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: PM CEM – Optical Technology and PS-11

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Outline

- : Optical PM CEM Technology Overview
 - : Opacity
 - : Scatter Light
- : Review of PS-11 Initial Correlation Audit (ICA)
 - : Requirements
 - : Field Experience
- : QA/QC Requirements (Procedure 2)
- : Response Correlation Audits (RCA)
- : Discussion

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: Measurement Technology Overview

Measuring Principle
Transmission

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- Measuring the amount of light received as a fraction of the amount of light emitted
- Opacity (Op) is the % of light lost
- Transmission (T) is the % of light received
- Calculation of the dust concentration
- Useable for medium and high dust concentrations



Transmission: $T = I/I_0$
 Opacity: $Op = 1 - T$
 Extinction: $E = \log(1/T) = -\lg(T)$

Linearity between Extinction and dust concentration described through:
 Lambert-Beersches law: $E = k \cdot c \cdot L$

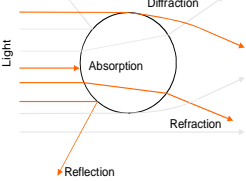


I = Received light
 I_0 = Sent light
 k = Extinctioncoefficient
 c = Dust concentration
 L = Path length (2 times)

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Measuring Principle
Scattered light

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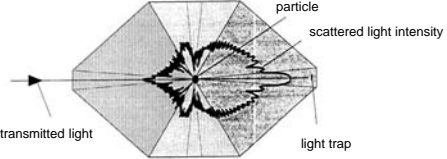
- Optical principle
- When light hits the particle, it is scattered
- Relation between the scattered light intensity and dust concentration
- Useable for low to medium dust concentrations

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Measuring Principle
Scattered light

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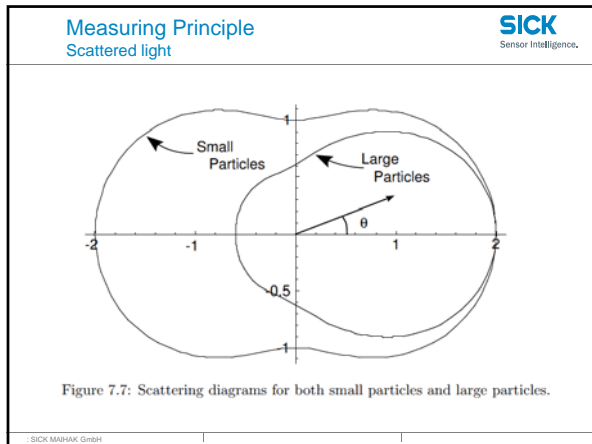
particle
scattered light intensity
transmitted light
light trap

90°-area
forward scattering area(0°)
backward scattering area (180°)

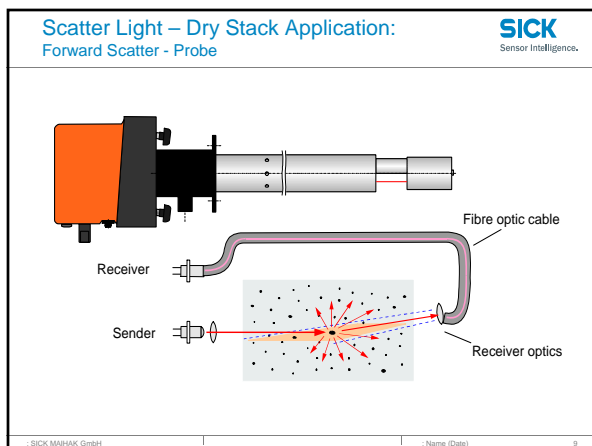
small angel measurement
wide angel measurement

