NOx ANALYZER CONVERTER EFFICIENCY TESTERS

Len Richter

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BACKGROUND

- $NO_X = NO + NO_2$
- CHEMILUMINESCENT TECHNOLOGY DETECTS ONLY THE NO MOLECULE NO + $O_3 = NO_2^* + O_2$
- TO CAPTURE THE NO_2 IN THE SAMPLE, AN NO_2 TO NO CONVERTER IS BUILT INTO THE ANALYZER AHEAD OF THE DETECTOR
- THEREFORE, WE CAN "SAY" WE HAVE A NO_X ANALYZER



WHY TEST EFFICIENCY?

• THE EFFICIENCY OF THE NO $_2$ TO NO CONVERTER DIRECTLY AFFECTS THE REPORTED NO_X VALUE

• CEMS REGULATIONS REQUIRE A MINIMUM OF 90% EFFICIENCY

• THIS REQUIRES TESTING THE EFFICIENCY OF THE CONVERTER PERIODICALLY TO VERIFY



WHY TEST EFFICIENCY?

- TWO TYPES OF NO $_2$ TO NO CONVERTERS
- 1. CATALYST
 - a. WILL LOOSE EFFICIENCY OVER TIME AS THE CATALYST IS USED UP
- 2. STAINLESS STEEL
 - a. CAN BECOME CONTAMINATED (DIRTY) AND THEREFORE LOOSE EFFICIENCY



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WHY TEST EFFICIENCY?

- MANUFACTURERS TYPICALLY RECOMMEND ANNUAL TESTING
- SOME REGULATIONS REQUIRE PERIODICAL
 TESTING
 - i.e., NEW JERSEY QUARTERLY



REGULATIONS

- 40CFR60: STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES
 - APPENDIX A TEST METHODS
 - METHOD 7E DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES (INSTRUMENTAL ANALYZER PROCEDURE)
 - §8.2.4 NO₂ TO NO CONVERTER EFFICIENCY TEST
 - §8.2.4.2 ALTERNATELY USE PROCEDURE IN §16.2
 - §16.2.1 USE PROCEDURE IN 40CFR86.123-78



40CFR86

- SUBPART B
 - §86.123-78 OXIDES
 OF NITROGEN
 ANALYZER
 CALIBRATION



FIGURE D79-4 NO, CONVERTER EFFICIENCY DETECTOR



CiSCO'S CE TESTERS

• TWO MODELS

- 1. MANUAL MODEL 2910
 - a. PORTABLE CAN BE USED IN MULTIPLE SYSTEMS

b. TECHNICIAN HANDWRITTEN REPORT

- 2. AUTO MODEL 2920
 - a. BUILT INTO SYSTEM PLC CONTROL
 - b. CeDAR GENERATED REPORT







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- OUTPUT-TO ANALYZER MANIFOLD
- INPUT-INSTRUMENT AIR
- INPUT-NO/N₂ (EXISTING SPAN CYLINDER)

MANUAL MODEL 2910

• POWER – 120 VAC

• GAS

• REQUIRED CONNECTIONS





• DRY INSTRUMENT AIR

• Tap off instrument air downstream of air dryer using TEE fitting and shut-off (plug) valve to be capped when not in use.

• NO SPAN GAS

 Install three-way value in cal gas manifold prior to calibration gas flowmeter to reroute NO cal gas from system to tester. Cap when not in use.

• CE TESTER OUTPUT

• Install three-way value in sample stream prior to sample manifold to reroute analyzer sample stream from system to CE Tester output. Cap when not in use.





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- ANALYZER SETUP
 - SET TO AUTO NO_X/NO MODE
 - INPUT/CHECK RANGE AND SPAN VALUES FOR BOTH
 - CHECK/SET CE COEFFICIENT TO 1 ON TAPI ANALYZERS
 - ZERO AND SPAN BOTH NO AND NO_X CHANNELS
 - SUGGEST SET READ TIME TO 5 SECONDS
 - RETURN ANALYZER TO NO_{X} MODE AFTER TEST DONE

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CONVERTER EFFICIENCY TEST PROCEDURE GRAPH

Step 1 -	Step 2 -	Step 3 -	Step 4 -	Step 5 -	Step 6 -	Calculation
Position OFF	Position 1	Position 2	Position 3	Position 4	Position 5	
Connect and Activate	Zero Analyzer	Span Analyzer On Cal Gas	Dilution Air Added	Ozonator On	NO Gas Off	Calculate Converter Efficiency
NO _x ACET						[1+(a-b-e)/(c-d)] * 100 =
			NO Value ≈ 90% of Step 3 Value			- % Efficiency
			NO = c	NO = d		
			$NO_x = b$	NO _x = a	$NO_x = e$	
				NO Value ≈ 20% of		
				Step 3 Value (Note 1)	NO _x LT 0.1 ppm	
Note 1: Must be	GT 10% of step	o 3 value.				

