Silica – European Developments

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Dirk Dahmann, Bochum, Germany

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Silica as a challenge for air monitoring

- Why „challenge“?
  Everybody samples and measures for decades!

- The problem is **comparability** or **standardization**!
- **Sampling** in the “respirable dust” fraction! (ISO, CEN)
  Preferably with personal samplers
  8 h shift values are mandatory
- **Analytical determination** is not (yet) standardized
  Infrared or x-ray techniques are both well suited
  ISO is active
  We (IGF) think that particle size dependency is of high importance

Comparability and standardization

- At least in the past the exposure results in industrial workplaces where NOT comparable under all circumstances on an international scale!
- Why?
  - Measurement strategy (time base, compliance or not etc.)
  - Sampling technique (Impingers, konimeters, thermal precipitators, filter samplers etc.)
  - Particle size fraction („total dust“, respirable dust etc.)
  - Analytical procedures (number counting, mass determination of dust, differing silica procedures etc.)
- Especially the epidemiological studies have suffered from this effect. (dose-response-relationship!)

Examples of „non-intuitive results“

Study	Average median of silica respirable dust exposure (mg/m³)	median of cumulative exposure (mg/m³xJahre)
US granite	0.05	0.71
Finnland granite	0.59	4.63
US gold mining	0.05	0.23
Australia gold mining	0.43	11.37

Examples of „non-intuitive results“, “industrial sand”

Job category [Steenland 2001]	No of Samples for 1974-96 (personal breathing zone) [Steenland 2001]	Geometric mean (µg/m³ silica) [Steenland 2001]	Job category, IGF	No of Samples for 1975-2000 (personal breathing zone plus area sampling), IGF	Geometric mean (µg/m³ silica), respirable fraction, IGF
Quarry	680	9.6	Quarrying-mining	23	257.5
Crushing	282	17.1			
Wet process	280	17.7	Wet process	58	80
Drying	427	30.8	Dry process	172	387.3
Screening	163	44.8			
Milling	392	30.2	Milling	115	58.6
Bagging	1142	60.2	Bagging	170	91.4
Loading	252	28.5	Internal transport	16	120.5

Conclusion

Let‘s do it better in future and use standardized and harmonized procedures!

A “worldwide alliance” is needed for this, but an Atlantic Alliance is a good start!

Market Access of Silica Containing Products

- Why is this a problem?

  We have „sold“ and used silica containing products for the last 10000 years!

- Depending on national legislation (carcinogenicity question!) market access may be a VERY relevant question.

- So IS silica carcinogenic?

- IARC: „There is *sufficient evidence* in humans for the carcinogenicity of inhaled crystalline silica in the form of quartz or cristobalite from occupational sources.“

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What about „Products“?

- Not every silica-containing product is carcinogenic.
- Here an example:

Silica content:

- About 100%

Particle diameter:

- About 1.5 m

Labelling

- In Europe:

> Every product which contains more than 0.1 mass percent of a carcinogenic substance has also to be labeled as carcinogenic.

- The „carcinogenic substance“ is: crystalline silica in the respirable dust fraction
- The key question is then:

> How much crystalline silica in the respirable dust fraction is contained in my product?

Possible answer to the question:

How much crystalline silica in the respirable dust fraction is contained in my product?

- …it is the mass content of particles/silica with a „**grain size**“ below 10 µm (7.15 µm, 12.35 µm, 20 µm…) in the product to be determined by granulometry or similar techniques.
- ***We think this answer is inappropriate!***

