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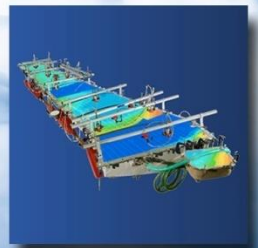
Philadelphia, Dec.05 2013

Comparison of Toxicity Test Methods

Diploma Thesis by Alexander Spieß



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Test Fixture

- MarlinEngineering ME1100-1 Smoke Density Chamber
- Smoke Density Test
- Smoke extraction via 4 tubes in center of chamber after SD-Test

Test Methods

- **amh-systems FGA5**
  - → Measurement of CO, NO_x and SO_2
  - → Flue gas analyzer
  - → Non reactive gases

- **Draeger-tubes**
  - → Measurement of HCl, HF and HCN
  - → Smoke extraction by device controlled pump amh-systems DCP4

Test Methods

▪ Wet Analysis

→ Measurement of HF

→ Gas-washing bottle

→ Gas extraction by DCP4

→ Per AITM 3.0005

▪ IGS Gas Analysator

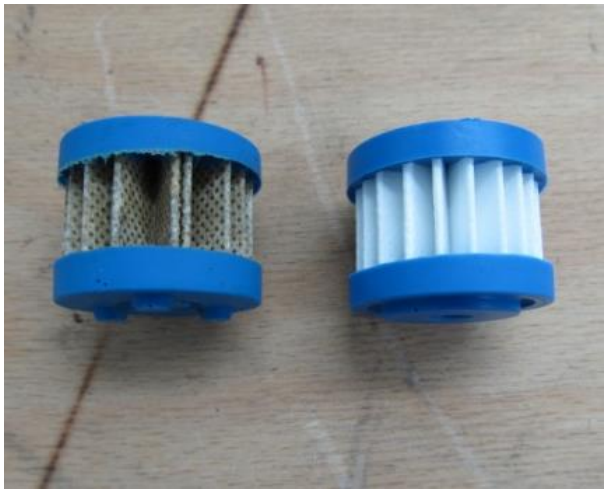
→ Measurement of CO, NO_x, SO_2, HCl, HF and HCN

→ Gas extraction by DCP4

Sources of Error

Following Sources of Error have been identified during the tests:

- Clogging of Draeger tubes
- Clogging of microfilter FGA5

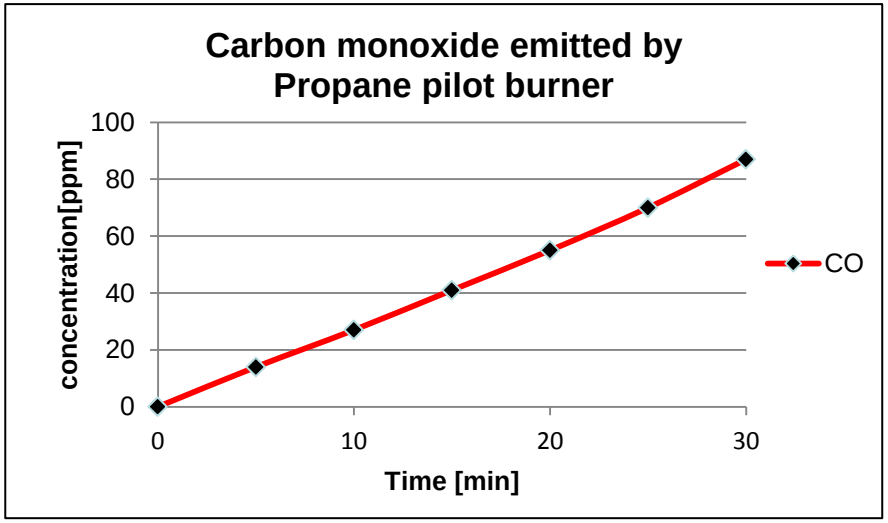


Sources of Error

- Influence of cleaning of the Smoke Density Chamber
- Remainings of Hydrogen-Fluoride in test fixture
- Influence of Propane pilot burner

HF	HCl
5,7	50
11,9	100
47,9	100
59,2	100
74,3	100
79,5	100
62,7	100
90,9	100
92	100
90,5	100
61,5	**95,0**

