WÖLFLE
CLEVER. EFFIZIENT. ERFINDERISCH

Adsorption Test
Following DIN EN 14387
ON FILTER ELEMENTS

TEST Report 313683

August 23rd, 2018

FOLLOWING DIN EN 14387

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1. Objectives and Test Set-up

The dynamic adsorption capacity of a bulk bed filters had to be tested following DIN EN 14387.
The test setup corresponds to the standard ISO 11 155 Part 2 'Air filters for motor vehicle compartments'. All tests carried out are listed in the test matrix below.

Variations from the standard: The filters were not subjected to a mechanical strength test prior gas testing or a special temperature / humidity conditioning (except the conditioning at test conditions). Only one filter per gas had to be tested.

The test bench comply with the ISO-Standard 11155-2 „Air filters for passenger compartments of motor vehicles".

a) Requested by: Wölfle GmbH
b) Test specimen / Construction: Filter element with activated carbon in a metal frame
c) Dimensions: ca. 295 x 246 x 180 mm (without sealing)

Table 1: Sample Information

Att.	Test gas	Chemical compound	Filter ID	Delivery date
1	NH_3	Ammonia	313683	06.08.2018
2	CHX	Cyclohexane	313683	06.07.2018
3	H_2S	Hydroen Sulfide	313683	06.07.2018
4	SO_2	Sulfur Dioxide	313683	10.04.2018

Table 2: Test Procedure

Test Wölfle-No.: 313683	A1	A2	A3	A4
Filter Weight	X	X	X	X
Pre Conditioning in climate chamber	X	X	X	X
Adsorption Ammonia (NH_3) 500 ppm, 50 min	X			
Adsorption Cyclohexane (CHX), 500 ppm, 70 min		X		
Adsorption Hydrogen Sulfide (H_2S), 500 ppm, 40 min			X	
Adsorption Sulfur Dioxide (SO_2), 500ppm, 20 min				X

Test Conditions:

Flow Rate: 40 m³/h
Temperature: 20°C ± 2°C
Relative Humidity: 70% ± 2 %
Test Dust Concentration: 500 ppm
Test Gas: see above
Test Duration: see above

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The accuracy of the flow controls is 2% of the nominal value. Pressure drops were measured using a sensor of the range 0 – 1600 Pa. The accuracy of the pressure transducers is 1% of the range maximum.
The analysis of cyclohexane was done with a FID 3006, (Sick Maihak GmbH). The measurement range of 0 ppm – 1000 ppm is used. The detection limit is <0,5 ppm absolute.

The analyses of Ammonia has been done with a FTIR, company Gasmet, Model DX4030.
Concentrations < 0,1 ppm with FTIR are considered as less reliable. The standard deviation of the zero level is 0,02-0,03 ppm.

For determination of the Hydrogen Sulfide-concentrations the Hydrogen Sulfide is converted into Sulfur Dioxide in a converter at about 1000°C. The analysis is done with the Sulfur Dioxide analyser Model 8850 E. The measurement range of 0 ppm – 50 ppm was used.

2. Results

The detailed results of the adsorption test are shown in the attachments 1 through 4. The key results are summarized in the following table.

Table 3: Summary of the most important results

313683	Test Gas	Pressure Drop at 40 m^3/h (Pa)	Initial Breakthrough (ppm)	Breakthrough at the end of test (ppm)	Capacity at the end of test (g)	Test Duration (min)
A1	NH_3	589	3,0	5,9	11,32	50
A2	CHX	411	0	3,0	80,30	70
A3	H_2S	645	0	1,8	27,24	40
A4	SO_2	242	0	0	17,34	20

ppa. Peter Geigle
Dipl.-Ing. (FH) / M.Sc.
Leiter Entwicklung und Vertrieb / Head of Development and Sales
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Attachments: 4