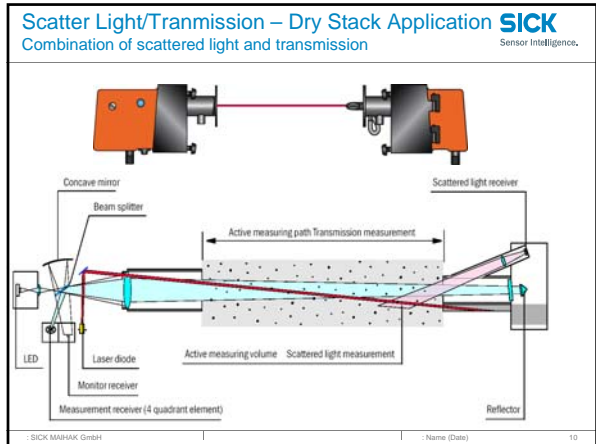
*Fortschrit-Berichte VDI Reihe 8, Nr. 773, Düsseldorf: VDI Verlag 1999

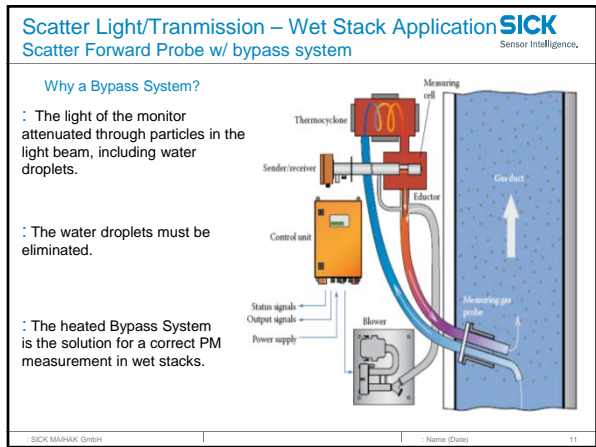
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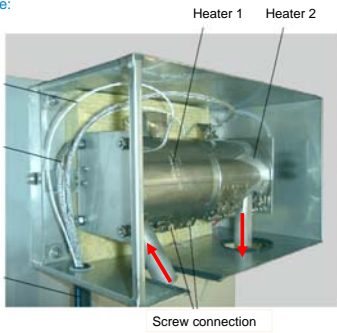




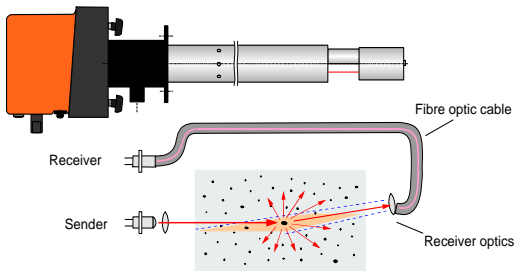
Scatter Light/Tranmission – Wet Stack Application **SICK**
Scatter Forward Probe w/ bypass system Sensor Intelligence.

Thermo cyclone:

Connection cable for heater and temperature sensor

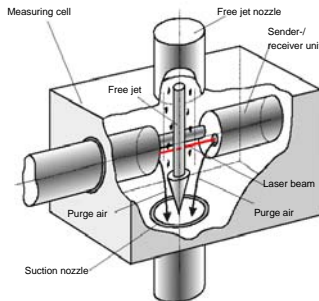


Scatter Light – Dry Stack Application:
Forward Scatter - Probe



Scatter Light/Tranmission – Wet Stack Application **SICK**
Scatter Forward Probe w/ bypass system Sensor Intelligence.

Function of the measuring cell:



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PS11 Correlation and Field Data

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Initial Correlation Audit

PS11 - Initial Correlation Audit (ICA)

- Pass the 7-day drift test
 - +/- 2% of Zero and Span Value
 - Zero – 0-20% of FS; Span – 50-100% of FS
- PS-11 Correlation requirements
 - Conduct at least 15 reference method tests at 3 particulate mass concentrations that represent the range of unit operation – de-tune process to achieve higher mass loadings
 - 95% confidence interval half range must be within 10% of PM emission limit
 - Tolerance interval half range must have 95% confidence that 75% of all possible values are within 25% of the PM emission limit


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Initial Correlation Audit


Field Installation:

- Unit Size: 525 MW
- Mounting Location: 200 ft
- Downstream disturbance: 75 ft
- Upstream disturbance: 400 ft
- Stack diameter: 19.5 ft
- Flue gas temp: ~130 °F