HF
35,9
12,2
11,2
3,14
0,3
0,3
0,1
0
0
0
6,3



Comparison of Test Methods

- **Calculation of Standard deviation**

- **Error propagation**

Calculation of standard deviation

Calculation of all standard deviations

▼

Filter irrelevant standard deviations

▼

Correction of Standard deviations according to problem statement

▼

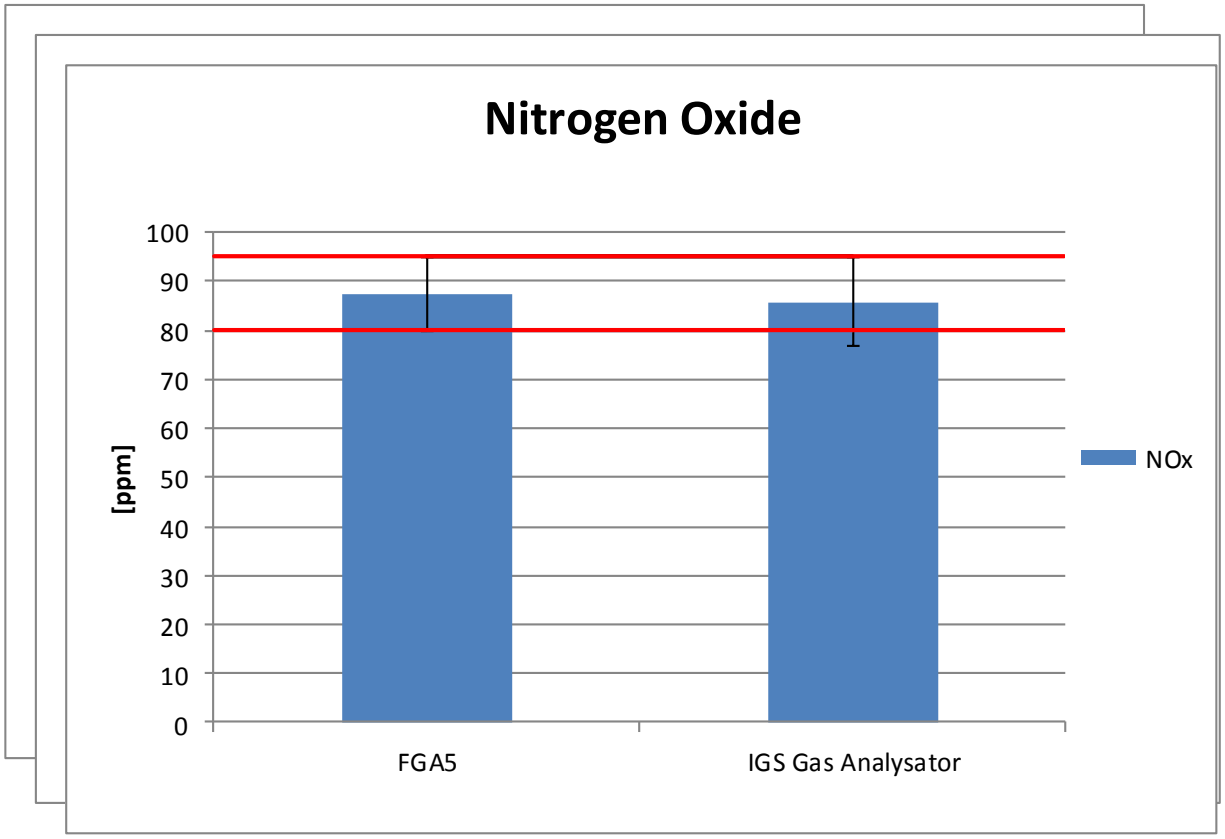
Comparison of test methods on the basis of standard deviation

Standard deviations

Sample number	HF	HCL	HCN	CO	NO_x	SO_2
Panel 16E						
K 0616	---	---	---	± 10,37 %	± 17,86 %	---
K 0617	---					
K 0618	---	---	---	± 9,76 %	± 25,27 %	---
Panel 16E + ISOVOLTA Airdec F1 / FOG						
K 0619	---	± 0,00 %	---	± 8,48 %	± 25,63 %	---
K 0620	± 13,12 %					
K 0621	± 20,84 %	± 22,79 %	---	± 6,36 %	± 17,24 %	---
Panel 16E + Schneller Aerfilm LHR / NEW DARK SHATTER						
K 0622	---	± 5,74 %	---	± 8,43 %	± 28,47 %	---
K 0623	± 28,72 %					
K 0624	± 18,70 %	± 10,50 %	---	± 6,08 %	± 23,12 %	---
Teflon 2.0 mm						
K 0625	---	± 44,21 %	---	± 10,58 %	---	---
K 0626	± 29,00 %					
K 0627	± 7,67 %	± 15,50 %	---	± 4,55 %	---	---
Leather / Vienna Grey / Lantal Textiles						
K 0628	---	---	± 29,75 %	± 11,28 %	± 8,32 %	± 17,10 %
K 0629	---					
K 0630	---	---	± 25,66 %	± 14,96 %	± 10,52 %	± 14,58 %
Europlex PPSU / Clear 4.0 mm / Evonik Röhm GmbH						
K 0631	---	---	---	± 12,73 %	---	± 18,41 %
K 0632	---					
K 0633	---	---	---	± 15,62 %	---	± 11,90 %