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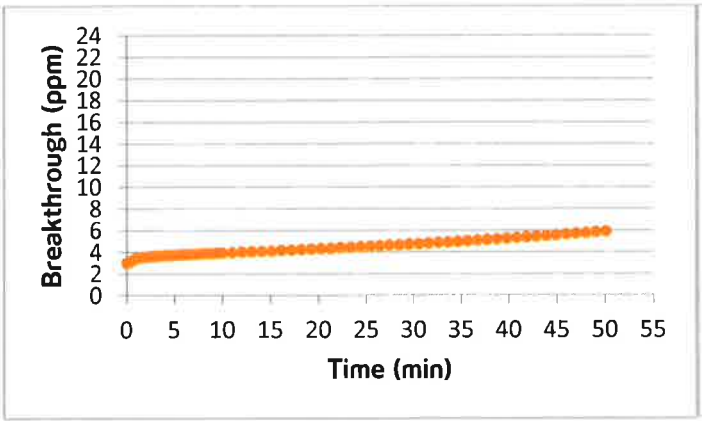
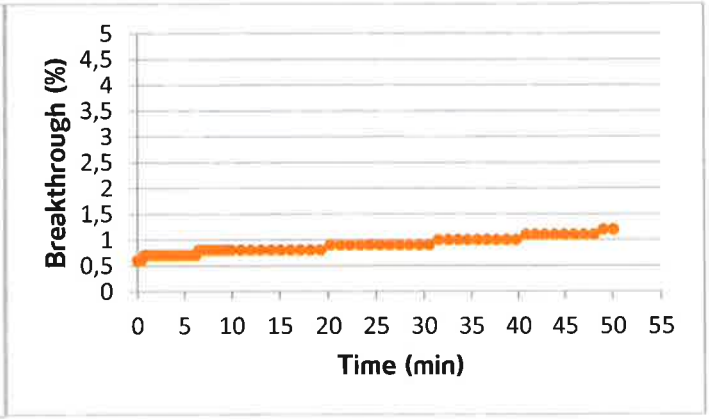
Attachment 1 to Test Report
Summary of Test Results for Sample

Adsorption of 500 ppm Ammonia

Specified Raw Gas Concentration:	500 ppm ± 25 ppm
Average Value of the Raw Gas Concentration:	503 ppm ± 12 ppm
Date of Test:	17.08.2018
Mass of New Filter:	6281,6 g
Mass after Conditioning:	6397,3 g
Flow Rate:	40 m³/h
Pressure Drop:	589 Pa
Temperature:	20°C ± 1°C
Relative Humidity:	70% ± 3%
Initial Breakthrough:	0,6%
Test Duration:	50 min
Capacity:	11318 mg

Conditioning: Pre Conditioning in climate chamber and under test conditions in the test bench for 15 minutes





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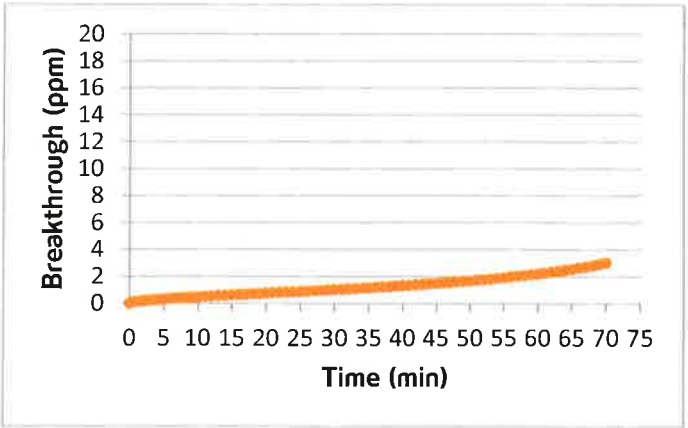
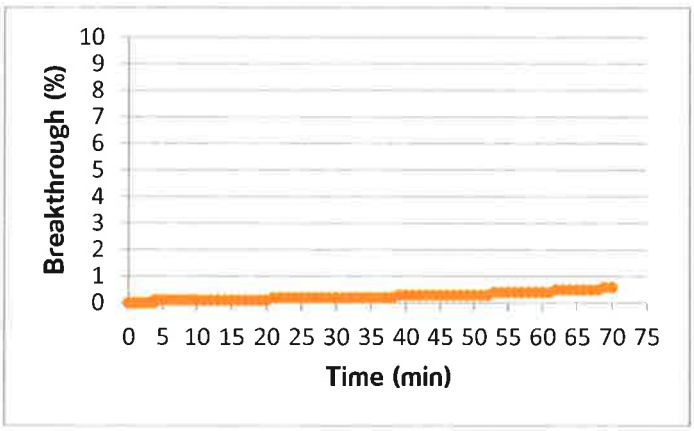
Attachment 2 to Test Report
Summary of Test Results for Sample

Adsorption of 500 ppm Cyclohexane

Specified Raw Gas Concentration:	500 ppm ± 25 ppm
Average Value of the Raw Gas Concentration at Beginning (A):	517 ppm ± 13 ppm
Average Value of the Raw Gas Concetration at the End (B):	514,1 ppm ± 2,02 ppm
Ratio A/B:	1,005
Date of Test:	11.07.2018
Mass of New Filter:	6956,9g
Mass after Conditioning:	7125,1g
Flow Rate:	40 m^3/h
Pressure Drop:	411 Pa
Temperature:	20°C ± 1°C
Relative Humidity:	70% ± 3%
Initial Breakthrough:	0,0%
Test Duration:	70 min
Capacity:	80298 mg

Conditioning: Pre Conditioning in climate chamber and under test conditions in the test bench for 15 minutes.





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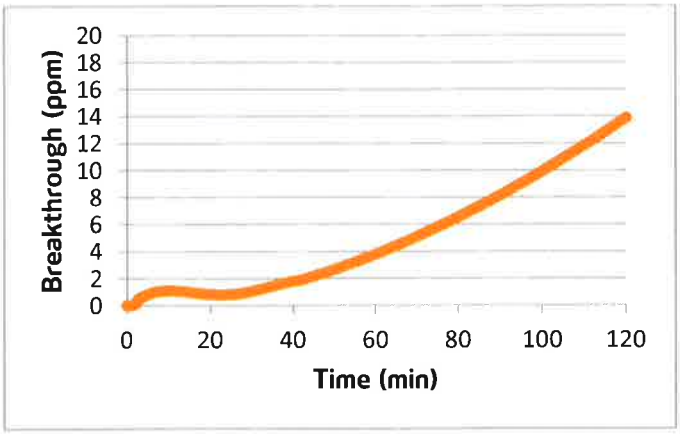
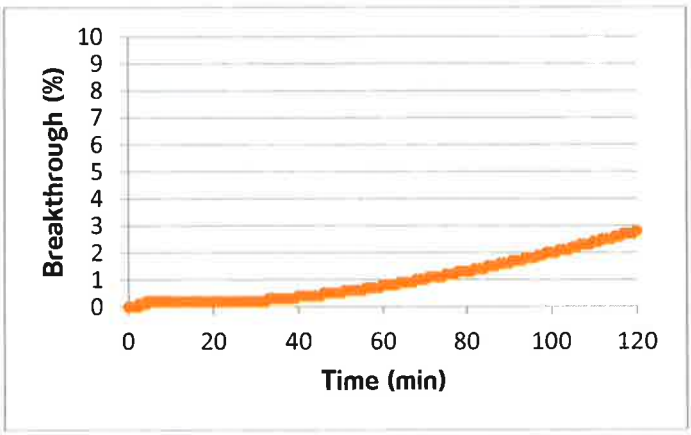
Attachment 3 to Test Report
Summary of Test Results for Sample

Adsorption of 500 ppm Hydrogen Sulfide

Specified Raw Gas Concentration:	500 ppm ± 25 ppm
Average Value of the Raw Gas Concentration at the End (B):	498 ppm ± 11 ppm
Ratio A/B:	0,987
Date of Test:	10.07.2018
Mass of New Filter:	7140,5 g
Mass after Conditioning:	7290,4 g
Flow Rate:	40 m³/h
Pressure Drop:	645 Pa
Temperature:	20°C ± 1°C
Relative Humidity:	70% ± 3%
Initial Breakthrough:	0,0%
Test Duration:	120 min
Capacity:	81042 mg

Conditioning: Pre Conditioning in climate chamber and under test conditions in the test bench for 15 minutes.





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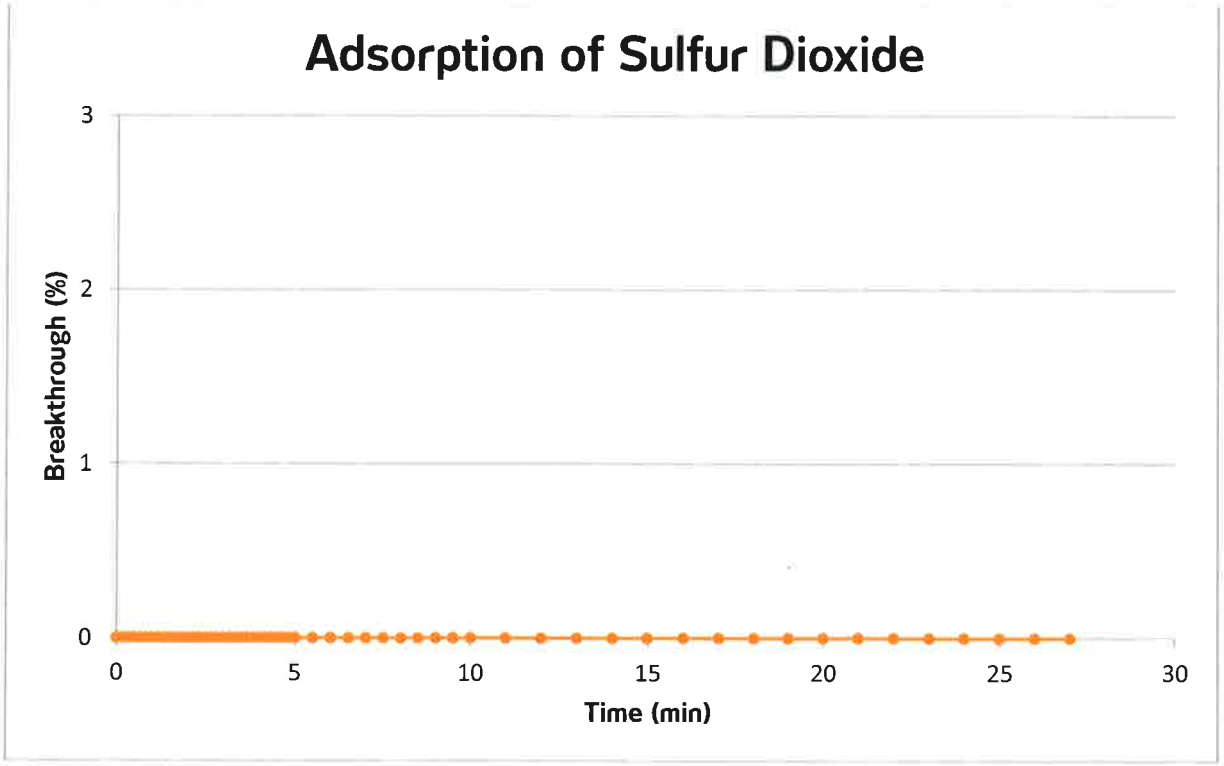
Attachment 4 to Test Report
Summary of Test Results for Sample

Adsorption of 500 ppm Sulfur Dioxide

Specified Raw Gas Concentration:	500 ppm ± 25 ppm
Average Value of the Raw Gas Concentration at Beginning (A):	507,03 ppm ± 0,63 ppm
Average Value of the Raw Gas Concetration at the End (B):	506,25 ppm ± 1,39 ppm
Ratio A/B:	1,002
Date of Test:	17.04.2018
Mass of New Filter:	6405,1 g
Flow Rate:	40 m^3/h
Pressure Drop:	242 Pa
Temperature:	20°C ± 1°C
Relative Humidity:	70% ± 3%
Initial Breakthrough:	0,0%
Test Duration:	20 min
Capacity:	17339 mg

Conditioning: Under test conditions in the test bench for 15 minutes.



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