The MAK Collection for Occupational Health and Safety

Vanadium and its inorganic compounds – Addendum: withdrawal of the EKA and evaluation of a BAR

Assessment Values in Biological Material – Translation of the German version from 2023

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Keywords

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Abstract

In 2022, the German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area re-evaluated vanadium [7440-62-2] and its inorganic compounds. The former classification in Carcinogen Category 2 was changed to Category 4 and a maximum concentration at the workplace (MAK value) of 0.005 mg vanadium/m^3 for the inhalable fraction (I) was established. With regard to the high concentrations covered by the exposure equivalents for carcinogenic substances (EKA) compared to the exposure limit in air and due to uncertainties in the underlying study, the EKA are no longer valid. Therefore, the EKA are withdrawn and a biological tolerance value (BAT value) cannot be established. Based on the 95th percentile of the urinary vanadium excretion in studies with occupationally unexposed persons, a biological reference value (BAR) of 0.15 µg vanadium/l urine was derived.

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EKA (2022)	**withdrawn**
BAR (2022)	**0.15 µg vanadium/l urine** Sampling time: at the end of shift, for long-term exposures: after several previous shifts
MAK value (2022)	**0.005 mg V/m³ I**
Carcinogenicity (2022)	Category 4

Re-evaluation

In 2005, vanadium and its inorganic compounds were classified by the Commission in Carcinogen Category 2 (translated in Greim 2009). Based on the study by Gylseth et al. (1979), exposure equivalents for carcinogenic substances (EKA) were derived (translated in Schaller et al. 2016). With regard to the reclassification of vanadium to Carcinogen Category 4 and the derivation of a MAK value of 0.005 mg/m³ I (Hartwig and MAK Commission 2023), it was examined whether a BAT value in this low concentration range can be derived via EKA.

In the study by Gylseth et al. (1979) with 17 workers in the ferro-vanadium manufacturing industry, of whom 6 persons had low and 11 persons had medium to high exposure to slag dust, significant correlations were found between the vanadium concentration in the air determined by personal measurements and the vanadium concentrations in the urine. No significant correlations were found in other studies, so that EKA for vanadium were derived from the study by Gylseth et al. (1979) for the range of 0.025–0.1 mg/m³ (Schaller et al. 2016).

With regard to the high concentrations covered by the EKA compared to the exposure limit in air and further existing uncertainties (exposure to different vanadium compounds with different solubility and unknown particle size distribution),

the EKA are withdrawn.

Recent studies with correlations between airborne vanadium exposure and urinary vanadium concentrations, from which EKA could be derived, are not available.

The derivation of a BAT value is not possible with the available data.

Background exposure

In 2004, 2006 and 2021, Heitland and Köster (2004, 2006, 2021) published data on vanadium concentrations in the urine of the general population. Similar values of 0.13 (Heitland and Köster 2004, 2021) and 0.17 µg vanadium/l urine (Heitland and Köster 2006) were observed as the 95th percentile of vanadium concentration in the urine. In a study by Tinkov et al. (2021), similar mean values were reported as in the studies by Heitland and Köster. However, information on the 95th percentile was not provided (see also Table 1).

A study by Morton et al. (2014) resulted in a significantly higher mean value and a significantly higher 95th percentile of 3.79 µg vanadium/l urine for the vanadium concentration in the urine of the English general population. However, this study is not considered relevant for evaluation because the urinary concentrations of other metals such as titanium were also significantly elevated due to deviating analytical conditions.

Higher background levels reported in earlier studies (Sabbioni et al. 1996; Schaller 1999) can be explained by a much greater accumulation of vanadium in the environment in former times due to residues from the combustion of fossil fuels such as oil and coal. Thus, based on the moss monitoring of the German Federal Environment Agency, a clear decrease in vanadium contamination in the environment can be documented in Germany from 1990 to 2015/2016 (UBA 2019).

Tab. 1 Selected studies on vanadium concentrations in the urine of the general population

Number of examined persons	Vanadium in urine [µg/l urine]		References
	Mean value	95th Percentile	
63	0.047	0.13	Heitland and Köster 2004
87	0.068	0.17	Heitland and Köster 2006
102	0.055	0.13	Heitland and Köster 2021
132	1.58[c)]	3.79	Morton et al. 2014
199[a)]	0.063 (0.036–0.088)[c), d)]	–	Tinkov et al. 2021
196[b)]	0.082 (0.053–0.408)[c), d)]	–	

[a)] control persons, not obese; [b)] obese; [c)] median; [d)] (interquartil range)

Evaluation of a biological reference value (BAR)

From the studies by Heitland and Köster (2004, 2006, 2021),

a BAR of 0.15 µg vanadium/l urine

is derived. The results of the study by Tinkov et al. (2021) support this value. Sampling is carried out at the end of the shift, for long-term exposures after several previous shifts.

Interpretation

The BAR refers to normally concentrated urine in which the creatinine content should be in the range of 0.3–3 g/l (translated in Bader et al. 2016). Generally, for urine samples outside the above-mentioned limits, it is recommended to repeat the measurement, when the test person is normally hydrated.

Notes

Competing interests

The established rules and measures of the Commission to avoid conflicts of interest (www.dfg.de/mak/conflicts_interest) ensure that the content and conclusions of the publication are strictly science-based.

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