Dry Scrubber NID Humidity Measurement and Control

EUEC 2018

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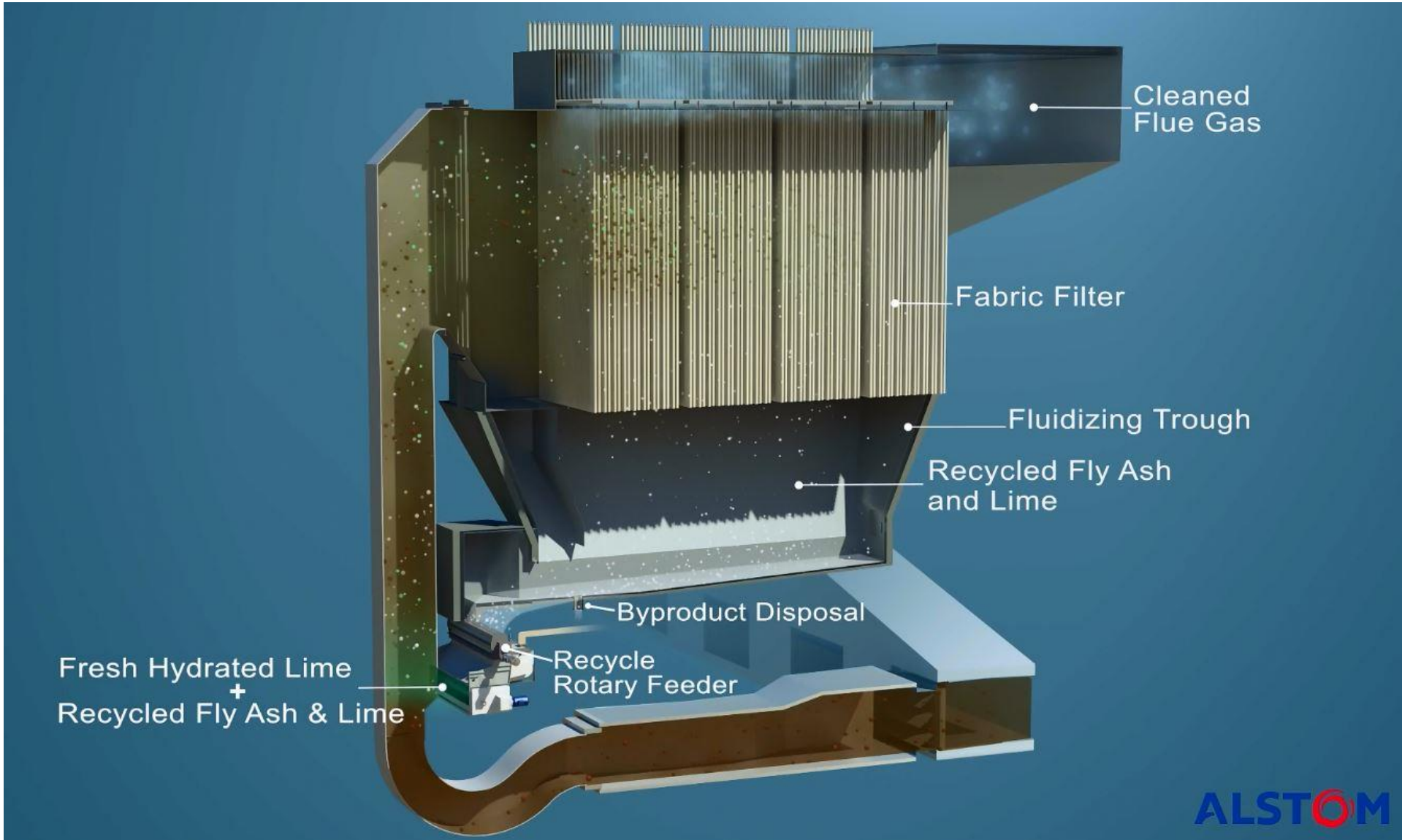
HUMIDITY 2 OPTIMIZATION

