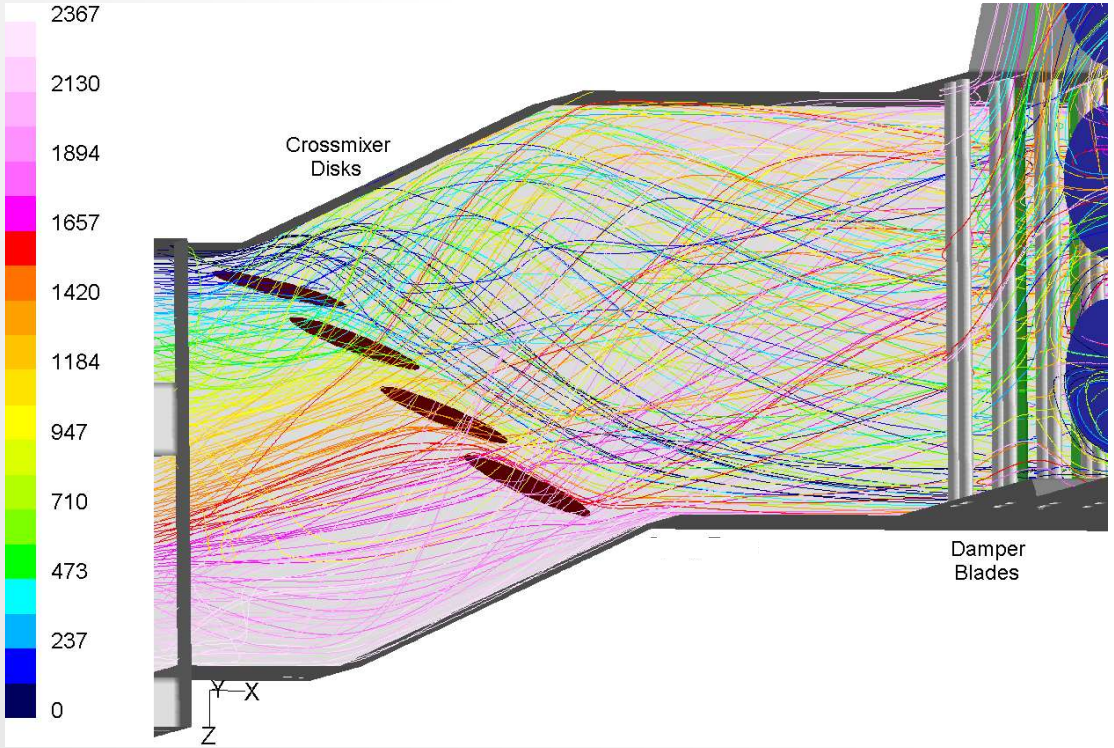
Model worst case then some NOx, temperature, and velocity variations.

Dust loading and hang out can be critical.

LPA Should be modeled if any indication of it is seen.

