TNO innovation for life

Research summary

Performance test

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Bosch diamond drill GDB 180 WE in combination with Bosch dust extractor GAS 35 M AFC

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WEKA Elektrowerkzeuge
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Germany

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 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, calcium silicate 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), 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 (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

For this project, TNO studied emissions of respirable quartz when drilling in calcium silicate (sand-lime blocks) using a WEKA diamond drill DK 17, connected to a Bosch dust extractor GAS 35 M AFC. The Bosch diamond drill GDB 180 WE is equivalent to the WEKA DK 17. The test results of the WEKA DK 17 are applied to the Bosch diamond drill GDB 180 WE, connected to a Bosch dust extractor GAS 35 M AFC.

System specifications

The tested system consisted of a Bosch diamond drill GDB 180 WE (or equivalent*) in combination with a Bosch GAS 35 M AFC dust extractor (or equivalent**) without dustbag. A flexible hose (length 5.0 m, diameter 32 mm) connects the diamond drill to the extractor. Figure 1 shows the complete system.

* An "equivalent" tool system is one with specifications for power and rotational speed which are the same as or less than those of the model tested.

** An "equivalent" dust extractor is one with specifications for capacity, dust collection, filter cleaning and recirculation which are the same as or better than those of the model tested.

Bosch diamond drill GDB 180 WE with drill bit

Bosch GAS 35 M AFC dust extractor

Figure 1. The complete system.

Table 1 lists the key technical specifications of the system tested. In Table 2 the technical specification of the dust extractor and it's equivalents are listed.

Table 1. Technical specifications of Bosch tool system.

Specification	GDB 180 WE
Input power [W]	2,000
Power supply [V]	220 - 240 (AC 50/60 Hz)
No load rotational speed [min-1]	900 / 2,800
Drilling diameter [mm]	30 - 180
Weight [kg]	5.2

Table 2. Technical specifications of Bosch dust extractors.

Specification	GAS 35 M AFC	GAS 55 M AFC
Input power [W]	1200	1,200
Power supply [V]	220 -240 (AC 50/60 Hz)	220 – 240 (AC 50/60 Hz)
Filter efficiency [%]	99.9 % (M)	99.9 % (M)
Maximum suction capacity[1] [m³/h]	266	266
Underpressure[2] [kPa]	23	23
Filter area [m²]	6,150	6,150
Container capacity [lt]	35	55
Weight [kg]	12.4	16.2

[1] At ventilator.

[2] At end of hose.

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Table 3 lists the key specific test conditions.

Table 3. "Worst case" test conditions.

Material: calcium silicate (sand-lime blocks) dimensions (440x300x70mm)	Extractor system compartmentalization: "complete".
Process: 60 minutes of drilling TNO Productivity (60 minutes): 32 drilling holes, (permanent operation), 256 holes per day	Suction capacity (dust extractor with hose): 105 m³/h (initial measurement) to 105 m³/h (final measurement)
Operator exposure period: eight-hour working day.	Filter efficiency: 99.9% (M) Dust extractor cleaning: automatic (reverse pulse system)
Drilling bit diameter: 87 mm Drilling depth: 50 mm Approximate rotational speed: 4.2 m/s	Dust collection: in container Dust filters: "open".
Direction of dust generation: perpendicular to the extractor system.	Suction hose length: 5.0 m. Suction hose diameter: 32 mm.

Test results

Table 4 and Figure 2 summarize the test results.

Situation	Respirable quartz concentration (mg/m^3)
OEL, eight-hour time-weighted average	0.075
Permanent operation	0.113
"Heavy" use	0.056
"Light" use	0.014
Outdoor use	-
Practical use	-

Table 4. Summary of measured data.