Objective of Presentation

- Plant Description
- Data Analysis
- Sensor Technology
- Questions / Discussion

GE Power / Alstom NID

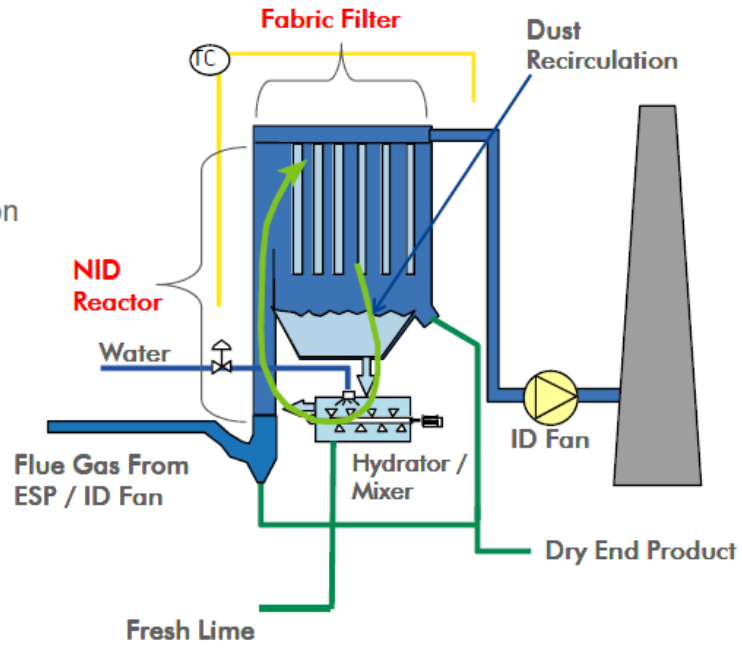


GE Power / Alstom NID

NID Process

NID DFGD Design

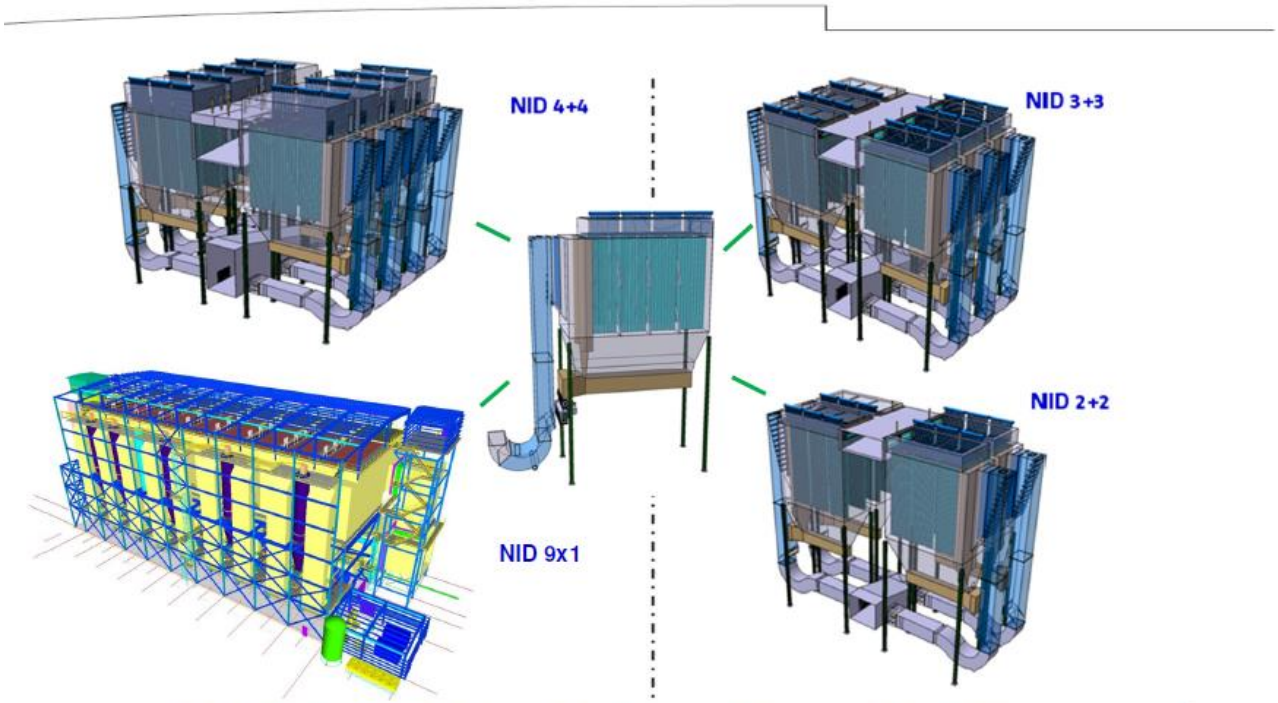
- Large gas flow range
- Unitized compartment design
- Compact footprint
- Gas cooling by thin film evaporation
- Very high solids recirculation
- Fluid bed / dust recirculated continuously
- No external hydrator
- No external dust recycle
- No slurry handling
- Free flowing dry end product