CROSS MIXING FLOW

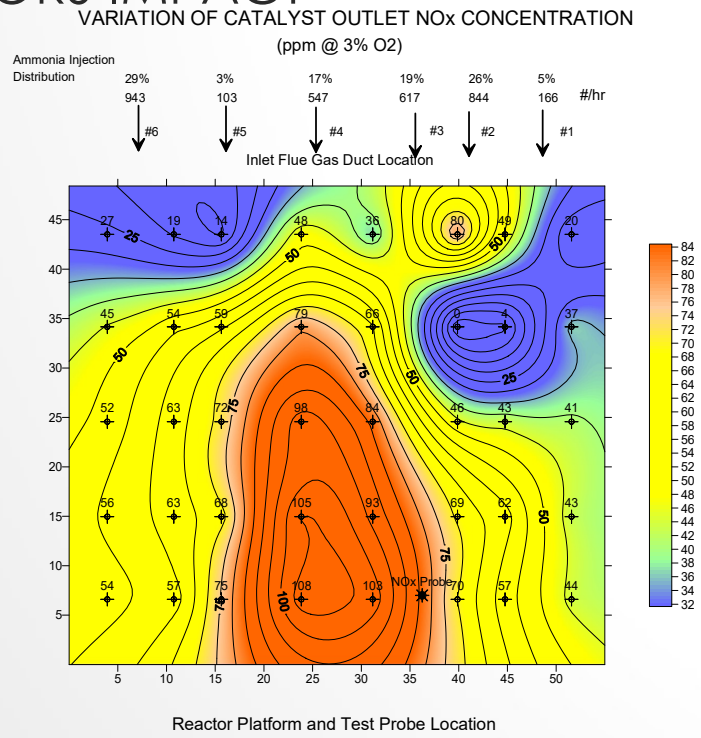
PHOTO COURTESY OF RILEY POWER



INSTALLATION

Mixing distances and orientation can be very critical with all designs. Relatively small errors can have a significant impact on performance.

INSTALLATION ERRORS IMPACT



BBP Contract #: 100109 Project Name: AEP Unit: Big Sandy 2 Reactor: R2

Test: Big Sandy 2 R2082303 Test 21 Test Date: 8/23/03 Test Start Time: 1617 Test End Time: 1645

Test Drescription: Full Load Lowered SP by 10ppm to 65ppm

Avg Outlet NOx ppm: 57 % Removal: 89 Std Deviation: 5.5

SUGGESTED ERROR CORRECTION STEPS

Carefully measure to find installation error.

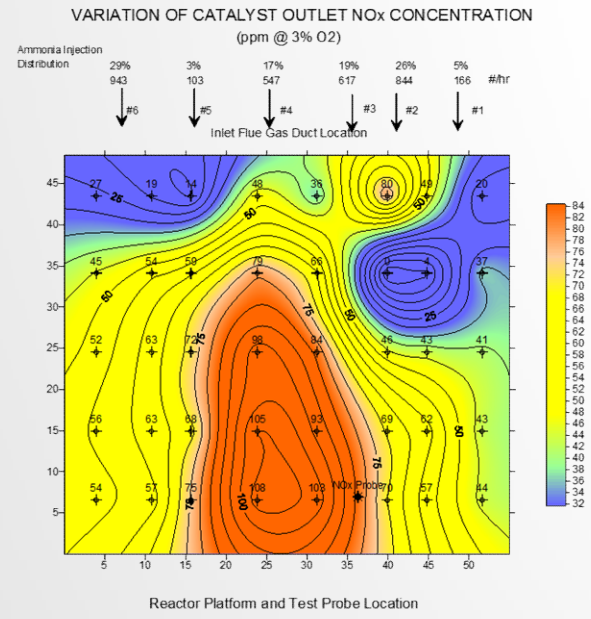
Model the error to verify the modeling.

Model a solution whether original or new.

Install modification with close attention to detail.

Suck some gas to see improvements.

