

Test Report

QIWQ 7741433b

Client: Dexwet Technology GmbH
Heidmayerstrasse 30
A-3100 St. Poelten
Austria

Order of: 11 Oct. 2004

Receipt of samples: 13 Oct. 2004

Test specifications: Testing with regard to the reduction, due to the use of
Dexwet particle filters, of particle emissions in the exhaust air
flow of laser printers

Any test results given relate only to the samples tested.

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1 Scope of work

LGA QualiTest GmbH was to test the reduction, due to the use of Dexwet air filters, of particle emissions in the exhaust air flow of laser printers. The pertinent tests were carried out as comparative measurements. In this context, the particle emissions of laser printers equipped with Dexwet air filters and laser printers without Dexwet air filters were determined.

2 Samples

On 13 October 2004 the samples to be tested were delivered to LGA by Mr Peteln.

3 Test procedures

The emission-reducing characteristics of the filters were tested in two different types of printers: a Lexmark T520 monochrome laser printer and a Kyocera Mita FS-C5016N colour laser printer. Both printers had previously been used for a longer period already. The particle emissions during printing were determined repeatedly and by means of two different measuring methods: with a particle measuring apparatus on the basis of light scattering (Type Partikel Monitor Model 28 D D, DEHA HAAN + WITTMER GmbH, 71292 Friezheim, Germany) and with a gravimetric test method.

4 Testing

Date of testing	14 Oct. 2004
Period of testing	09:30 to 16:00
Duration of print job	14 min (Kyocera FS-C5016N) and 12 min (Lexmark T520)
Number of sheets printed	190 (Kyocera FS-C5016N) and 250 (Lexmark T520)

For the combination of Dexwet air filter / Kyocera printer, particle counts were carried out during the printing stage. In addition, gravimetric dust measurements were performed. With regard to the combination of Dexwet air filter / Lexmark printer, particle counts were carried out during the printing stage and during after-print running time. No gravimetric dust measurements were performed.

On the test page to be printed out, 9.5% of the sheet were covered: with black in the case of the Lexmark printer and with black, cyan, magenta and yellow in the case of the Kyocera printer. The printouts were made on Steinbeis Vision trend white 80 g/m² recycling paper.

4.1 Test conditions

The tests were carried out on 14 October 2004 in a test cabinet with the following parameters:

- Cabinet volume: 1 m³
- Air exchange: 5 h⁻¹
- Temperature: See Figs. 1–5
- Rel. air humidity: See Figs. 1–5

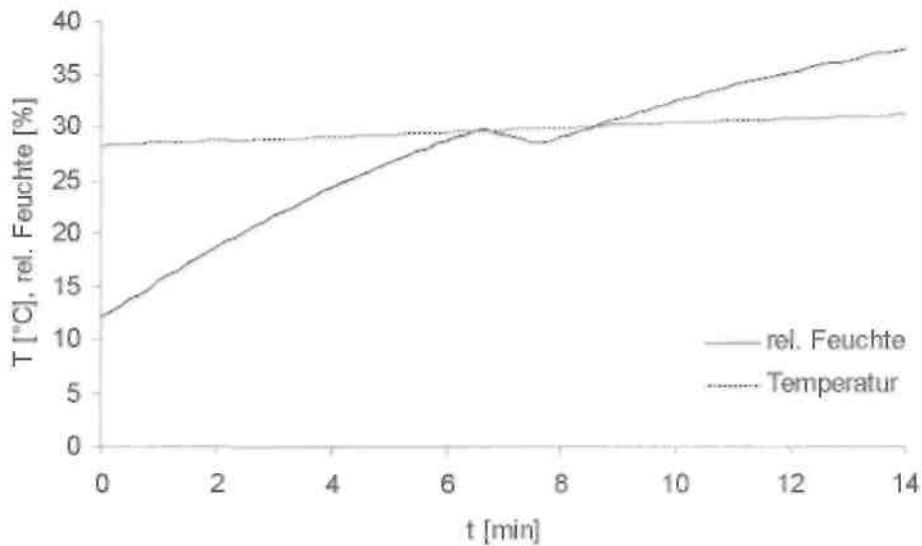


Fig. 1: Development of temperature and humidity, Kyocera FS-C5016N without Dexwet air filter

