Research summary

Performance test

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The TNO quality system is ISO 9001 certified.

Metabo combination hammer KHEV 8-45 BL with Metabo dust extractor ASR 35 M ACP for drilling and hammering

Commissioned by:
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In recent years, TNO has focused intensively upon innovative improvements to tools, processes and workplace design in the industrial environment. The main purpose of these efforts is to create low-dust production processes and tools. As well as construction, our product and process development activities have targeted the construction, metal, aircraft and wood industries, working closely with industry organizations, trades unions, governments, employers, employees and manufacturers.

To describe innovative production processes and tools, and to assess their practical functionality, we have developed the TNO Performance Test. This checks that relevant statutory and in-house occupational exposure limits (OELs) for hazardous substances such as crystalline silica, hardwood dust and hexavalent chromium are not exceeded in areas where they may be inhaled by workers in the course of their everyday duties.

Inspectie SZW, the Dutch labour inspectorate, explicitly endorses the TNO Performance Test in its "Basic Inspection Module for Crystalline Silica" (Basisinspectiemodule Kwartsstof). That document states, "If you decide to conduct your working activities using the measures contained in a TNO Performance Test, as described on the TNO website (stofvrijwerken.tno.nl or dustfreeworking.tno.nl), I [the inspector] will regard exposure as being adequately managed".

This means that an employer using the test is able to communicate unambiguously with the inspectors and that no additional exposure measurements need to be agreed. Moreover, it provides both the employer and its personnel with an objective measuring tool for the accurate assessment of proposed investments. Innovative manufacturers and suppliers of production processes and tools can also highlight their quality by complying with the test criteria.

Assessment criteria

The TNO Performance Test assesses exposure to hazardous substances in the "employee inhalation zone" in the workplace. The applicable norms for each substance, both statutory and in-house, are those contained in the database of Occupational Exposure Limits or OEL (Grenswaarde Stoffen op de Werkplek, GSW) maintained by the Social and Economic Council of the Netherlands (see http://www.ser.nl/en/oel_database.aspx).

Project description– DRILLING –

For this project, TNO studied emissions of respirable quartz dust while drilling concrete using a combination hammer Metabo KHEV 8-45 BL in combination with dust adapter 'extractor head short' and connected to dust extractor ASR 35 M ACP.

Project description – HAMMERING –

For this project, TNO studied emissions of respirable quartz dust while hammering concrete using a combination hammer Metabo KHEV 8-45 BL in combination with dust adapter 'bellow long' and connected to dust extractor ASR 35 M ACP.

System specifications

The tested system consisted of the Metabo combination hammer KHEV 8-45 BL (or equivalent *) in combination with dust adapter 'extractor head short' for drilling and dust adapter 'bellow long' for hammering connected to dust extractor Metabo ASR 35 M ACP (or equivalent **) by using a 3.5 meter exhaust hose with diameter 35 mm. Figure 1 shows the complete system.

* A "equivalent" combination hammer is one with specifications equal or lower for power use and rpm.
** A "equivalent" vacuum cleaner is one with specifications equal or higher for capacity, dust filter cleaning, filtration and dust capture.

Upper photo: extractor head long/ short (drillin
Lower photo: bellow long/ short (hammering)
Right photo: connector hammers for different adapters

Figure 1. The complete system

Table 1 lists the technical data of the Metabo combination hammers (or equivalent)
Table 2 lists the technical data of the Metabo dust extractors (or equivalent)

Tabel 1. Technical specifications of Metabo combination hammers that can be used with the Metabo adapters and Metabo dust extractor ASR 35 M ACP

Characteristics	KHEV 5-40 BL	KHEV 8-45 BL	KHEV 11-52 BL
Power use [W]	1.150	1.500	1.500
Voltage [V]	230	230	230
No-load speed [min^{-1}]	350 - 500	210 - 300	200 - 270
Loaded speed	350 - 500	210 - 300	200 - 270
Maximum number of strokes [min^{-1}]	2.900	2.900	2.360
Max. individual impact energy (EPTA) [J]	8,7	12,2	18,8
Netto weight [kg]	8,3	10,1	12,4

Characteristics	MHEV 5 BL	MHEV 11 BL
Power use [W]	1.150	1.500
Voltage [V]	230	230
Maximum number of strokes [min^{-1}]	2.900	2.100
Max. individual impact energy (EPTA) [J]	8,7	18
Netto weight [kg]	7,9	12,2