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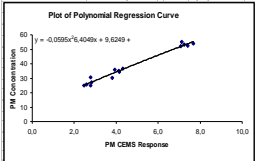
Initial Correlation Audit SICK
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Summary of Acceptance Criteria for PS-11			
Criterion	Actual	Allowable	Acceptable?
Correlation coefficient	0.988	≥ 0.985	yes
Confidence interval	± 2.4%	± 2.0%	yes
Tolerance interval	± 3.3%	± 2.5%	yes

* Indicates correlation coefficient is undistorted

Check for Correlation Curve Minimum/Maximum	
Correlation curve minimum point	NA
Minimum allowable x value	NA
Is correlation curve maximum = minimum x value?	NA
Correlation curve maximum point	93.8
Extrapolation limit for x (125% of maximum x value)	9.6
Is correlation curve maximum = extrapolation limit?	yes



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QA/QC – Procedure 2 SICK
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PS11 - Absolute Correlation Audit (ACA)

- : Quarterly filter audit of PM CEM (unless RRA or RCA is performed)
 - : No fewer than 2 months between tests
- : 3 filter ranges tested 3 times each (similar to opacity filter audit)
 - : Low: 0-20%
 - : Mid: 40-60%
 - : High: 70-100%

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QA/QC – Procedure 2 SICK
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Absolute Correlation Audit Testing Results

Date	Reference Filter	Reference Value (%)	Response Value (%)	Absolute Difference (%)
January	1	0.00	0.0	0.0
	2	37.9	37.8	0.1
	3	55.3	56.2	0.9
	4	92.6	92.8	0.2
April	1	0.00	0.0	0.0
	2	37.9	37.1	0.8
	3	55.3	56.0	0.7
	4	92.6	93.1	0.5
June	1	0.00	0.0	0.0
	2	37.9	37.9	0.0
	3	55.3	55.6	0.3
	4	92.6	93.2	0.6

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QA/QC – Procedure 2



PS11 - Relative Response Audit (RRA)

- : Annual check of PM CEM response
- : 3 simultaneous Reference Methods tests in comparison to PM CEM "as found" status.
- : In compliance if:
 - : 2 of the 3 tests are within +/- 25% of the permit limit of the ICA curve
 - : 2 of the 3 tests are within the output range of the original curve

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Response Correlation Audit



PS11 - Response Correlation Audit (RCA)

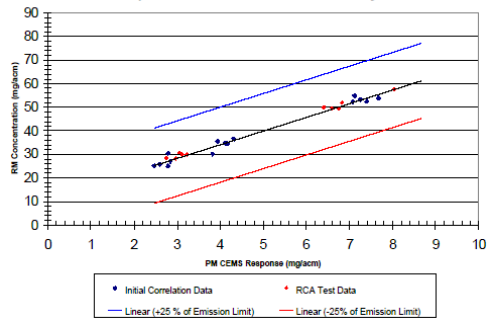
- : Verify curve stability over time
- : Requirements
 - Conduct at least 12 reference method tests at 3 particulate mass concentrations
 - Each of the 12 runs must be less than or equal to the highest value obtained during the PS-11 testing
 - Must have 9 out of 12 inside the range of values used to create the correlation curve
 - 75% of the 12 data points must fall within two parallel lines that represent +/- 25% of the equivalent emission limit from the correlation curve
- : Failure to pass an RCA is usually caused by a change in the process or a process condition that was not accounted for in the correlation plan.

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Response Correlation Audit



Response Correlation Audit Summary



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Summary



- : There are over 100 PM CEM of various technologies installed and certified to PS-11 in the US
 - : Power (Majority)
 - : Cement

- : The initial correlation audit is the biggest challenge with installing a PM CEM
 - : Varying of the dust load
 - : Proper planning is key
 - : System is only as accurate as the Reference Method comparison

- : QA/QC is similar to that of a standard opacity/CEM device

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: Discussion – Questions?