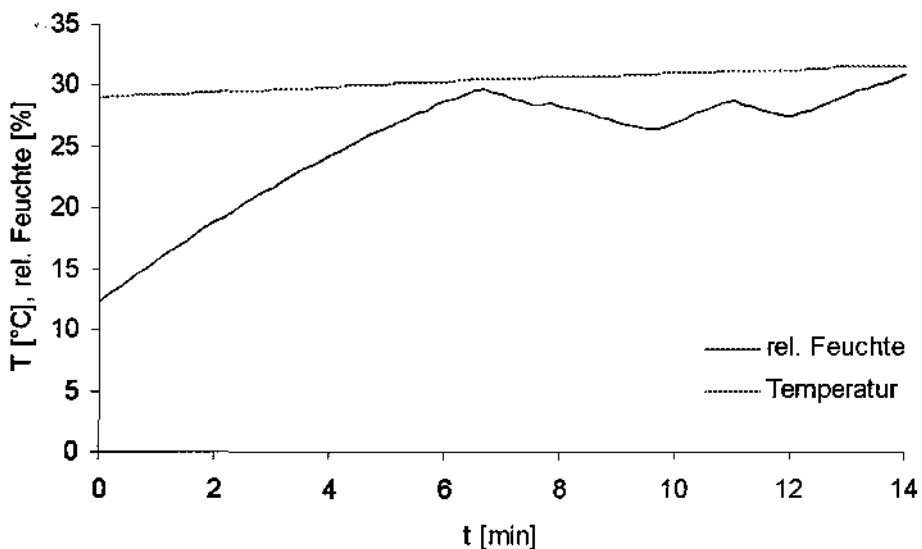


Fig. 2: Development of temperature and humidity, Kyocera FS-C5016N with Dexwet air filter

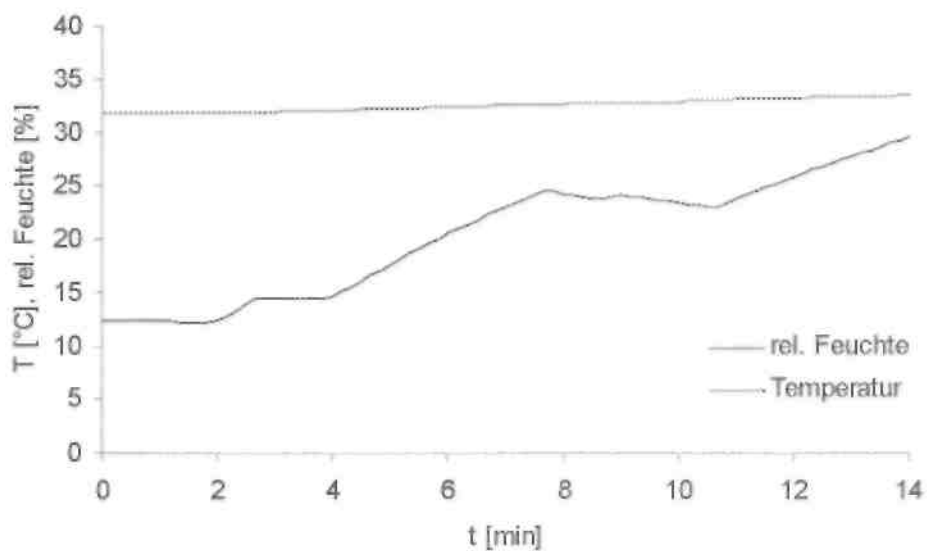


Fig. 3: Development of temperature and humidity, Kyocera FS-C5016N with Dexwet air filter, repeat measurement