NO_X ANALYZER

NO₂ to NO CONVERTER EFFICIENCY TEST PROCEDURE

40CFR86 SUBPART B §86.123-78(a)

STEP	CE TESTER	NO _X ANALYZER	VALUE
1	Connect CE Tester per Diagram 1. Turn Rear Panel Power Switch On.	Place NO _X Analyzer in NO/NO _X mode	
2	Turn CE Tester Switch from OFF Position to Position 1 – Adjust Air Flow for about 0.6 LPM -	Zero both NO and NO _X Channels	NO: NO _X :
2	Place CE Tester Switch in Position 2 – Adjust NO Flow for about 4 LPM	Span the NO Channel on the NO Value of the Span Cylinder	NO:
3	NO_X Value LT 105% of NO Value	Span NO _X Channel on the NO _X Value of the Span Cylinder	NO _X :
4	Place CE Tester Switch in Position 3 – Adjust NO flow until the value of the NO Mode of the analyzer is 80% to 90% of Step 3	NO Channel Value NO _X Channel Value	c= b=
5	Place CE Tester Switch in Position 4 – Allow time for the value of the NO Mode of the analyzer to decrease to about 20% of Step 3	NO Channel Value NO _X Channel Value	d= a=
6	Place CE Tester Switch in Position 5	NO _X Channel Value	e=

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NO_X ACET DOCUMENTATION FORM

DATE:
PLANT NAME:
UNIT ID:
NOX ANALYZER MODEL:
NOX ANALYZER SERIAL No:
NOX ANALYZER RANGE:
SPAN CYLINDER No:
SPAN CYLINDER NO VALUE:
SPAN CYLINDER NOX VALUE: <u>*</u>
NO ZERO VALUE FROM STEP 2:
NOX ZERO VALUE FROM STEP 2:
NO SPAN VALUE FROM STEP 3:
NOX SPAN VALUE FROM STEP 3:
NO + O2 VALUE FROM STEP 4:
NOX VALUE OF NO + O2 FROM STEP 4:
NO + O3 VALUE FROM STEP 5: d=
NOX VALUE OF NO + O3 FROM STEP 5: a=
NOX VALUE OF AIR + O3 FROM STEP 6 e=
Percent Efficiency = [1 + (a-b-e) / (c-d)] * 100
[1 + () / ()] * 100 =
*NOX Value must be Less Than 105% of NO Value Note: Percent Efficiency must be greater than 90% Keep this form for your records.

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CEMS Technician:

• LIMITATIONS

- + TESTED ONLY ON VACUUM NO_{X} ANALYZERS
 - TAPI 200 AND TEI 42
 - MIGHT WORK ON PRESSURE NO_{X} ANALYZERS JUST HAVE NOT TRIED
- NO₂ CREATION LIMITED
 - GOOD FOR 10 ppm FULL SCALE RANGE ANALYZER
 - COULD BE STRETCHED TO 20 ppm FULL SCALE RANGE ANALYZER
 - PROBABLY WON'T BE ABLE TO DRIVE NO DOWN TO 20% IN STEP 5 BUT WOULD STILL PROVIDE GOOD EFFICIENCY TEST







- RACK MOUNT 5-1/4" HEIGHT
- PLUMBED AND WIRED INTO SYSTEM
- PLC CONTROLLED
 - STEP TIMES OPERATOR INPUT
- OIT OR CeDAR REAL-TIME INTERFACE
 - ONE INPUT START TEST
- CeDAR GENERATED REPORT



- ADDITIONAL SYSTEM REQUIREMENTS
 - PLUMBING
 - TWO (2) THREE WAY 24 VDC SOLENOID VALVES
 - CONTROL
 - FIVE (5) PLC RELAY OUTPUTS (24 VDC)
 - SIGNAL
 - ONE (1) PLC ANALOG INPUT CHANNEL