DEFINITE IMPROVEMENT



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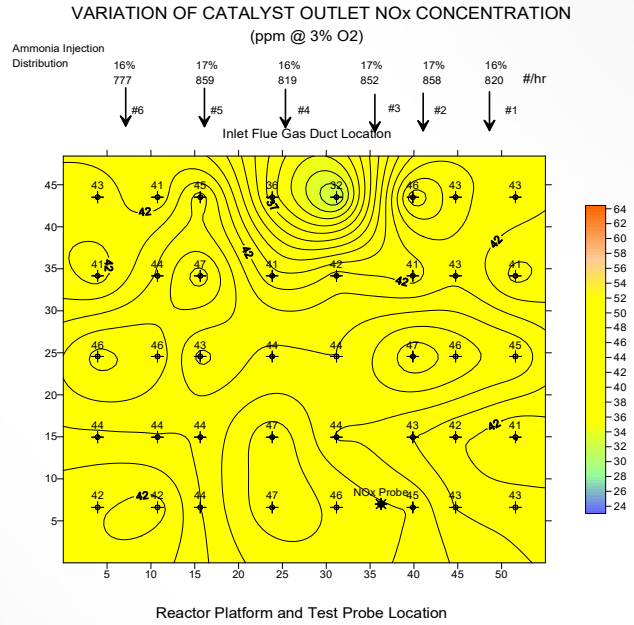
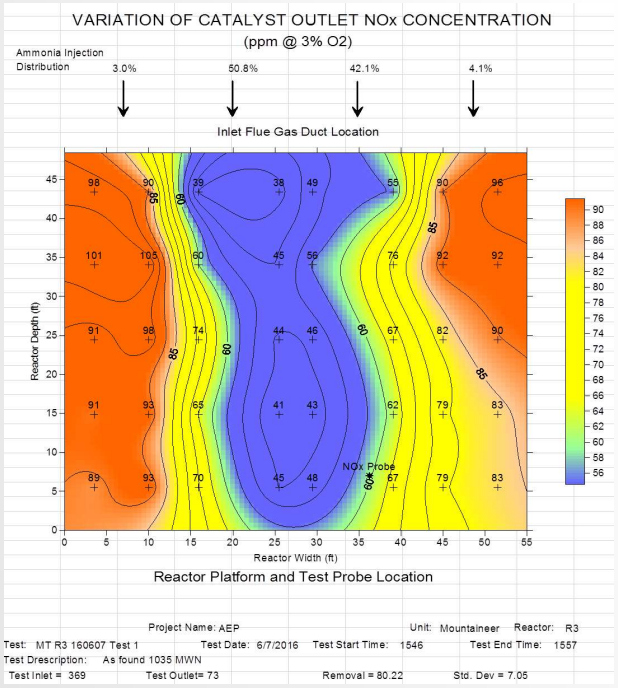
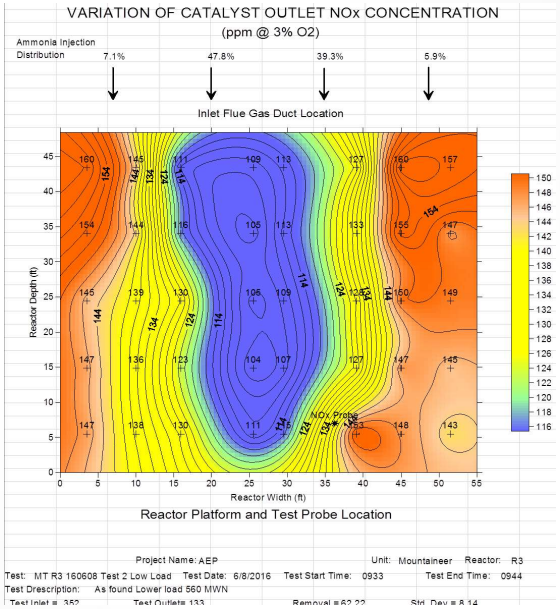
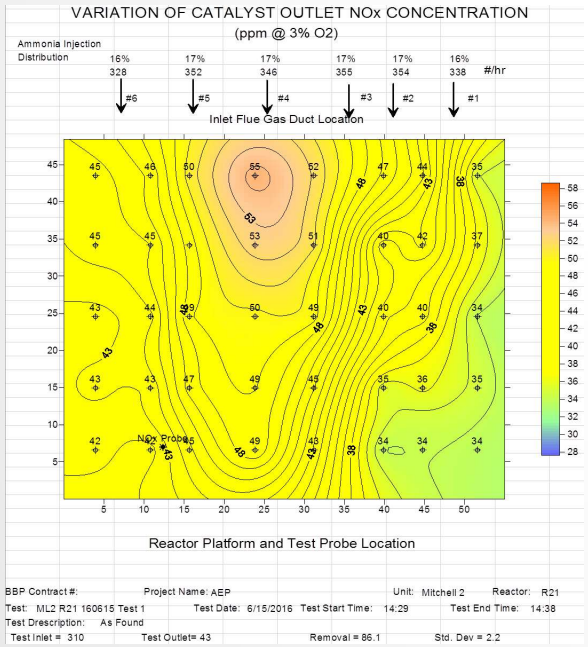