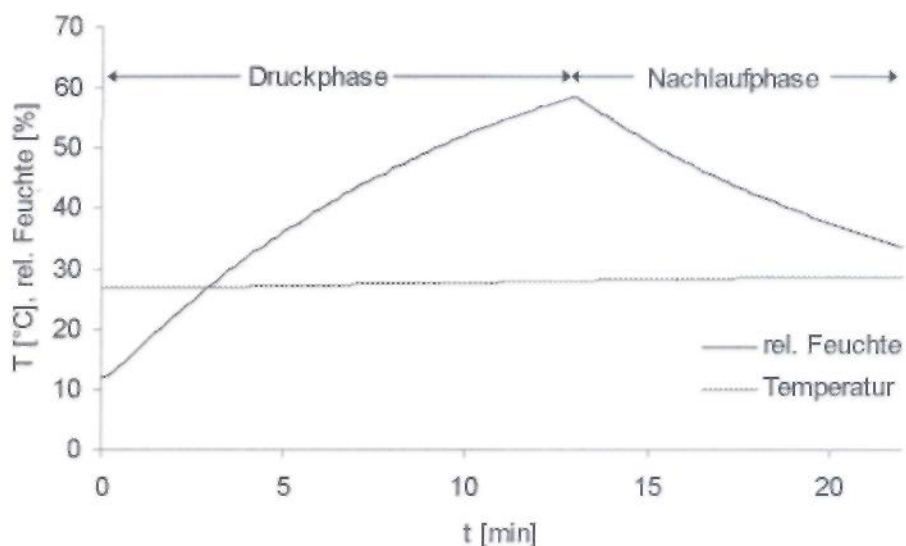


Fig. 4: Development of temperature and humidity, Lexmark T520 without Dexwet air filter

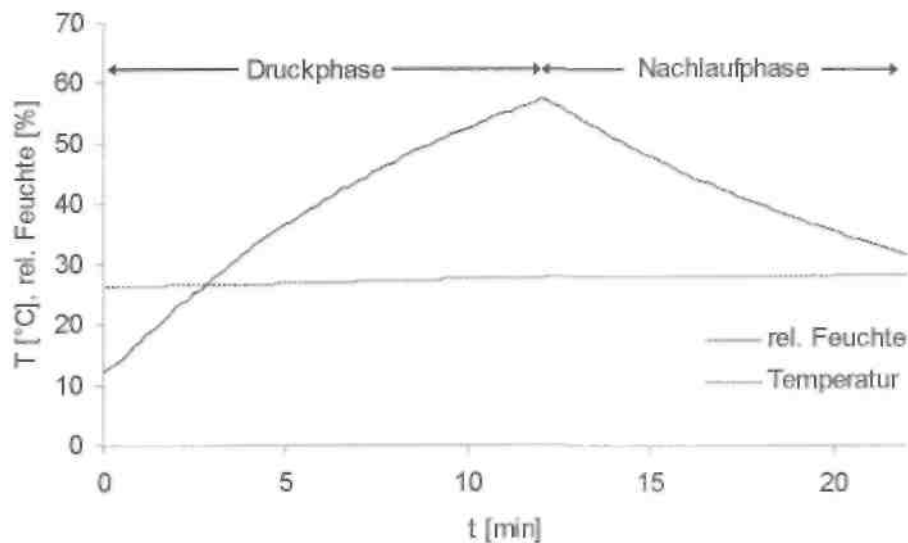


Fig. 5: Development of temperature and humidity, Lexmark T520 with Dexwet air filter

4.2 Particle count on the basis of light scattering

The samples were taken at distances between 10 and 20 cm to the fan grids of the printers.

Table 1: Measuring parameters of particle count

Test phase	Measuring time [min]	Measuring intervals [min]	Volume flow [1 ft ³ /min]
Blank reading	1	5	1.0
Printing stage and after-print running time	1	2	1.0

4.3 Dust sampling

The combination of Dexwet air filter/ Kyocera printer was also used to carry out gravimetric dust examinations. As small masses of particles collecting on the filters were to be expected, sampling was carried out for a longer period than in the case of the particle measurements by means of light scattering (see Table 5).

The measuring filters that were used for gravimetric dust measurements were stored in an air-conditioned room (balance room) before and after the measurements and conditioned to constant mass in the atmosphere of this room. Absolute dust weighing was performed by means of difference weighing of the filters.

5 Test results

5.1 Particle measurements

The particle data obtained in the context of the measurements are given as lists in Tables 2 and 3 and as graphs in Figures 6–11. Table 4 shows the blank readings measured on the test date in the test cabinet. All results are given as number of particles per cubic foot (#/ft³).

Table 2: Particle concentrations measured for the Kyocera printer, with and without Dexwet air filter

Kyocera	Duration [min]	#/ft ³ , no filter			#/ft ³ , with filter			#/ft ³ , no filter		
		>0.3 µm	>0.5 µm	> 5 µm	>0.3µm	>0.5µm	>5 µm	>0.3µm	>0.5µm	>5 µm
Printing stage	0	17804	10019	694	9816	3587	78	2964	577	6
	2	21169	10154	254	15785	5543	31	5949	2049	10
	4	21082	9516	127	18442	6775	8	10105	3763	17
	6	22014	9504	82	21391	7576	13	14842	5316	10
	8	21416	8636	36	18140	6806	13	— ¹⁾	— ¹⁾	— ¹⁾
	10	27088	8873	41	18761	6914	25	— ¹⁾	— ¹⁾	— ¹⁾
	12	43158	9450	22	19803	7231	18	— ¹⁾	— ¹⁾	— ¹⁾
	14	73182	10557	36	31727	8944	29	— ¹⁾	— ¹⁾	— ¹⁾

¹⁾ Intervention in the test cabinet because of paper jam, measuring results discarded

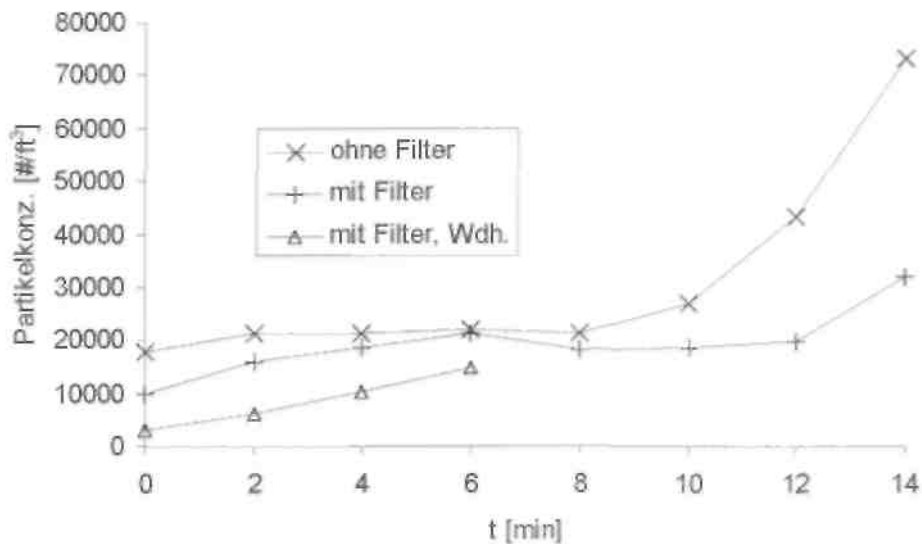


Fig. 6: Particle concentration during printing stage, particles > 0.3 µm, Kyocera FS-C5016N

ohne Filter: no filter – mit Filter: with filter – mit Filter, Wdh: with filter, repeated