ALSTOM

GE Power / Alstom NID

Modular Design



Modularization Offers Design and Layout Flexibility

ALSTOM

Process Description

- Boiler - 2 Hot Sided Precipitators – Split Gas
- Air Heaters A & B - Activated Carbon
- NID Inlet Plenum (ducts recombine from AC before inlet)
  - SO_2 inlet monitor
- 4x4 Module System - 8 NID Reactors / 8 PJFF
  - 7 modules in service / 1 standby at full load
  - 4 modules at base load
- NID Outlet
  - Outlet temperature measured after each module damper
  - All eight modules recombine and feed outlet duct
- Outlet Duct
- ID Fan / Stack2 H2O sensors installed (January 2016) across duct

Process Description

Control

- Hydrated lime, air flow, recycled FF solids and moisture
- Inlet / outlet SO2 CEM controls quicklime to hydrators
- Mixer water addition controls ADP
- Higher humidity increases scrubbing efficiency
- Accurate humidity control optimizes lime usage
- Protects baghouse from blinding and corrosion
- 40 degree approach to dew point
  - Average of the two sensors is the control point
  - Adiabatic saturation temperature can also be calculated
- No maintenance since installation on either unit

Installation Picture – Top of Duct

Installation Picture – Connections

Installation Picture – Inside Duct

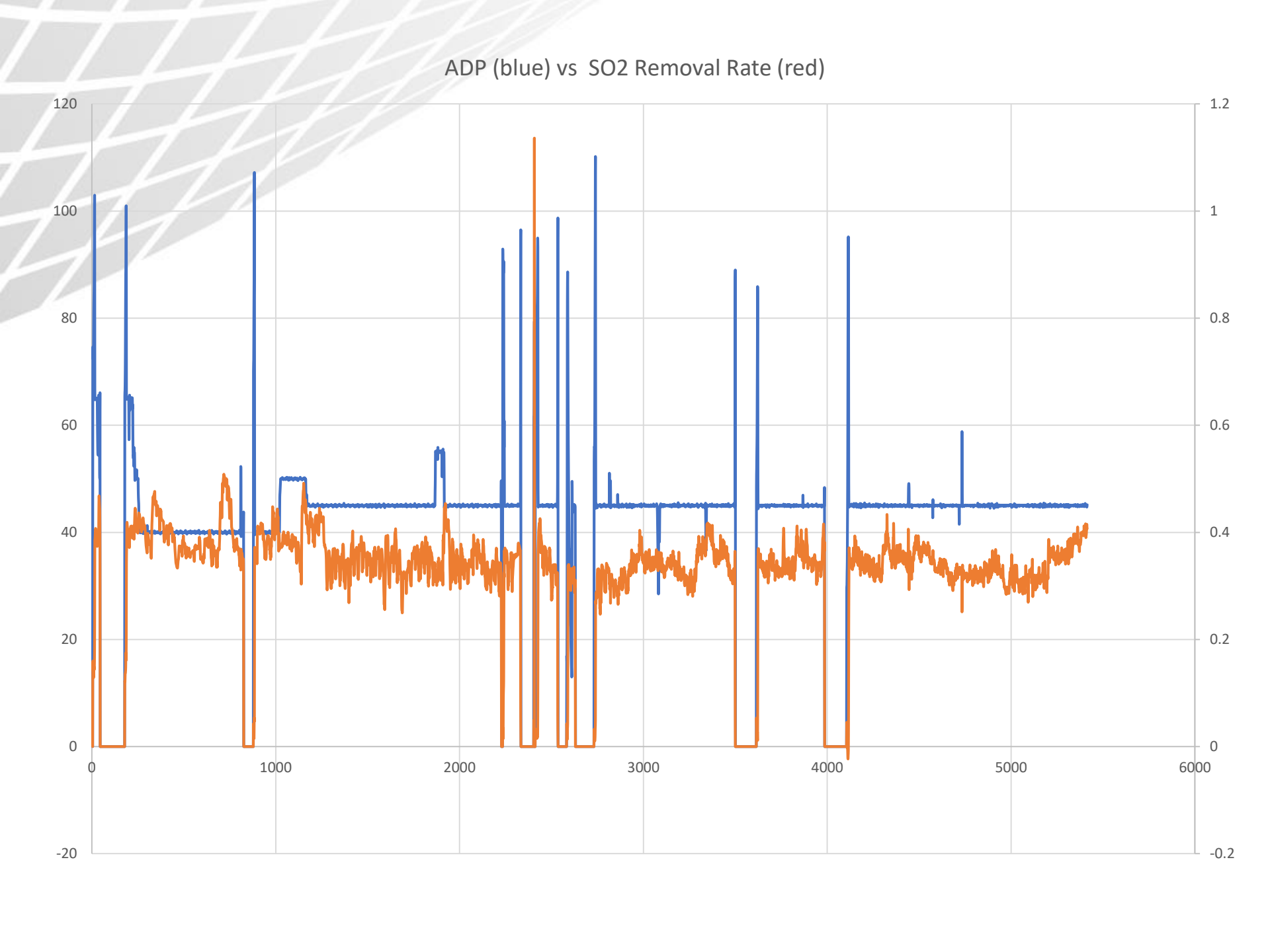
Installation Picture – Inside Duct

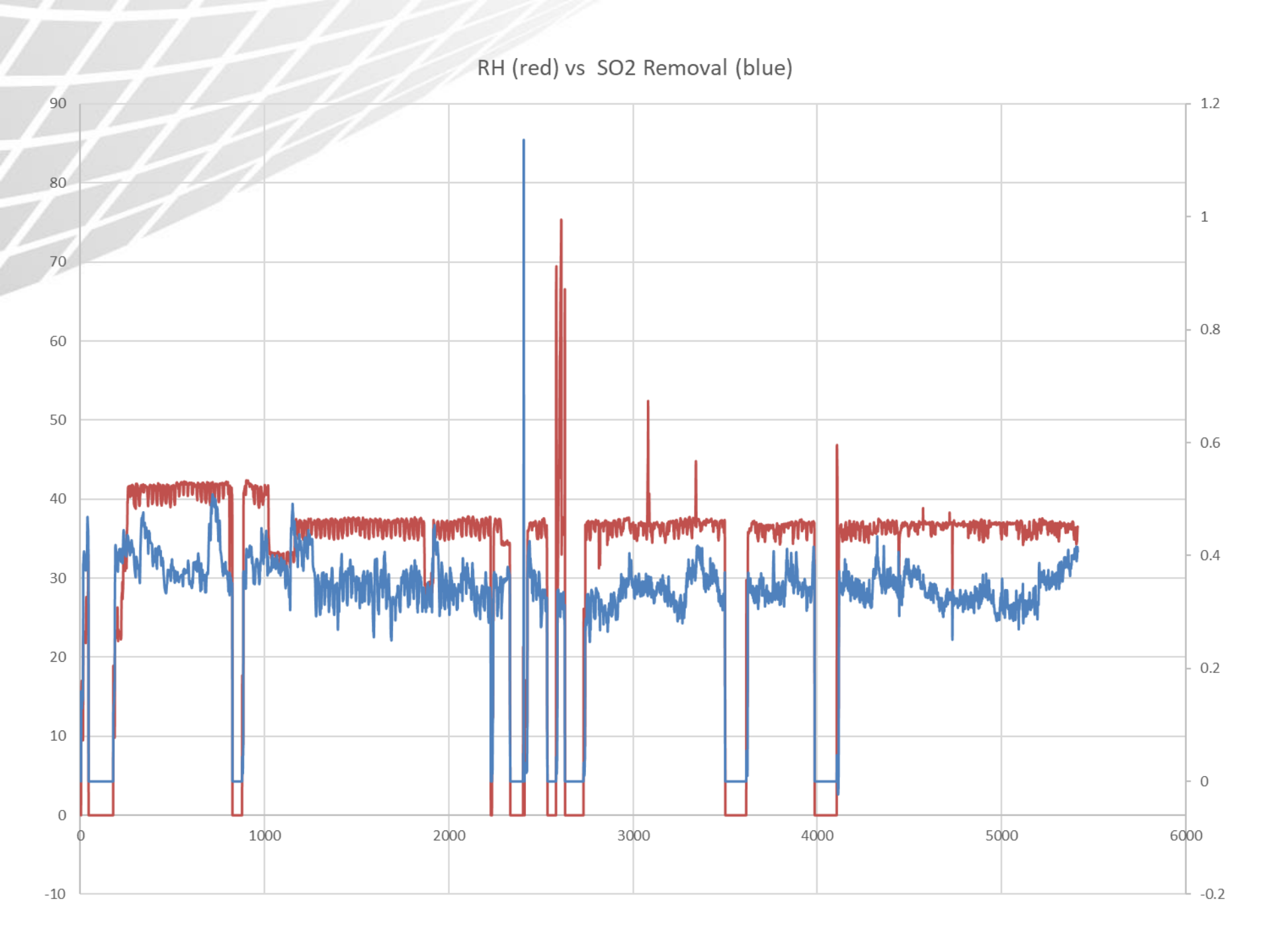
Moisture Variables at Probes

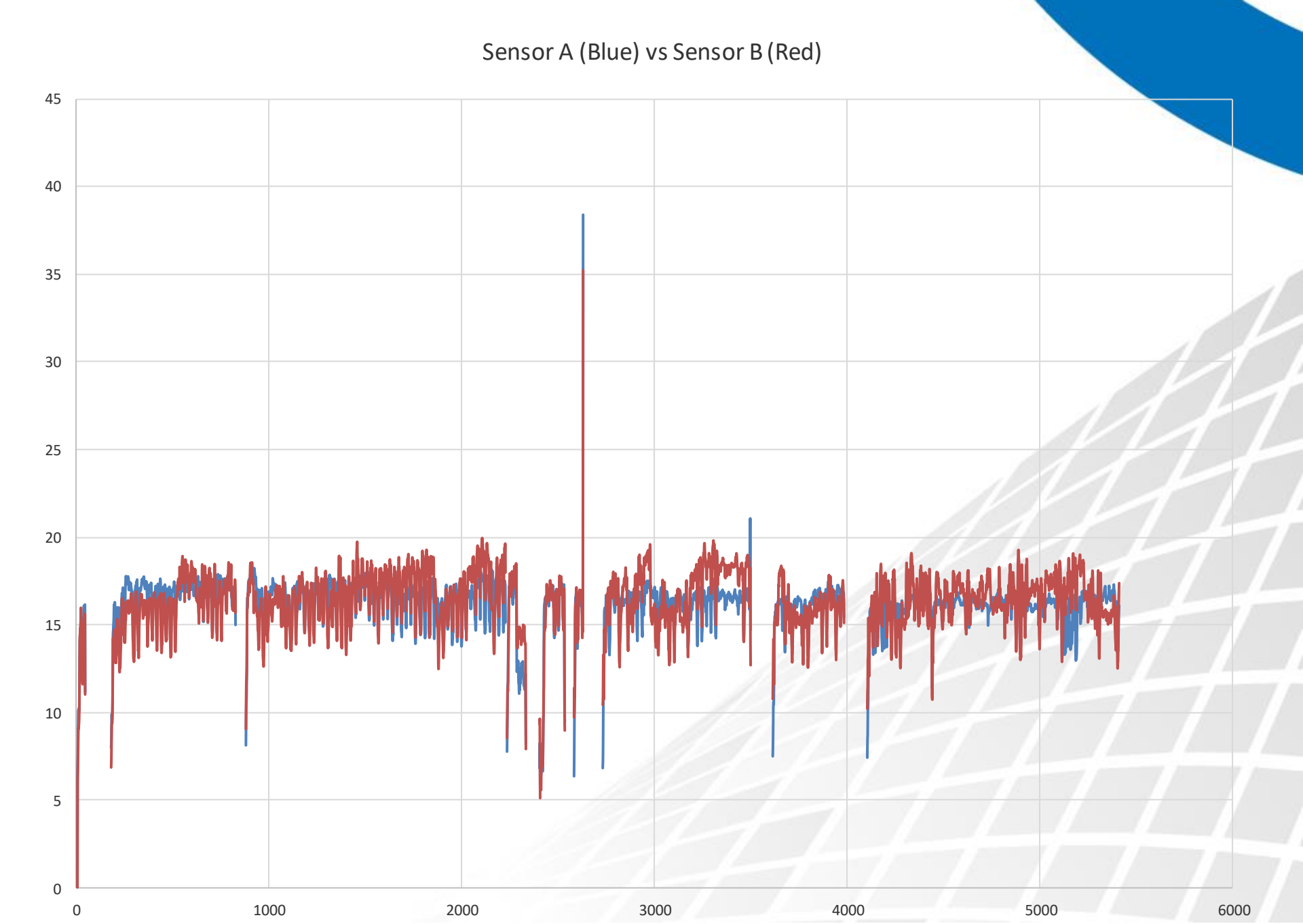
- Ambient Humidity
  - Jan 1, 2017 – 0.8% volume
  - July 1, 2017 – 2.25% volume
  - Relates to a 4 degree dew point difference at scrubber inlet
- Load Condition
- Soot Blows
- Coal Moisture
- Tube Leak
- Scrubber Approach to Dewpoint