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NO_X ANALYZER CONVERTER EFFICIENCY TEST PROCEDURE

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7	CALCULATION
NO _X READING ON ANALYZER	NO READING ON ANALYZER	NO READING ON	NO READING	NOx READING ON	NO _X READING ON ANALYZER	NOx READING ON	CALCULATE
			ON ANALYZER	ANALIZER		ANALYZER	CONVERTER EFFICIENCY
SPAN GAS	SPAN GAS	=c		=a	b=		[1+(a-b-e)/(c-d)] *100 =
ON	ON	SPAN GAS ON	SPAN GAS ON	SPAN GAS ON	SPAN GAS ON	SPAN GAS OFF	% EFFICIENCY
		DILUTION AIR ON	DILUTION AIR ON	DILUTION AIR ON	DILUTION AIR ON	DILUTION AIR ON	
			OZONE ON	OZONE ON	OZONE	OZONE ON	
		≈90% OF STEP 2	≈20% OF STEP 2		OFF		
			=d				
			MIN 10%				
						=е	
NO _X MODE	DE NO MODE			NO _X MODE			

AUTO MODEL 2920 CeDAR REPORT

Training System TEI NOx Converter Efficiency **CiSCO** Training System

Test Information			Analyzer and Monitor Information			
Tes Res	t Date ult	9/13/2021 Passed		Range Instrum Manufa Model Serial N	ent Span cturer lumber	Low 10 ppm THERMO 42ILS 1160600008
	Step	Time	Reference Gas	CEMS Response		Cylinder Information
NO2	1 (g) (NOx) 2 (f) (NO) 3 (c) 4 (d) 5 (a) 6 (b) 7 (e) NOx C NO2 C Content Deten NO2 content m NO2 content m NO2 content m NO2 content m NO2 content m	8:40 AM 8:41 AM 8:42 AM 8:44 AM 8:46 AM 8:46 AM 8:50 AM converter Efficiency (%) content (% of NOx) mination ust be < 5% of NOx cont 8% of NOx reference gas ntration from step 1 [86,1 refution from step 1 [86,1]	† † 11 n/a n/a n/a 96.3 -2.1 ent [40 CFR 86. s = ((NOx - NO) 23-78(a)(4)] 23-78(a)(4)]	9.41 9.61 8.75†† 1.40‡‡ 8.34 8.54 0.07 <i>LimitMin 90</i> <i>Limit 5</i> 123-78(a)(4)] / NOx) * 100	Passed	
NOx	Converter Perc PE must be > 5 PE = (1 + ((a - a = NOx concer b = NOx concer c = NO concer d = NO concer e = NOx concer by ozone lar	ent Efficiency Determina 10% [40 CFR 86.123-78(b - e) / (c - d)) * 100 intration measured in step intration measured in step tration measured in step intration measured in step intration measured in step intration measured in step intration measured in step	tion a)(11)] o 5 [86.123-78(a) o 6 [86.123-78(a)(3 [86.123-78(a)(4 [86.123-78(a)(o 7 (optional; cor)(8)])(9)] 6)] 7)] npensates for s	small amount	t of NO/NO2 generated
† Fn	om cylinder cert	ification sheet				
† Fri ‡ Sh	om cylinder cert ould be approxi	ification sheet mately 80% (8 ppm) of th	e range (10 ppn	n) [86.123-78(a	a)(4)].	
† Fri ‡ Sh †† 8	om cylinder cert ould be approxi .1685 - 9.1295 j	lfication sheet mately 80% (8 ppm) of th ppm is recommended. Sh	e range (10 ppn ould be approxi	n) [86.123-78(a mately 90% (8.	a)(4)]. 649 ppm) of	f [86.123-78(a)(6)].

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• LIMITATIONS

- + CURRENTLY THERMO 42 NO_{X} ANALYZERS ONLY
 - ALLOWS REMOTE MODE CONTROL
 - T SERIES TAPI NOX ANALYZERS DO NOT HAVE THIS CAPABILITY
 - NEW TAPI "N" SERIES MAY HAVE THIS FEATURE
- NO₂ CREATION LIMITED
 - GOOD FOR 10 ppm FULL SCALE RANGE ANALYZER
 - COULD BE STRETCHED TO 20 ppm FULL SCALE RANGE ANALYZER
 - PROBABLY WON'T BE ABLE TO DRIVE NO DOWN TO 20% IN
 STEP 5 BUT WOULD STILL PROVIDE GOOD EFFICIENCY TEST



40CFR86 PROCEDURE CLARIFICATION

- APPLIES TO BOTH MODELS
- ADDED A FINAL STEP TO 40CFR86 PROCEDURE
- NO_X VALUE ON AIR WITH OZONATOR ON ABT. 0.05 ppm
- ADDED THIS VARIABLE INTO THE CE CALCULATION
- COMPENSATE FOR NO₂ CREATED BY OZONE LAMP FROM NITROGEN IN THE AIR



CISCO CONVERTER EFFICIENCY TESTERS

QUESTIONS?