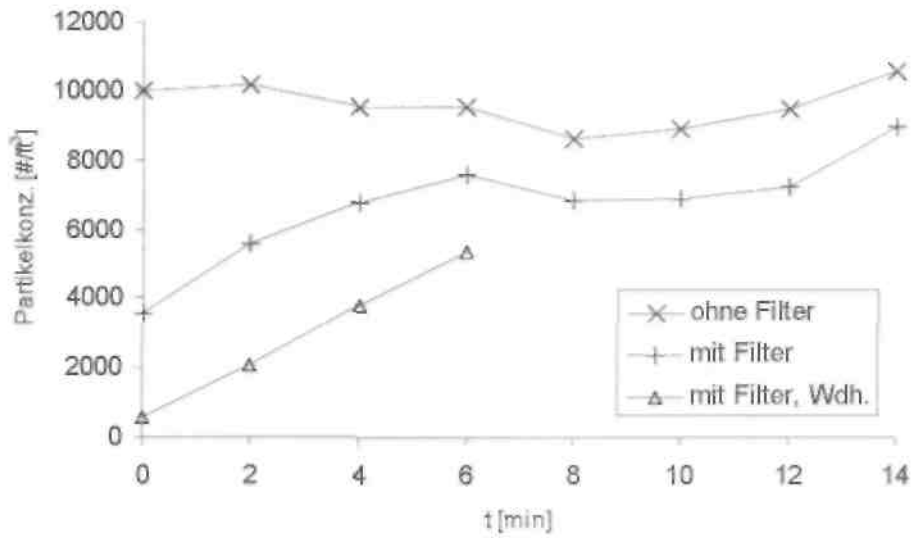


Fig. 7: Particle concentration during printing stage, particles > 0.5 µm, Kyocera FS-C5016N

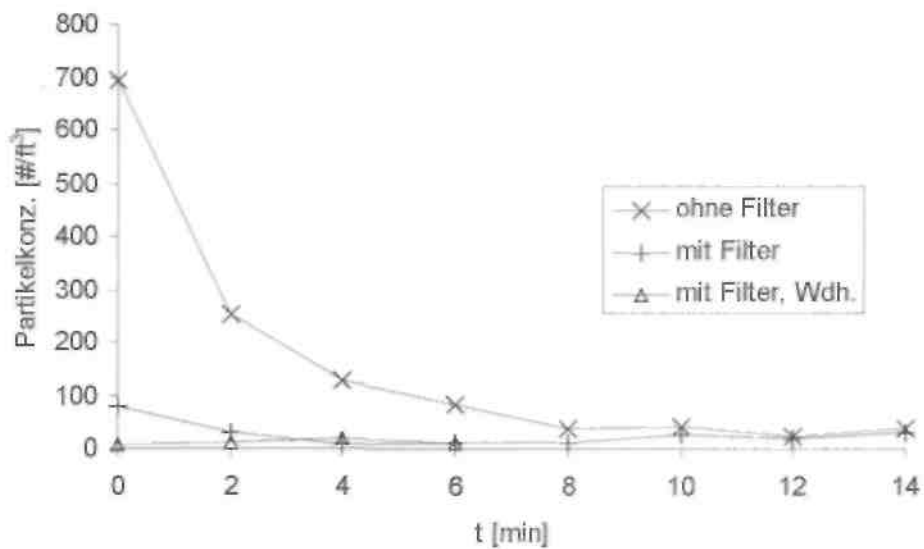


Fig. 8: Particle concentration during printing stage, particles > 5 µm, Kyocera FS-C5016N

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Table. 3: Particle concentrations measured for the Lexmark printer, with and without Dexwet air filter

Lexmark	Duration [min]	#/ft, no filter			#/ft ³ , with filter		
		> 0.3 um	> 0.5 um	> 5 um	> 0.3 um	> 0.5 um	> 5 um
Printing stage	0	19284	12922	1400	20831	5702	103
	2	14393	8593	489	19001	5148	31
	4	13157	7280	248	17365	5123	31
	6	17641	11365	1152	16415	5017	46
	8	14577	8656	476	15985	5231	25
	10	14500	8403	368	15636	5197	24
After-print running	12	15159	9268	572	14409	4956	31
time	14	8727	4612	33	10802	3702	14
	16	6712	3554	14	8001	2715	3
	18	5187	2670	15	6384	2259	2
	20	4383	2293	29	5092	1704	2
	22	3400	1740	8	4090	1367	1

