FLUORIDES

Identity

Name (parent)	Hydrogen fluoride (organic/inorganic fluoride containing substances)
UN number	1052 (anhydrous), 1790 (solution) and others
CAS number	7664-39-3
Intervention value (AGW in mg/m^3)	20
Structure	HF

Occurrence

Chemical state (at 20°C)	gas
Physical appearances	under pressure colorless anhydrous fluid
Industrial products	cleaning, polishing, etching and frosting of surfaces for cleaning purposes and removing of rust. Oil and uranium isotope refining, production of semiconductor products, product of thermal degradation of Teflon

Physicochemical properties

Molecular weight	20.0
Vapor pressure (mbar at 20°C)	1000
Octanol/water partition coefficient (log Po/w)	-0.9
Water solubility	complete

Toxicokinetics (parent)

Uptake by inhalation	Inhalation of gas/vapor/mist causes irritation and burns in the upper airways
Uptake by skin absorption	Causes severe skin lesions and subsequently penetrates deeply into the skin
Uptake via gastrointestinal tract	Causes burns of the gastrointestinal tract.
Distribution	Accumulation in bone and tooth enamel
Metabolism	n/a
Excretion via lungs	n/a
Excretion via urine	as fluoride ion 51.5 % in children using fluoride for dental caries protection [9]
Excretion via feces	negligible
Elimination kinetics	Elimination is slowed down due to formation of water insoluble salts

Toxicodynamics

Mechanisms of toxicity	Irritation of mucous and respiratory tract membranes. Binds irreversibly to calcium and magnesium ions to form insoluble salts. Low blood calcium results in excitability and seizures of the neurons leading to increased muscle tone, muscle tremors, cramps and tetany. A similar mechanism results in ventricular dysrythmias and ventricular fibrillation which can lead to cardiac arrest.
Classifications for carcinogenicity	Not classified
Classifications for reprotoxicity	Not classified
Classifications for sensitizing properties	Not classified

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Biological monitoring

Biomarkers	**Fluoride ion in urine**	**Fluoride in whole blood**	**Fluoride in plasma**
Molecular weight	19.0	19.0	19.0
Involved enzymatic metabolism	n/a	n/a	n/a
Biological material	urine	blood	blood
Type of sample	spot sample	venous sample	venous sample
Sampling strategy	as soon as possible	as soon as possible	as soon as possible
Excretion pattern	In nine workers exposed to AlF_3 the mean (range) half life was 9.0 (6.5-13.5) h. In two of these workers a second half life of 18 and 15 h was observed [1]; Following oral administration of sodium fluoride (NaF) in five volunteers the excretion half-life of fluoride was 5.11 h [2]	Following oral administration of sodium fluoride (NaF) the excretion half-life of fluoride in plasma was 5.78 h in five volunteers [2] and 3.3-6.9 h in serum, following occupational exposure to cryolite (Na_3AlF_6) dust [6]	Following oral administration of sodium fluoride (NaF) the excretion half-life of fluoride in plasma was 5.78 h in 5 volunteers [2] and 3.3-6.9 h in serum, following occupational exposure to cryolite (Na_3AlF_6) dust [6]
Materials	Polypropylene containers	Heparinized test tubes	Heparinized test tubes
Transportation	at ambient temperature	4°C	4 °C
Storage	-20°C	-20°C	-20°C
Stability	Not reported	Note reported	Not reported
Pretreatment	Urine samples were prepared for measurement by diluting 10 times with a 0.05 M solution sodium acetate at pH 5.30 [4].	An aliquot of 0.1 mL of the sample was vortexed for 17 min with 0.5 ml of 300 mM of pentafluorobenzyl bromide in acetone with 0.2 ml 0.5 M phosphate buffer (pH 6.8) and heated at 80°C for 60 min. After cooling to room temp, 1.0 ml of 0.1 mM CB solution in *n*-hexane was added and vortexed for 1 min and centrifuged for 15 min. A 1.0 µl aliquot of the organic phase was injected into the GC-MS instrument [3].	Each serum was mixed with a double volume of diluting solution (0.075 mol/L sodium acetate solution, pH 4.97.). The pH value was adjusted precisely to 5.38 ± 0.02 using HCl or NaOH [4].
Measurement principle	Ion selective (fluoride) electrode; GC-MS [3] flow injection analysis [4]	GC-MS [3]	Ion selective electrode flow injection analysis [4]
Aliquot for 1 analysis	1 mL	1 mL	1mL
Limit of quantification	LOD: 500 µg/L [3] LOD: 3.0 µg/L [4]	LOD: 500 µg/L [3]	LOD: 3.0 µg/L [4]
Recommended adjustments	Specific gravity	n/a	n/a
Preferred units for expression of results	µmol/mol creatinine	µmol/L	µmol/L
Conversion factor	nmol/L = 62.6 x µg/L µmol/mol creatininie = 5.95 x µg/g creatinine	nmol/L = 62.6 x µg/L µmol/mol creatininie = 5.95 x µg/g creatinine	nmol/L = 62.6 x µg/L µmol/mol creatininie = 5.95 x µg/g creatinine

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Biological exposure values	n/a	n/a	n/a
Background value	Background values in children in Texas who used drinking water with fluoride ranged from 1.26 to 1.42 mg/L [10]; In French children 10-14 years of age, who used potassium fluoride or sodium fluoride supplements average fluoride concentrations in urine ranged from 0.28 mg /L (no supplements) to 0.99 mg/L (1.0 mg F/day) [11].		
Possible confounders	Occupational exposure or patient's exposure to enflurane, isofluorane and sevofluorane inhalation anesthesia. In patients fluoride was detected up to 24 h following sevofluorane anesthesia [7]; use of fluoridated water and dental paste in dental caries prevention [8]		
Remarks:	Comparison of plasma and urine fluoride as a biomarker of fluoride exposure in a volunteer study, resulted in a preference for the use of urinary fluoride as a biomarker of occupational exposure to fluoride [2]		

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