Tabel 2. Technical specifications Metabo dust extractors

Characteristics	ASR 35 M ACP	ASR 35 L ACP	ASR 50 M SC
Filter class	M	M	M
Filter surface [cm^2]	8.600	8.600	8.600
Filter cleaning	Autoclean	Autoclean	Vibration
Diameter of suction hose (mm)	35	35	35
Length suction hose (m)	3,2	3,2	4
Power use [W]	1.400	1.400	1.400
Maximum volume flow[1] [m^3/hour]	260	260	260
Maximum vacuum[2] [mbar]	248	248	248
Reservoir volume [l]	35	35	50
Weigth [kg]	16	16	16

Characteristics	ASR 50 M SC	ASR 50 L SC	ASR 25 L SC
Filter class	M	M	M
Filter surface [cm^2]	8.600	8.600	8.600
Filter cleaning	Vibration	Vibration	Vibration
Diameter of suction hose (mm)	35	35	35
Length suction hose (m)	4	4	4
Power use [W]	1.400	1.400	1.400
Maximum volume flow[1] [m^3/hour]	220	220	220
Maximum vacuum[2] [mbar]	248	248	248
Reservoir volume [l]	50	50	25
Weigth [kg]	16	16	16

[1] on the fan

[2] at the hose end

TNO Performance test

Table 4 lists the key specific test conditions.

Table 4. Test conditions "Worst Case" for DRILLING

(Test)material: concrete element (600 x 600 x 150 mm) Percentage of quartz in respirable dust of concrete: 15% TNO productivity (60 minutes): 125 drilling holes (hole diameter 20 mm). 1000 drilling holes (for a eight-hour working day) Operator exposure period: eight-hour working day. Adapter: bellow long Diameter drill: 20 mm Length drill: 520 mm	Capacity vacuum cleaner: 140 m^3/h (start of test) /131 m^3/h(end of test) Filter class: 99,9% (M) Filter cleaning: mechanical (vibration) Compartmentalization adapter: "semi open" Dust collection in container: "open" Dust filters: "open" Length exhaust hose: 3.5 meter Diameter exhaust hose: 35 mm

Table 5. Test conditions "Worst Case" for HAMMERING

(Test)material: concrete element (600 x 600 x 150 mm) Percentage of quartz in respirable dust of concrete: 15% Production: 100% switch-on time Operator exposure period: eight-hour working day. Adapter: extractor head long Type chisel: pointed chisel Diameter chisel: 18 mm Length chisel: 345 mm	Capacity vacuum cleaner: 145 m^3/h (start of test) /140 m^3/h (end of test) Filter class: 99,9% (M) Filter cleaning: mechanical (vibration) Compartmentalization adapter: "semi open" Dust collection in container: "open" Dust filters: "open" Length exhaust hose: 3.5 meter Diameter exhaust hose: 35 mm

Test results

The test results are summarized in Table 6 and Figure 2 for drilling.

Table 6. Summary of measured data

Situation	Respirable quartz dust concentration (mg/m³)
OEL, eight-hour time-weighted average (TWA)	0.075
Permanent operation	0.029
"Heavy" use	0.015
"Light" use	0.004
Outdoor use	-
Practical use	-

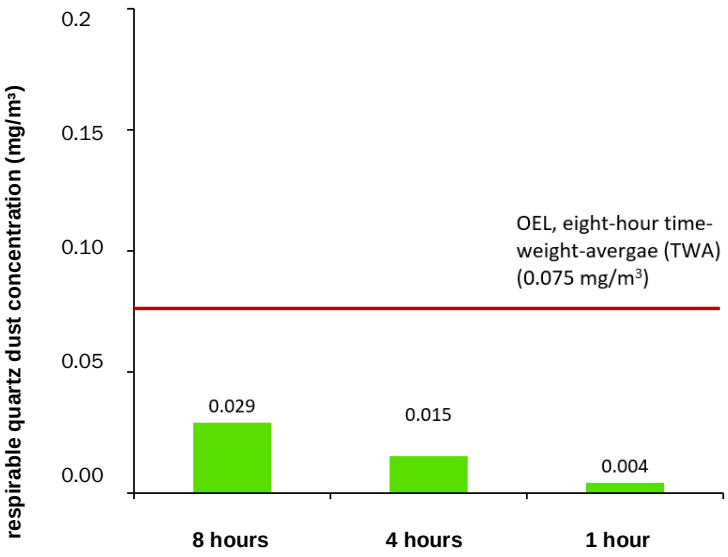


Figure 2. Respirable quartz dust concentration

The test results are summarized in Table 7 and Figure 3 for hammering.