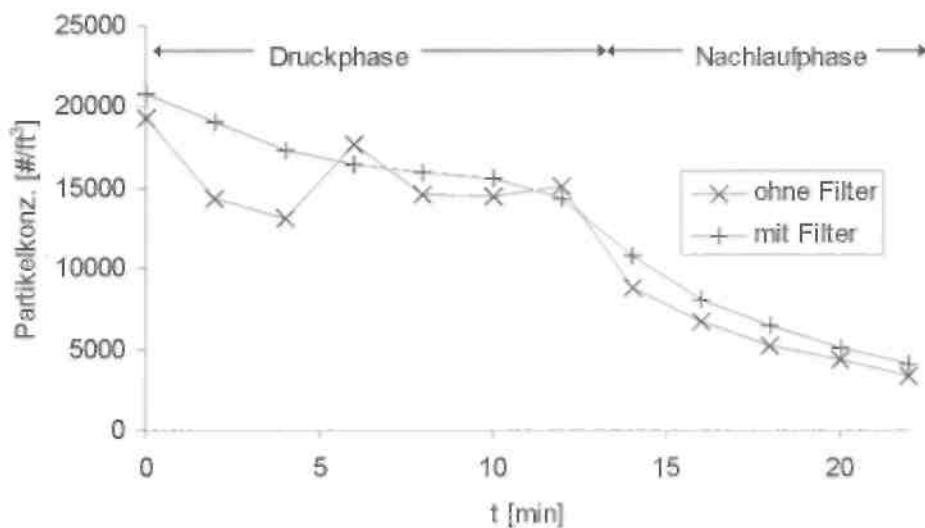


Fig. 9: Particle concentration during printing stage and after-print running time, particles > 0.3 µm, Lexmark T520

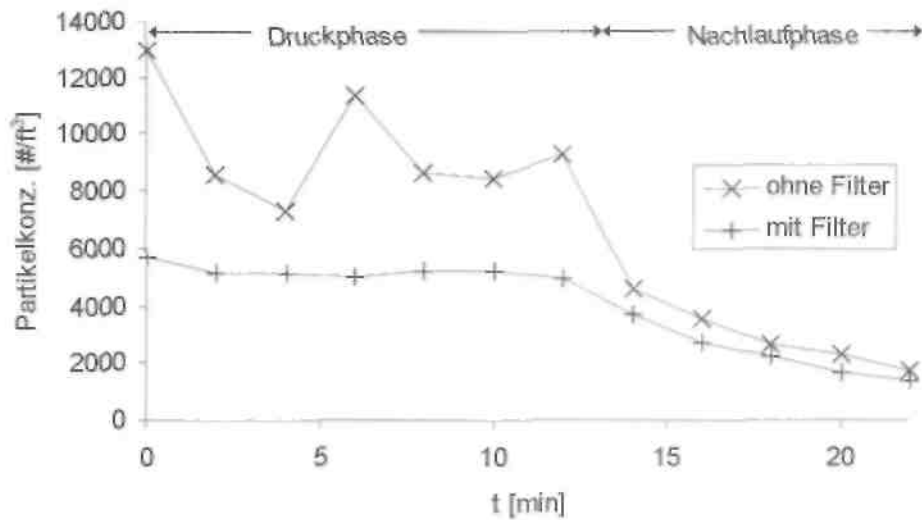


Fig. 10: Particle concentration during printing stage and after-print running time, particles > 0.5 µm, Lexmark T520

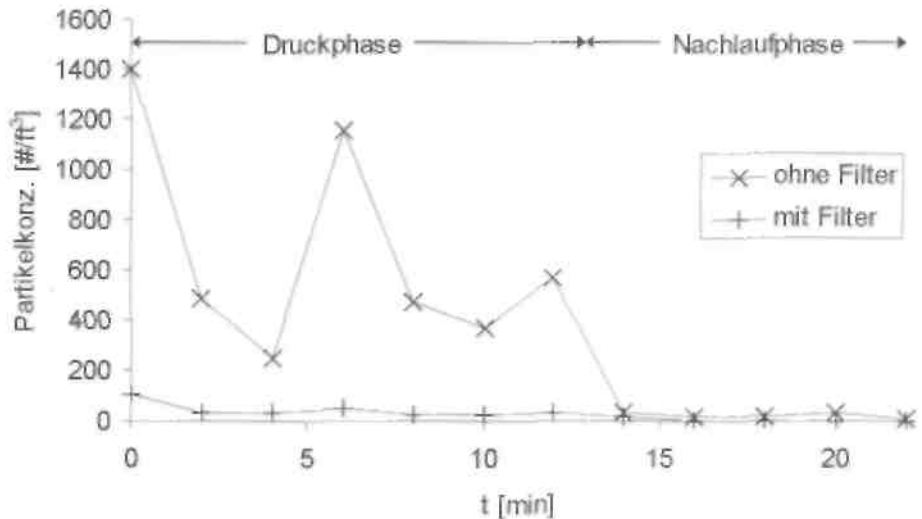


Fig. 11: Particle concentration during printing stage and after-print running time, particles > 5 µm, Lexmark T520