Load Condition Moisture

	NID M8 Dew Point Temp Avg °F	Gross MW
6/20/2017 13:00	118.8	277.2
6/20/2017 14:00	124.0	324.3
6/20/2017 15:00	124.8	344.3
6/20/2017 16:00	125.0	371.6
6/20/2017 17:00	125.5	432.4
6/20/2017 18:00	125.7	437.2
6/20/2017 19:00	126.0	437.9
6/20/2017 20:00	126.8	437.6
6/20/2017 21:00	127.1	438.7
6/20/2017 22:00	126.6	423.6
6/20/2017 23:00	126.3	412.1
6/21/2017 0:00	126.0	385.9
6/21/2017 1:00	125.0	312.5
6/21/2017 2:00	121.7	251.5
6/21/2017 3:00	119.8	224.7
6/21/2017 4:00	119.8	213.2
6/21/2017 5:00	119.7	213.6
6/21/2017 6:00	120.4	214.2
6/21/2017 7:00	121.1	220.7
6/21/2017 8:00	120.7	218.4
6/21/2017 9:00	121.2	251.3
6/21/2017 10:00	125.1	365.8
6/21/2017 11:00	125.8	506.5
6/21/2017 12:00	126.8	533.6
6/21/2017 13:00	126.9	527.1
6/21/2017 14:00	126.5	526.9
6/21/2017 15:00	126.8	527.1
6/21/2017 16:00	127.1	526.7
6/21/2017 17:00	127.5	530.8
6/21/2017 18:00	113.1	227.9


ADP (blue) vs SO2 Removal Rate (red)
120
100
80
60
40
20
0
-20
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
1000
2000
3000
4000
5000
6000


RH (red) vs SO2 Removal (blue)
90
80
70
60
50
40
30
20
10
0
-10
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
1000
2000
3000
4000
5000
6000


Sensor A (Blue) vs Sensor B (Red)
45
40
35
30
25
20
15
10
5
0
0
1000
2000
3000
4000
5000
6000

Scrubber Metrics

- Dew point varied by 15 degrees over the course of 2017
- $672,000 in 2017 lime costs
- Every 5 degrees – 5% savings
- If assuming a safe dew point / the savings is $100,800
- Initially started at 65 degree approach to dew point due to learning the system
- Now at 40 degree approach to dew point
- Tube leak detection at scrubber inlet
- No corrosion seen during outages

