Research summary

Performance test

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The TNO quality system is ISO 9001 certified.

Rubi dust extraction ZERO DUST VACUUM ADAPTER with different drill hammers or angle grinders and Hitachi vacuum cleaner RP250YDM

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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

For this project, TNO studied emissions of respirable quartz dust drilling ceramic tiles with a drill hammer using the Rubi dust extraction ZERO DUST VACUUM ADAPTER connected to a dust extractor classification A or B. The tests are performed in the TNO worst-case room, which is a room of 15 m^3 and a ventilation flow of 150 m^3/h. The tested system will normally not be used in small rooms. Therefore a correction will be made for larger room sizes of 100 m^3. From earlier tests we have seen that de concentration of harmful dust in the employees breathing zone reduces with a factor of five when working in a 100 m^3 room compared to a 15 m^3 room.

System specifications

The tested system consisted of the Rubi dust extraction ZERO DUST VACUUM ADAPTER, applicable with different drill hammers. Testing was done using a Metabo angle grinder WE 9-125 Quick. The Rubi dust extraction ZERO DUST VACUUM ADAPTER was connected to a Hitachi vacuum cleaner RP250YDM (or equivalent*). This vacuum cleaner is classified as a B category vacuum cleaner.
Figure 1 shows the complete system.

* A “equivalent” vacuum cleaner is one with specifications equal or higher for capacity, dust filter cleaning, filtration and dust capture.

Rubi dust extraction ZERO DUST VACUUM ADAPTER

Different drill hammers (or angle grinders)

Different vacuum cleaners

Figure 1. The total system

Categories of vacuum cleaners

Testing was done using a Hitachi vacuum cleaner RP250-YDM (or equivalent*). This vacuum cleaner is classified as a class B category vacuum cleaner. This means that similar vacuum cleaner in class A or B category can be used and has the same effectiveness in working dust free.
This label shows which classification category a vacuum dust extractor falls into. TNO has defined four of these.

Categories are specified in the following table:

Category	**Operational capacity (airflow in m³/h)***	**TNO label**
Class A	> 150	5-8 hours
Class B	101-150	2-4 hours
Class C	≤ 100	1 hour
Class D	For wood-dust extractors only.	

* Capacity measured after test, at end of hose after filter has been cleaned.

To qualify for a particular category, an extractor must comply with both its capacity *and* its TNO labelling requirements. All class A, B and C devices are also suitable for wood-dust extraction.

For more information visit our website at:
www.dustfreeworking.tno.nl/dust-extractors/dust-extractor-classification

TNO Performance Test

Table 2 lists the key specific test conditions.

Table 2. "Worst case" test conditions.

Worst-case room specifications: 15 m^3 volume and 150 m^3/h ventilation flow	Capacity vacuum cleaner 166 m^3/h (start of test)/ 112 m^3/h (end of test)
	Filtering; 99,9%
Material: ceramic tiles, dimensions (450x300x10 mm)	Filter cleaning: semi-automatic
Percentage of quartz in respirable dust: ceramic tiles: 25% natural stone tile: 50% bricks and concrete: 15% sandstone and limestone: 25%	Length hose: 3 m Diameter hose: Ø32 mm System compartmentalization: "semi complete"
Process: 60 minutes of drilling TNO productivity (60 minutes): 60 drilling holes Ø75 mm Operator exposure period: eight-hour working day.	

Test results

The test results are summarized in Table 3 and Figure 3.

Situation	Respirable quartz dust concentration (mg/m^3)
OEL, eight-hour time-weighted average (TWA)	0.075
Permanent operation	0.048
"Heavy" use	0.024
"Light" use	0.006
Outdoor use	-
Practical use	-
Quartz percentage in material	25%

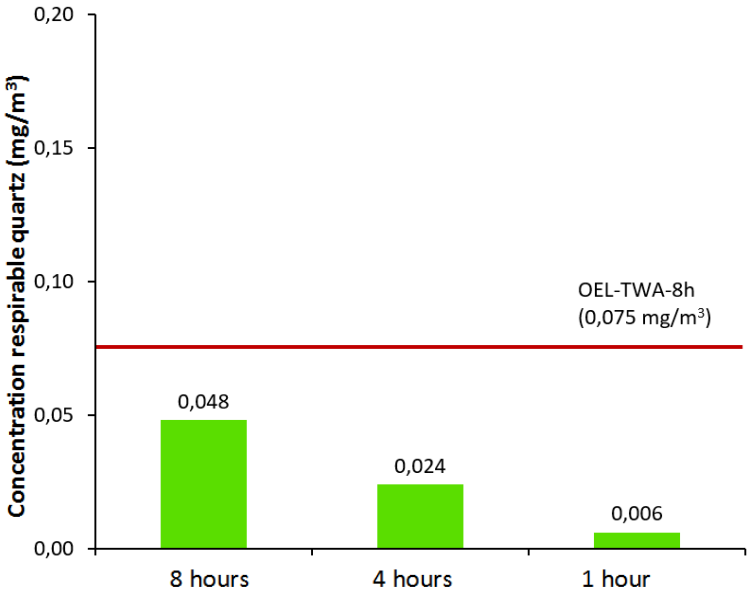


Table 3. Summary of measured data.

Initials:

Conclusion

TNO measured exposure to respirable quartz dust in the “employee inhalation zone” when drilling ceramic tiles using a Rubi dust extraction ZERO DUST VACUUM ADAPTER connected to a class B vacuum cleaner and a drill hammer.

In permanent operation (an entire eight-hour working day), average exposure was 0.048 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.
The system is tested in the TNO worst-case room with a volume of 15 m^3. This machine is normally not used in such a small room due to the size of the machine. For a more realistic situation, the results are also presented for a room size of 100 m^3. Previous tests performed by TNO show that the concentration of respirable quartz in the employees breathing zone decrease by a factor of five compared to the worst-case room.
The machine can also be used to saw brick, concrete and sand blocks and lime blocks. Results are also presented for these materials. It should be noted that the results are obtained for a given source. The source is the dust production which is based on the number, length, thickness and height of the kerfs. The presented labels for brick, sandstone, limestone and concrete are based on the same source. If the source is altered (materials with other dimensions) also the dust production will change. This is mainly applicable since the material thickness of brick, sandstone and concrete is larger (50 to 100 mm) than the thickness of the tested tiles (10 mm).

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

Label for drilling in natural stone tiles (50% quartz)

Reference: permanent operation.

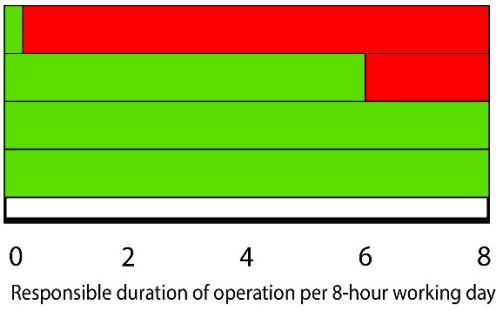
No measures

100% duration of operation (8 hrs per 8-hour working day*)

Heavy use (4 hrs per 8-hour working day*)

Light use (1 hrs per 8-hour working day*)

* Given proportional operation during an 8-hour working day



Label for drilling in ceramic tiles/ sand lime brick (25% quartz) and concrete/ brick (15% quartz)

Reference: permanent operation.

No measures

100% duration of operation (8 hrs per 8hr working day)

Heavy use (4 hrs per 8hr working day*)

Light use (1 hrs per 8hr working day*)

* Given proportional operation during an 8-hour working day