Table 4: Particle blank readings of test cabinet

Time	#/ft ³		
	> 0.3 µm	> 0.5 µm	> 5 µm
Start of test	6476	1917	16
End of test	12423	2588	8

5.2 Dust measurements

The mean dust emission rate in the test cabinet was determined according to Equation 1, and the results obtained are given in Table 5.

n: air exchange - V: volume of test cabinet - t_G: total sampling time - V_p: sampling volume – t_D: printing time – m_{st}: dust mass – SER: specific emission rate

$$SER_{U_x} = \frac{m_{st} \cdot n \cdot V \cdot t_G}{V_p \cdot t_D} \quad (Gl. 1)$$

- n: Luftwechsel [h⁻¹]
- V: Prüfkammervolumen [m³]
- t_G: Gesamtprobenahmezeit [min]
- V_p: Probenahmevermögen [m³]
- t_D: Druckzeit [min]
- m_{st}: Staubmasse [mg]
- SER: Spezifische Emissionsrate [mg/h]

Table 5: Dust emission rates: Kyocera printer with and without Dexwet air filter

Measurement	Duration of sampling [min]	Sampling volume [m ³]	Dust mass (atmosphere-corrected) [mg]	Dust emission rate [mg/h]
No filter	37	1.325	0.3432	1.30
With filter	25	1.411	0.2984	106
With filter, repeated	37	1.697	0.2401	0.71

6 Results

The tests have shown that as a result of the use of Dexwet air filters, particles contained in the exhaust air of laser printers may partly be collected, and thus particle emissions in room air may be reduced. For determining retention rates, the individual sizes and types of printer are regarded separately (see Table 6).

Table 6: Retention rates

Test phase	Retention rate	Kyocera			Lexmark		
		> 0.3 µm	> 0.5 µm	> 5 µm	> 0.3 µm	> 0.5 µm	> 5 µm
Printing stage	Min.	3%	15%	18%	0	30%	88%
	Max.	83%	94%	99%	7%	56%	96%
	Mean	40%	43%	72%	0	44%	93%
After-print running time	Min.	—	—	—	0	15%	58%
	Max.	—	—	—	0	26%	93%
	Mean	—	—	—	0	21%	81%

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In the combination of Dexwet air filter/ Kyocera printer, a mean retention rate of approx. 40% showed for particles of sizes $> 0.3 \mu\text{m}$, and particles larger than $0.5 \mu\text{m}$. This rate rose to more than 70% with regard to particle sizes larger than $5 \mu\text{m}$.

The combination of Dexwet air filter / Lexmark printer showed a stronger correlation between retention rate and particle size: with regard to particle sizes larger than $0.3 \mu\text{m}$, no definite effect of Dexwet air filters could be found, while in the case of particle sizes larger than $0.5 \mu\text{m}$, a reduction of particle emissions was established. The average retention rate was approx. 40% during printing and approx. 20% in the after-print running time. An even higher retention rate was measured for particle sizes over $5 \mu\text{m}$: approx 90% during printing and approx. 80% during after-print running time.

The gravimetric dust measurements revealed dust emissions, but no significant differences between the tests with and without Dexwet air filters were found, as the maximum mass difference detected, i.e., 0.1 mg, was too small.

For an assessment, the absolute particle count, e.g., during printing, has to be taken into account as well: the Kyocera printer emitted about twice as many particles larger than $0.3 \mu\text{m}$ than the Lexmark printer. With regard to particles larger than $5 \mu\text{m}$, the situation was reversed: in this case, the Lexmark printer emitted about four times as many particles as the Kyocera printer.

All results have been obtained on the basis of individual tests. It is regarded as absolutely necessary to confirm these results by further tests.

Please note: the original version (QIWQ 7741433) of this Report was drawn up on 19 October 21004. Upon request of our client, on 13 May 2005 the name of the client was changed to: Dexwet Technology GmbH. No other modifications were made.

LGA QualiTest GmbH Ecological Product Testing – Christine Kühn Vice Director – Staff in charge: Dr. Bernd Maciej Chemist

Nuremberg, 13. May 2005

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