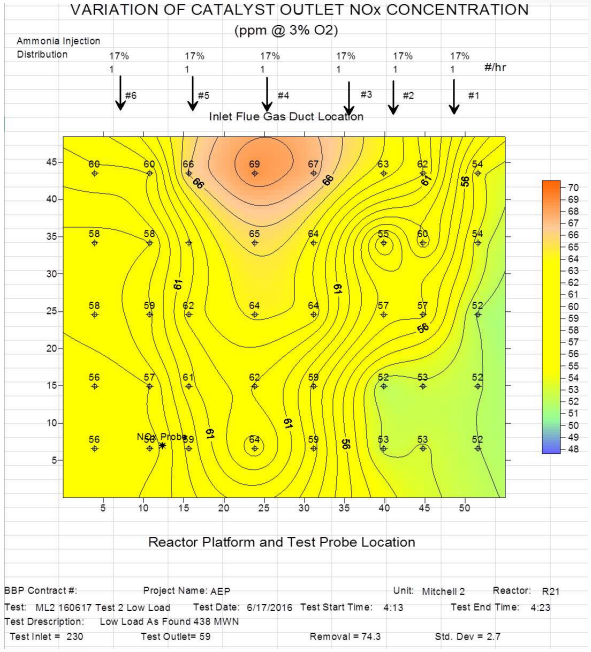
BBP Contract #: 100109 Project Name: AEP Unit: Big Sandy 2 Reactor: R2
Test: BS2 R2 042704 Test 4 Test Date: 4/27/04 Test Start Time: 18:30 Test End Time: 18:52
Test Description: Full Load, After valve adjustments, All mills in service
Avg Outlet NOx ppm: 43 % Removal: 91 Std Deviation: 0.7