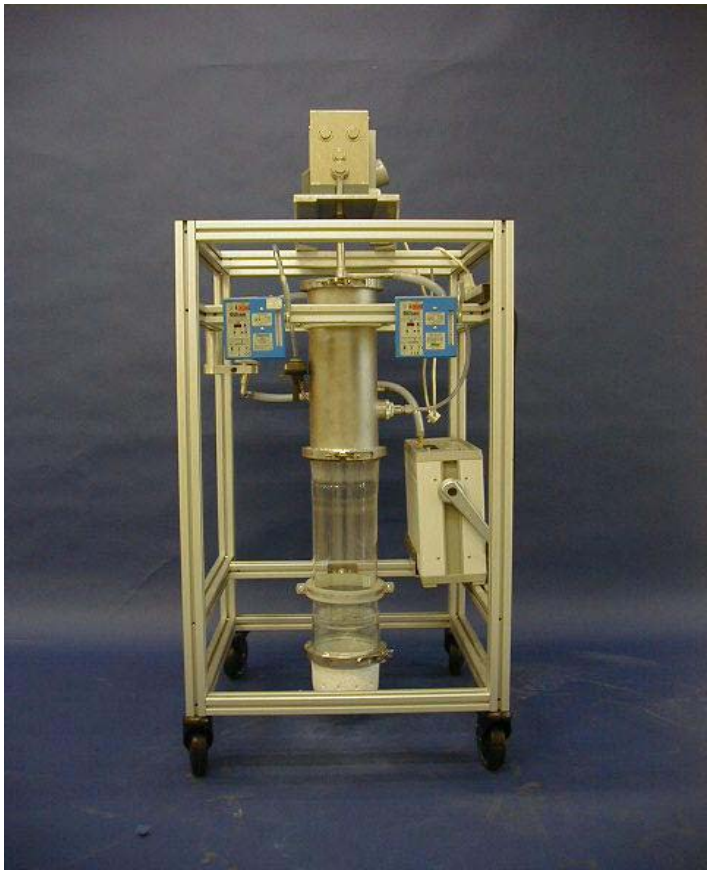
A new concept: Dustiness of materials!

- **Respirable silica** means: the **silica** contained in the **respirable airborne** fraction of dust resulting from **typical handling processes** “using” a given product!

1. Apply the product (drop it, turn it around in a drum etc.) under well defined conditions!
2. Sample the typically generated respirable dust during this handling process under standardized conditions!
3. Measure the silica mass in the respirable fraction.
4. Correlate this number with the total mass of handled material!

Dustiness: Continuous drop pipe

1. Bulk material is dropped continuously into the vertical pipe while a slight airflow is generated from bottom to top.
2. During the experiment respirable and inhalable dust is sampled on filters.
3. The result (“Dustiness”) is the mass ratio of respirable/inhalable dust on the filters to the mass dropped.



This equipment can be modified to detect nanoparticles or fibers!

Rationale behind the method:

- Most dust generating procedures involve the dropping of powders at some step:
  - Shoveling bulk material
  - Dropping of bulk material from conveyor belts during transportation
  - Feeding powders into reactors
  - Investigating powders during laboratory procedures
- During these drops a gentle airflow is present/produced, mainly into the opposite direction of the material flow.
- These procedures should be simulated as closely as possible and under standardized conditions.

Standardization

- The method has been published as prEN 15051 together with an additional procedure („rotating drum“) from the UK.
- We are a few weeks before the final voting procedure (commencing this fall).
- The method is very sensitive with dustiness numbers varying over 3 orders of magnitude.
- It gives **RELEVANT** information.

Examples:

1. Nickel carbonate for electrolytic processes

a) $NiCO_3$ (without crystalline water)

Inhalable dustiness (EN 15051): **86000** mg/kg

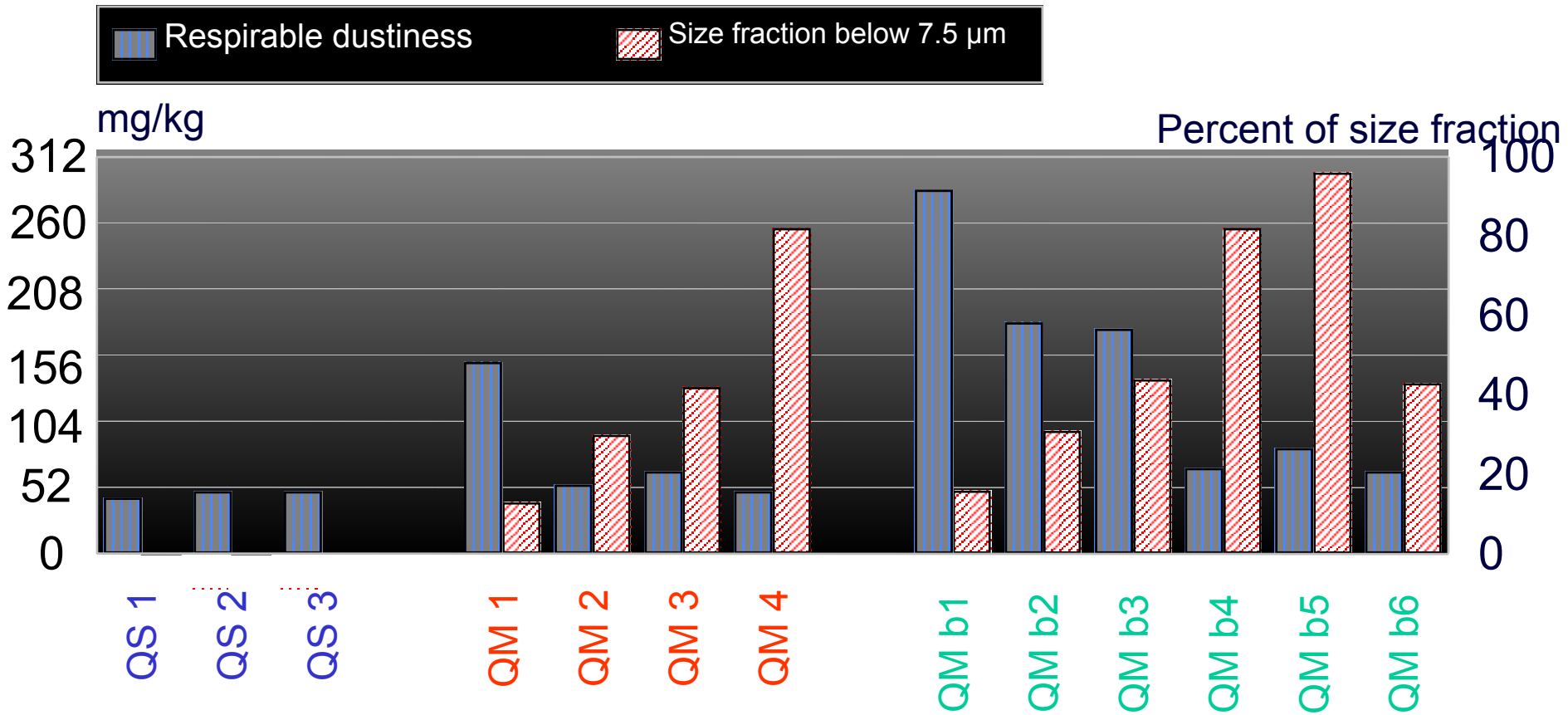
b) $NiCO_3 \cdot XH_2O$ (water treated)

Inhalable dustiness (EN 15051): **15** mg/kg

Example two:

- Respirable dustiness of quartz flours and sands:
- Material resulting from ONE deposit
- Compared were washed sands and “flours” (ground to various degrees) and surface treated flours
- Compared was the technique of dustiness measurement and of grain size determination (laser granulometry)

Respirable dustiness of quartz flours and sands:



Sample description:

QS=Sand, QM=Flour, QM b=surface treated flour

Results in Labeling

- The Dustiness Numbers could be used for labeling of products *and for "control banding*(!). However, in these cases a completely new approach would be needed (at least for labeling).
- These numbers would have the advantage of being relevant!
- We have done more than 250 product measurements and regularly report the dustiness numbers as a percentage already.
- We hope that this will make it into legislation eventually!

Conclusions

- A harmonized approach for sampling and measurement of silica in workplace air is urgently needed on a worldwide scale. The methods for this are existing already.
- For epidemiological studies the re-evaluation of exposure data needs a lot more attention in order to make sense. Currently a lot of implausible data is used in these studies.
- For labeling of products the report of grain size measurements with determination of silica content in specific grain fractions does not make a lot of sense.
- The modern concept of dustiness measurements has been evaluated and is ready for use; especially for the purpose of labeling silica-containing materials.

Thank you for your attention!