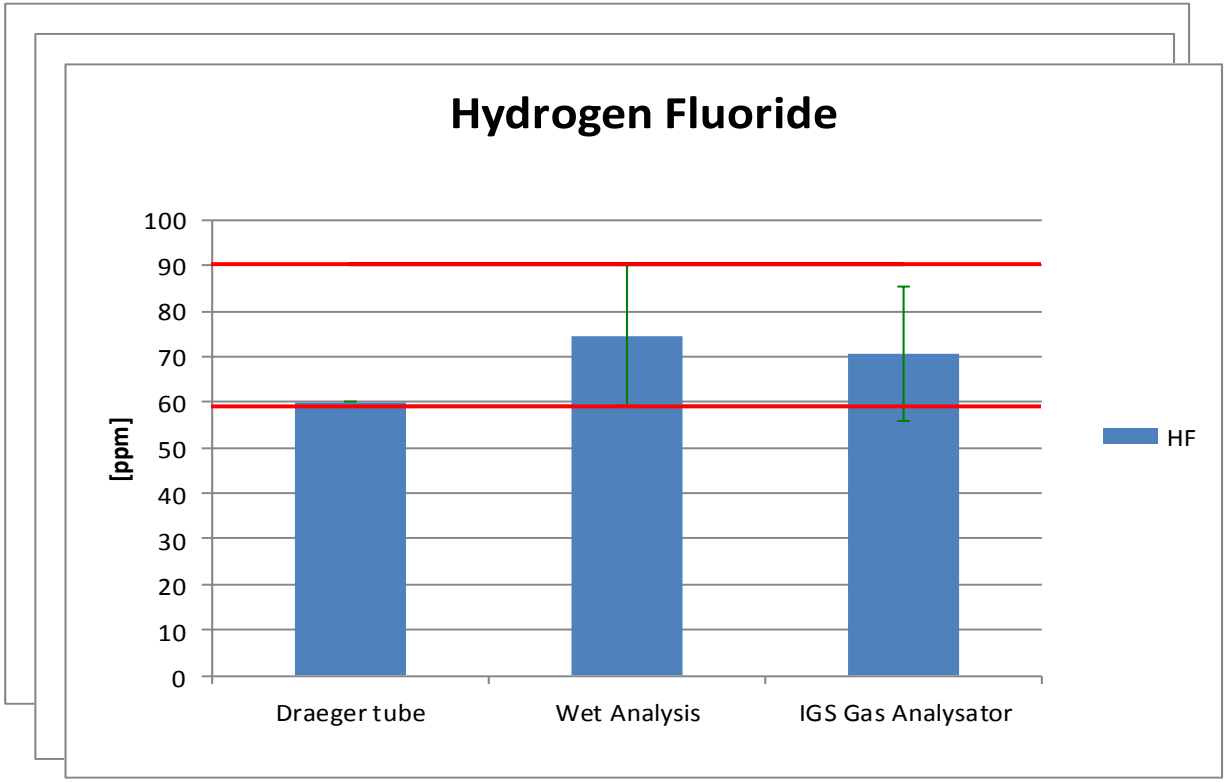
Comparison of Test Results

- **Sample: Leather**



Comparison of Test Results

- **Honeycomb Panel with Decorative Laminate**



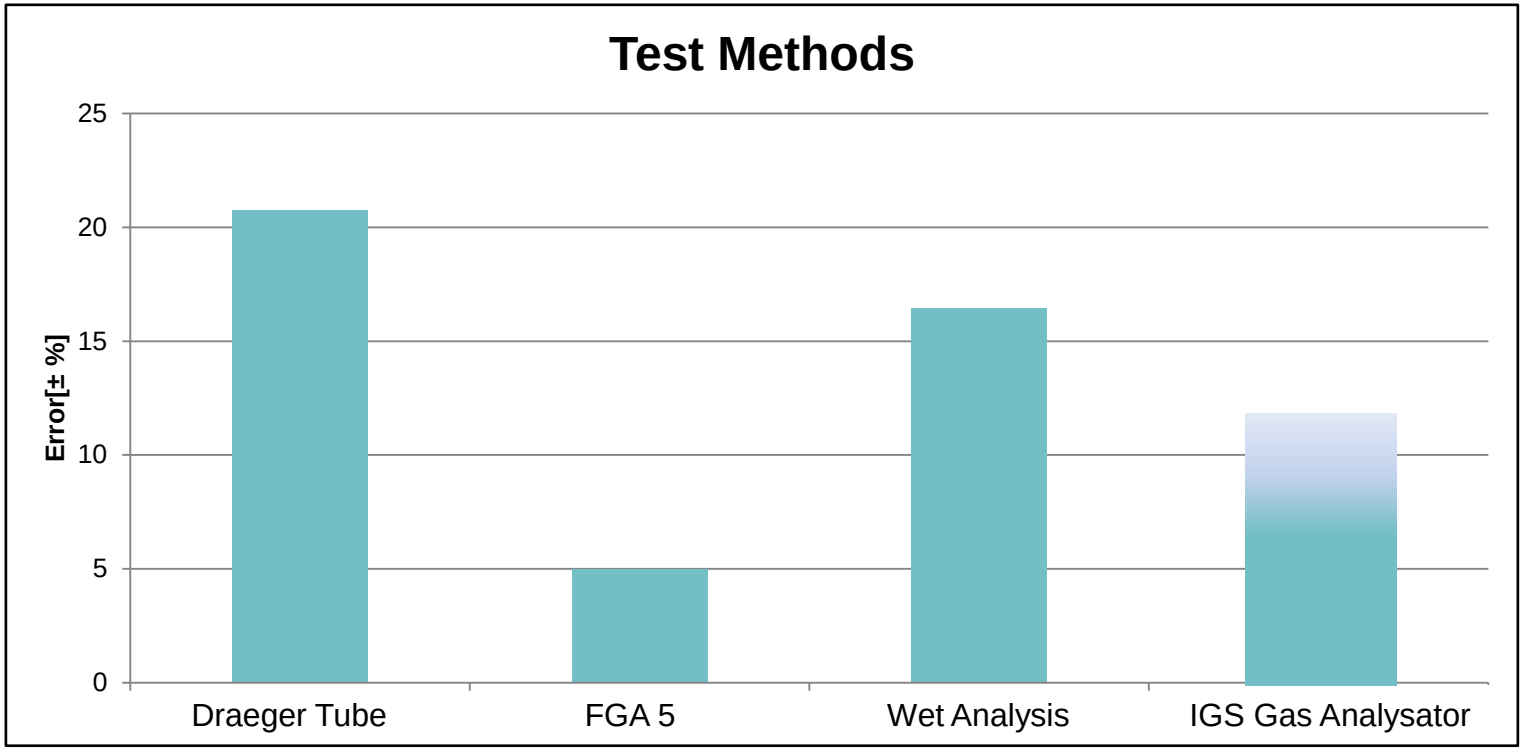
Error propagation

- **Sources of Error for Test Methods**

FGA5	Draeger	Wet Analysis	IGS
• Flue gas analyzer FGA5 (± 5 %)	• DCP4 (± 5 %) • Draeger tubes(± 15 %) • Scale difficult to read exact result	• DCP4 (± 5 %) • pH/ISE-Meter (± 0,05 %) • Volume of measuring solution (± 0,3 %) • evaporation of measuring solution (± 2 %) • composition of measuring solution (± 2 %) • decanting (± 2 %) • filling to reference mark (± 0,1 %) • Bubble size / number (± 2 %) • Composition of calibration solutions for electrode (± 2 %)	• IGS Gas Analysator (± 5-10 %) • distance from gas extraction location to device (± 2 %)

Error propagation

- **Maximum Error**



Conclusion

- For non-reactive gases the flue gas analyzer has advantage over IGS Infrared Gas Analyzer
- For reactive gases the IGS Infrared Gas Analyzer has superior precision in comparison to wet analysis and Draeger tubes
- Wet analysis has many sources of error
- Gas needs to be extracted from chamber for analysis with IGS Infrared Gas Analyzer, result depending on tube length
- Heated tubes minimize influence
- IGS Infrared Gas Analyzer is the fastest and easiest test method