Table 7. Summary of measured data

Situation	Respirable quartz dust concentration (mg/m³)
OEL, eight-hour time-weighted average (TWA)	0.075
Permanent operation	0.110
"Heavy" use	0.055
"Light" use	0.014
Outdoor use	-
Practical use	-

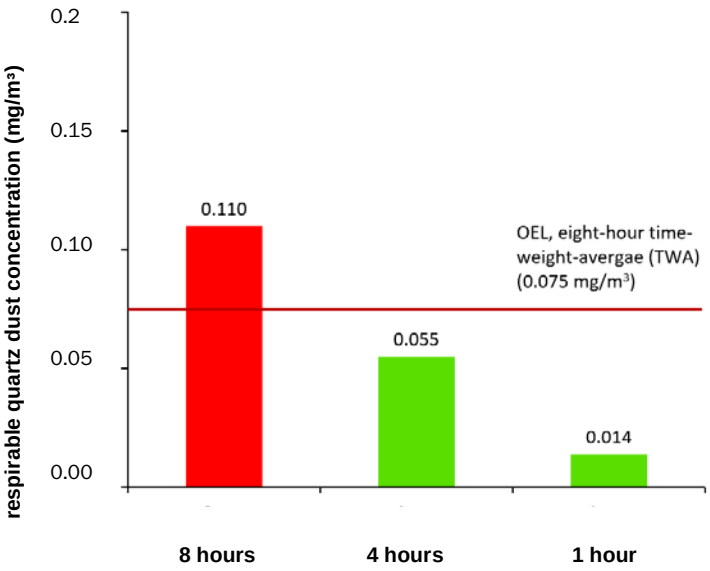


Figure 3 Respirable quartz dust concentration

Conclusion

TNO measured exposure to respirable quartz dust in the "employee inhalation zone" when drilling or hammering using the Metabo combination hammer KHEV 8-45 BL (or equivalent*) in combination with dust adapter 'extractor head short' for drilling and dust adapter 'bellow long' for hammering connected to dust extractor Metabo ASR 35 M ACP (or equivalent **) by using a 3.5 meter exhaust hose with diameter 35 mm.

DRILLING

In permanent operation (an entire eight-hour working day), average exposure was 0.029 mg/m³. This is below the statutory occupational exposure limit (OEL) of 0.075 mg/m³ (eight-hour time-weighted average or TWA), meaning that the system tested complies with the applicable standard for exposure to respirable quartz in this situation.

As well as "permanent operation" TNO has also defined two more reference situations.

- Heavy use: four hours of operation per eight-hour working day.
- Light use: one hour of operation per eight-hour working day.

For heavy and light use, the system also complies with the standard.

HAMMERING

In permanent operation (an entire eight-hour working day), average exposure was 0.110 mg/m³. This is above the statutory occupational exposure limit (OEL) of 0.075 mg/m³ (eight-hour time-weighted average or TWA), meaning that the system tested does not comply with the applicable standard for exposure to respirable quartz in this situation.

As well as "permanent operation" TNO has also defined two more reference situations.

- Heavy use: four hours of operation per eight-hour working day.
- Light use: one hour of operation per eight-hour working day.

For heavy and light use, the system complies with the standard.

The inaccuracy of the exposure measurements is about 15% (5% for the analysis, 5% sampling and 5% reproducibility of the test operator). Readers are referred to the TNO measurement protocol (see TNO website www.dustfreeworking.tno.nl).

The labels below present the system's performance in graphic form. The round label shows the total "responsible operating time" in hours per eight-hour working day. The rectangular label provides more detailed information f or the situations tested, with the green bars indicating what proportion of each type of use during an eight-hour working day remains within the OEL.

DRILLING:

Label for drilling sand lime brick (25% quartz)

Reference: permanent operation.

No measures

100% duration of operation (2000 drilling holes/8hrs)

Heavy use (1000 drilling holes/8hrs*)

Light use (250 drilling holes/8hrs*)

* Given proportionel operation during an eight-hour working day

Label for drilling concrete (15% quartz)

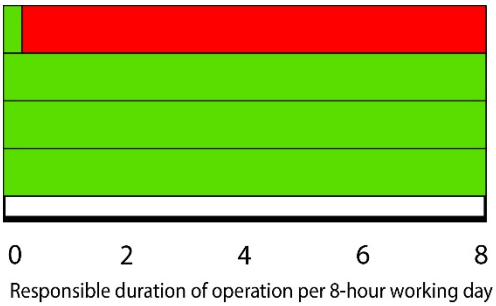
Reference: permanent operation.