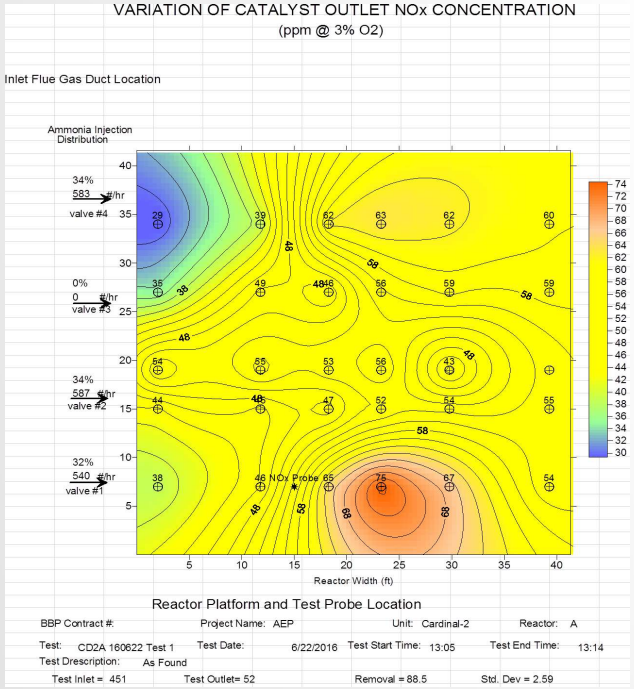
Load Variation Testing

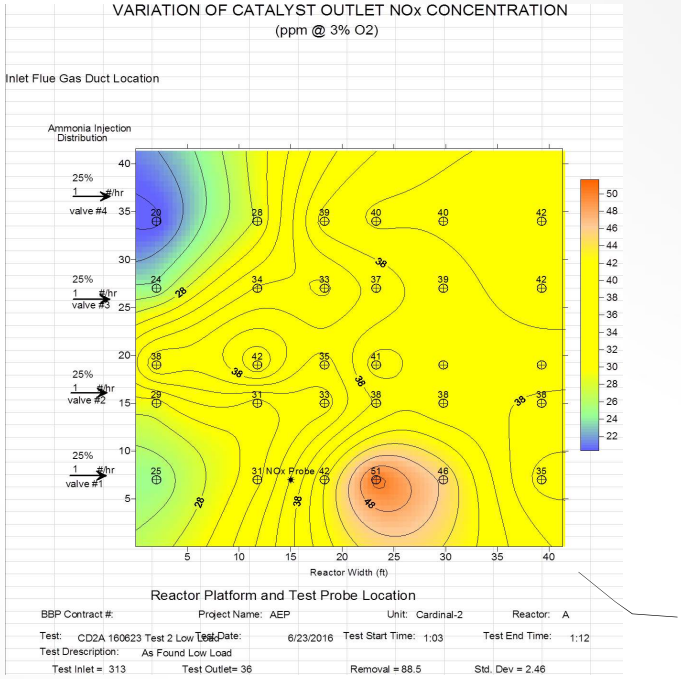





VARIATION OF CATALYST OUTLET NOx CONCENTRATION
(ppm @ 3% O2)
Ammonia Injection Distribution
16% 17% 17% 17% 17% 16%
328 352 346 355 354 338 #/hr
#6 #5 #4 #3 #2 #1
Inlet Flue Gas Duct Location
NOx Probe
Reactor Platform and Test Probe Location
BBP Contract #: Project Name: AEP Unit: Mitchell 2 Reactor: R21
Test: ML2 R21 160615 Test 1 Test Date: 6/15/2016 Test Start Time: 14:29 Test End Time: 14:38
Test Drescription: As Found
Test Inlet = 310 Test Outlet= 43 Removal = 86.1 Std. Dev = 2.2


VARIATION OF CATALYST OUTLET NOx CONCENTRATION
(ppm @ 3% O2)
Ammonia Injection Distribution
17% 17% 17% 17% 17% 17%
1 1 1 1 1 1 #/hr
#6 #5 #4 #3 #2 #1
Inlet Flue Gas Duct Location
NOx Probe
Reactor Platform and Test Probe Location
BBP Contract #: Project Name: AEP Unit: Mitchell 2 Reactor: R21
Test: ML2 160617 Test 2 Low Load Test Date: 6/17/2016 Test Start Time: 4:13 Test End Time: 4:23
Test Drescription: Low Load As Found 438 MWN
Test Inlet = 230 Test Outlet= 59 Removal = 74.3 Std. Dev = 2.7


VARIATION OF CATALYST OUTLET NOx CONCENTRATION
(ppm @ 3% O2)
Inlet Flue Gas Duct Location
Ammonia Injection Distribution
34%
583 #/hr
valve #4
0%
0 #/hr
valve #3
34%
587 #/hr
valve #2
32%
540 #/hr
valve #1
46 NOx Probe 85
Reactor Width (ft)
Reactor Platform and Test Probe Location
BBP Contract #:
Project Name: AEP
Unit: Cardinal-2
Reactor: A
Test: CD2A 160622 Test 1
Test Date: 6/22/2016
Test Start Time: 13:05
Test End Time: 13:14
Test Drescription: As Found
Test Inlet = 451
Test Outlet= 52
Removal = 88.5
Std. Dev = 2.59


VARIATION OF CATALYST OUTLET NOx CONCENTRATION
(ppm @ 3% O2)
Inlet Flue Gas Duct Location
Ammonia Injection Distribution
25%
1 #/hr
valve #4
25%
1 #/hr
valve #3
25%
1 #/hr
valve #2
25%
1 #/hr
valve #1
31 NOx Probe 42
Reactor Width (ft)
Reactor Platform and Test Probe Location
BBP Contract #:
Project Name: AEP
Unit: Cardinal-2
Reactor: A
Test: CD2A 160623 Test 2 Low Load
Test Date: 6/23/2016
Test Start Time: 1:03
Test End Time: 1:12
Test Drescription: As Found Low Load
Test Inlet = 313
Test Outlet= 36
Removal = 88.5
Std. Dev = 2.46

SUMMARY

Mixing is CRITICAL to achieve the goals of your SCR.

Choose the amount of mixing required to reach your established reduction goals.

Now on to

Rob Mudry