Tube Leak Occurrence

	NID OUT MST A %	NID OUT MST B %	NID OUT MST Average %	SO2 Inlet Rate lb/mm Btu	SO2 Outlet Rate lb/mm Btu	NID M8 Inlet Temp Avg °F	NID M8 Outlet Temp Avg °F	NID M8 Dew Point Temp Avg °F	FC Gross MW	Ambient °F	Approach to dewpoint	SO2 removal	Nid M8 Lime Lb/Hr	Outlet temp C	abs humidity	vap pressure	sat pres RH	Delta T of Scrubber
10/7/2017 9:00	16.09	14.75	15.43	0.42	0.112	256.2	172.8	127.7	347.7	67.5	45.10	0.31	254.6	78.21	96.29	156	35.49	83.42
10/7/2017 10:00	15.87	14.58	15.22	0.41	0.110	253.2	171.9	127.0	363.4	67.1	44.94	0.30	254.6	77.75	95.14	154	35.69	81.30
10/7/2017 11:00	16.37	14.72	15.56	0.40	0.091	266.0	171.8	127.0	469.0	67.0	44.77	0.31	254.7	77.67	97.25	157.3	36.59	94.23
10/7/2017 12:00	38.41	35.23	36.82			286.5	184.1	158.5	169.0	66.6	25.60	0.00	76.2	84.52	225.8	372.4	65.74	102.40

H2O Technology

- Absolute Humidity Sensor
  - Direct measurement of the water molecule
  - Dipole moment measuring effect
  - In-situ measurement
- Advantages
  - High temperature operation – 1000 F
  - High particulate operation
  - Minimal maintenance
  - Corrosive and condensing environments a
  - Accurate
  - Robust (sensor life is 10 years minimum)

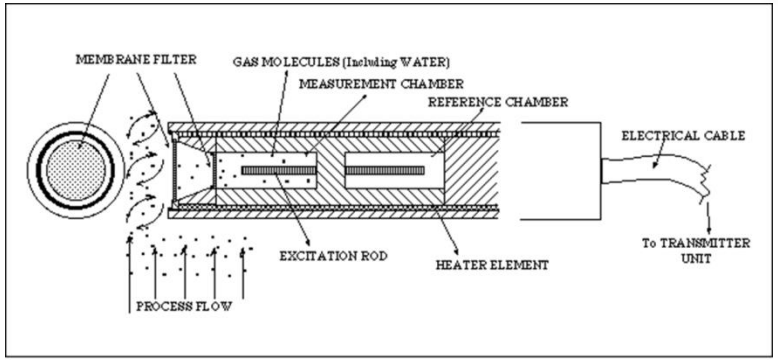
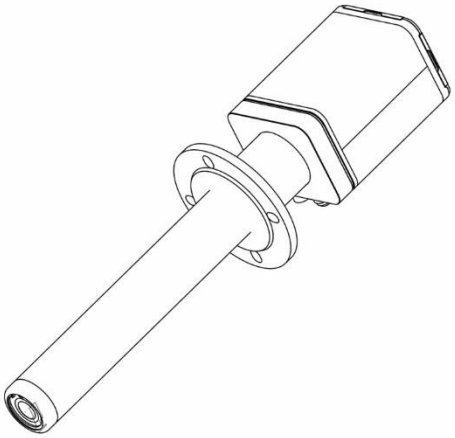


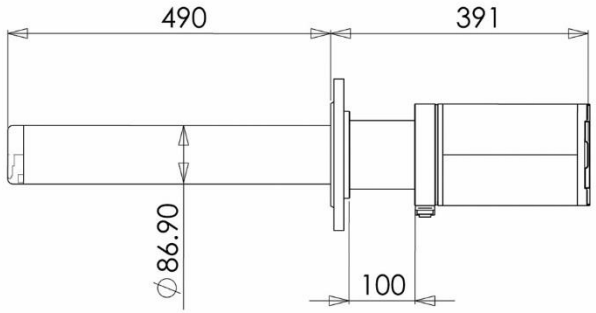
FIG. 3 - PROBE SCHEMATIC

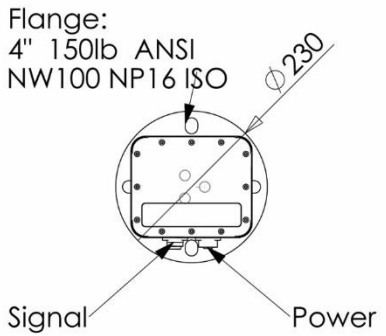
Installation Requirements

- Probe sizes – 490 mm or 1,470 mm lengths
- Flange - 4 inch, 150 lb. ANSI
- Power – 110V, 5 Amps
- Output Signal – 4..20 mA isolated
- Measurement unit – g/m3 corrected to 0C at process pressure
- Other Units – Equations are provided (i.e., dew point, RH, humidity ratio)

Picture / Drawing







Questions / Discussion

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