No measures

100% duration of operation (2000 drilling holes/8hrs)

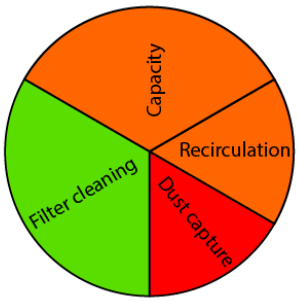
Heavy use (1000 drilling holes/8hrs*)

Light use (250 drilling holes/8hrs*)



* Given proportionel operation during an eight-hour working day

Dust extractor with 3.5 meter exhaust hose (diameter 35 mm)



Capacity (operational)

150 - 200 m³/hour

100 - 150 m³/hour

< 100 m³/hour

Recirculation dust extractor

H-classification according to IEC-norm 60335-2-69

M-classification according to IEC-norm 60335-2-69

L-classification according to IEC-norm 60335-2-69

Filter cleaning

Automatic cleaning (mechanic/air pulse) or filter replacement

Manual

None

Dust capture

Closed system (dust bag)

Open system (container)

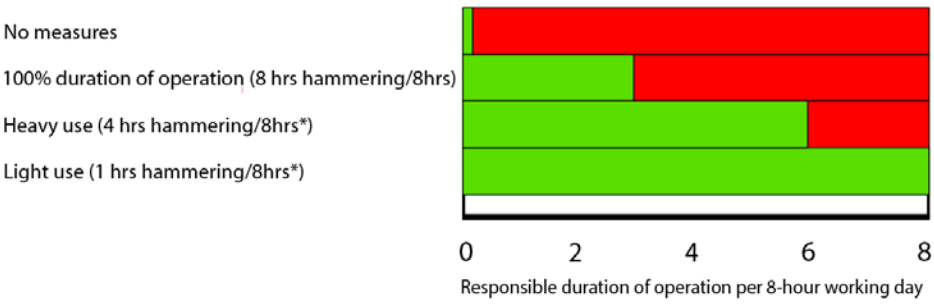
No statement is made about long-term use in this test.

Initials:

HAMMERING:

Label for hammering sand lime brick (25% quartz)

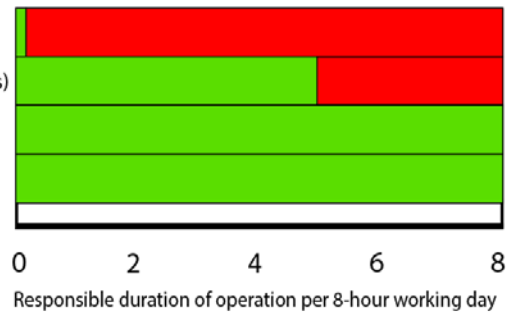
Reference: permanent operation.



* Given proportionel operation during an eight-hour working day

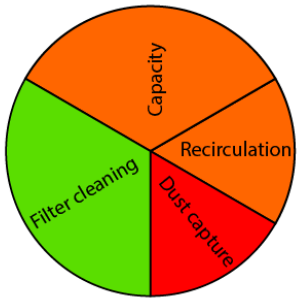
Label for hammering concrete (15% quartz)

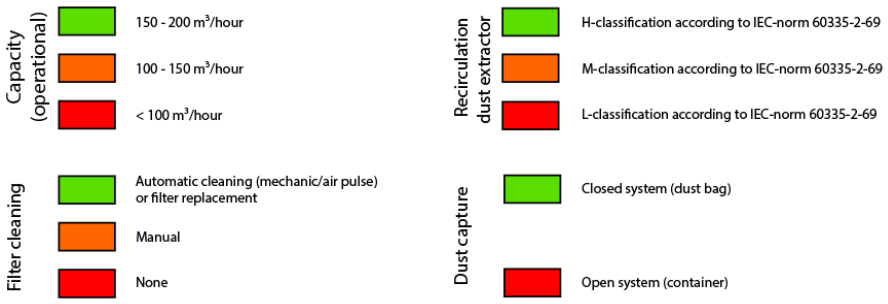
Reference: permanent operation.



* Given proportionel operation during an eight-hour working day

Dust extractor with 3.5 meter exhaust hose (diameter 35 mm)





No statement is made about long-term use in this test.

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