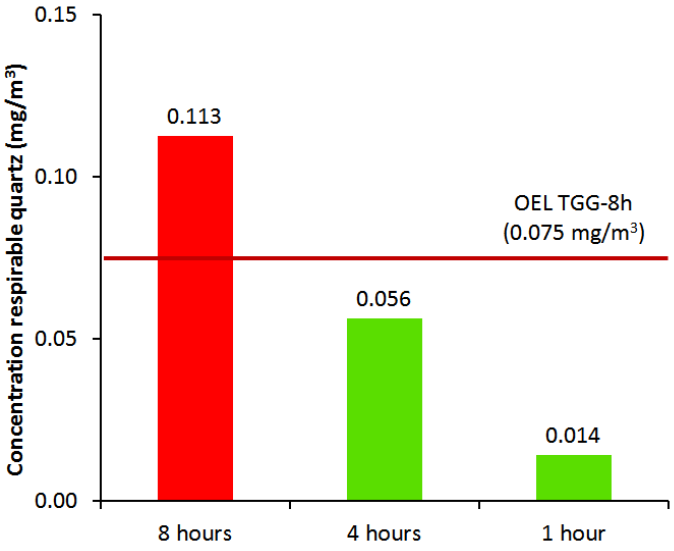


Figure 2. Exposure to respirable quartz at OEL.

Conclusion

TNO measured exposure to respirable quartz in the "employee inhalation zone" when drilling in calcium silicate (sand-lime blocks) using a Bosch diamond drill GDB 180 WE connected to a Bosch GAS 35 M AFC dust extractor.

In permanent operation (an entire eight-hour working day), average exposure was 0.113 mg/m³. This is above the statutory occupational exposure limit (OEL) of 0.075 mg/m³ (eight-hour time-weighted average), meaning that the system tested does not comply with the applicable standard for exposure to 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.

In both of these situations, the system complies with the norm.

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 for 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.

Label for drilling in calcium silicate (sand-lime blocks)

Reference: permanent operation.

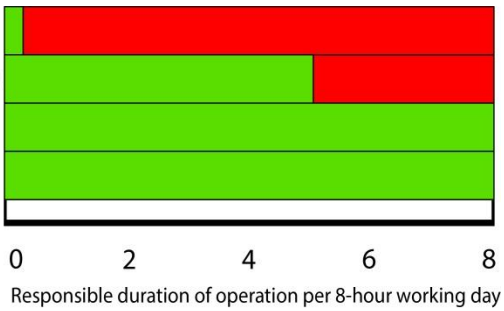
No measures

100% duration of operation (256 drilling holes/8hrs)

Heavy use (128 drilling holes/8hrs*)

Light use (32 drilling holes/8hrs*)

* Given proportional operation during an 8-hour working day



Label for drilling in concrete

Reference: permanent operation.

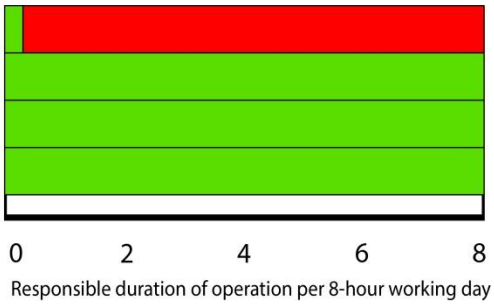
No measures

100% duration of operation (256 drilling holes/8hrs)

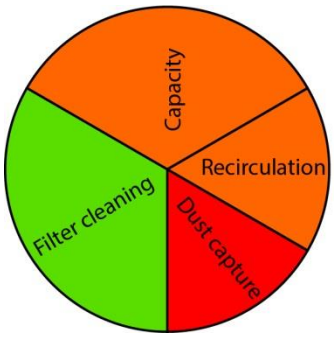
Heavy use (128 drilling holes/8hrs*)

Light use (32 drilling holes/8hrs*)

* Given proportional operation during an 8-hour working day



Dust extractor with 5.0 metre suction hose (diameter 32 mm), without dust collection bag



Capacity (operational)

150 - 200 m^3/hour

100 - 150 m^3/hour

< 100 m^3/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 (dust bag)

NB. This test says nothing about the long-term use of dust extractors.

Initials: