

Certificate for Primary Reference Material**BAM-Y010****high purity potassium chloride****(BAM-A-primary-KCl-1)****Certified quantity value**

When applying the prescribed sample treatment as specified below, the mass fraction w of potassium chloride in material BAM-Y010 is:

Compound	Mass fraction w in kg/kg	Uncertainty in kg/kg
Potassium chloride	0,999 83	$\pm 0,000 10$

The uncertainty given is an expanded uncertainty $U=k \cdot u_c$ with $k=2$ evaluated according the GUM [1].

Taking the IUPAC value [2] for the atomic weight of potassium chloride to be $(74,551 0 \pm 0,000 9)$, the certified value corresponds to a potassium chloride amount-of-substance content of $k(\text{KCl}) = w/M = (13,411 4 \pm 0,001 4)$ mol/kg (expanded uncertainty $U=k \cdot u_c$ with $k=2$) in the solid material.

The certified value has been established by subtracting the sum of the mass fractions of 90 possible impurities with other elements from the value for ideal purity of 1,000 000 kg/kg.

69 of 91 values of possible impurities with other elements are based on measurements. The sum of the mass fractions of the measured impurities is $w_{\Sigma}(\text{measured values}) = (101 \pm 42)$ mg/kg.

From theoretical considerations very reasonable estimates have been made for the upper limits of the impurities with noble gases and artificial/instable elements. The sum of the mass fractions of these 14 of 90 possible impurities is $w_{\Sigma}(\text{theoretical values}) = (0,26 \pm 0,25)$ mg/kg. The influence of this value on the certified value and its associated uncertainty is marginal.

The impurities of H, F, Si, S, Mn, Fe and As (7 of 91 possible impurities) have not been measured yet. For these impurities upper limit values have been conservatively estimated. The sum of the mass fractions of the impurities estimated is $w_{\Sigma}(\text{estimated values}) = (65 \pm 30)$ mg/kg. The influence of this value on the certified value

Note: In line with the ISO 31-0 (1992) in this document the comma (and not the dot) is used as a decimal separator.

and its associated uncertainty is significant.

Note, that the values for w_{Σ} (measured values), w_{Σ} (theoretical values) and w_{Σ} (estimated values) are not certified but only of informative nature. The uncertainties given for these three values are combined uncertainties u_c .

Safety instructions: Avoid skin contact and incorporation. Handle with caution - as any chemical substance.

Sample description: The material is provided in glass bottles containing about 0,5 g of material.

Recommendation for correct storing: The bottle should be kept closed at ambient conditions and in a clean and dry environment.

Expiration of certificate: This certificate expires formally ten years after seal affixation on the certificate. (The material itself is assumed to be stable > 200 years).

Prescribed sample treatment

Before use, the material has to be pre-treated in order to achieve the defined state, to which the certified quantity value applies.

T1. Heat material for 5 h at 500 °C. Avoid contamination.

T2. Sub-sample masses of $m > 0,1$ g must be used.

T3. The material must be stored in a desiccator to avoid contamination and moisture take-up.

Obey the safety instructions of the chemicals and equipment used!

Notes

N01. The certified quantity value with associated measurement uncertainty carried by BAM-Y010, is traceable to the related units of the Système International d'Unités (SI).

N02. The certified value with associated measurement uncertainty carried by BAM-Y010, is a realisation of the unit for mass fraction measurements of potassium chloride. Using the concept of molar mass and gravimetry, it is a realisation of the unit for amount-of-substance content (amount-of-substance per mass) measurements of potassium chloride.

N03. In co-operation with Physikalisch Technische Bundesanstalt (PTB), BAM-Y010 is the primary National Measurement Standard of Germany for the measurement of potassium chloride.

N04. BAM-Y010 is intended to be used to prepare gravimetrically secondary measurement standards (solid or solution).

N05. The material is intended for metrological use within National and International Metrology Institutes only.

N06. Technical details about the certification can be found in the 'Certification Report BAM-Y010', which is available from BAM on request and at www.bam.de.

N07. The certified value with associated measurement uncertainty has been established by measuring the impurities in a high purity potassium chloride material using a variety of

measurement methods. The quantity values for the individual impurities are given as additional information in Table 1. These quantity values are not certified values.

N08. All measurements, which were used for the certification of BAM-Y010 have been performed by BAM laboratories.

Abbreviations

HE	Carrier gas hot extraction and combustion analysis
HR-ICP-MS	High resolution mass spectrometry using inductively coupled plasma
ICP-MS	Mass spectrometry using inductively coupled plasma
THE	Estimated value based on theoretical considerations
U	Expanded measurement uncertainty
u_c	Combined measurement uncertainty
ULV	Upper limit value based on measurements
ULV-EST	Upper limit value based on estimate; not yet measured
unc. contr.	Parameter characterising the relative influence of the uncertainty of an individual impurity mass fraction to the combined uncertainty of the potassium chloride mass fraction calculated according to: $u^2(w_i) / \sum u^2(w_j)$

Table 1: : The individual quantity values used to establish the certified value. Note, that the quantity values given are not certified, but only of informative nature!

method	w mg/kg	u(w) mg/kg	unc. contr.	method	w mg/kg	u(w) mg/kg	unc. contr.	method	w mg/kg	u(w) mg/kg	unc. contr.
H ULV-EST	< 50	25	0,24	Ge ICP-MS	< 0,04	0,02	<< 0,01	Eu ICP-MS	< 0,003	0,0015	<< 0,01
He THE	< 0,001	0,0005	<< 0,01	As ULV-EST	< 10	5	0,01	Gd ICP-MS	< 1	0,5	<< 0,01
Li ICP-MS	< 3	1,5	<< 0,01	Se ICP-MS	< 0,08	0,04	<< 0,01	Tb ICP-MS	< 0,01	0,005	<< 0,01
Be ICP-MS	< 3	1,5	<< 0,01	Br ICP-MS	< 20	10	0,04	Dy ICP-MS	< 0,001	0,0005	<< 0,01
B ICP-MS	< 3	1,5	<< 0,01	Kr THE	< 0,001	0,0005	<< 0,01	Ho ICP-MS	< 0,001	0,0005	<< 0,01
C HE	< 20	10	0,04	Rb ICP-MS	< 2	1	<< 0,01	Er ICP-MS	< 0,001	0,0005	<< 0,01
N HE	< 50	25	0,24	Sr ICP-MS	< 0,01	0,005	<< 0,01	Tm ICP-MS	< 0,001	0,0005	<< 0,01
O HE	< 32	16	0,10	Y ICP-MS	< 5	2,5	<< 0,01	Yb ICP-MS	< 0,1	0,05	<< 0,01
F ULV-EST	< 20	10	0,04	Zr ICP-MS	< 0,004	0,002	<< 0,01	Lu ICP-MS	< 0,01	0,005	<< 0,01
Ne THE	< 0,001	0,0005	<< 0,01	Nb ICP-MS	< 0,001	0,0005	<< 0,01	Hf ICP-MS	< 0,001	0,0005	<< 0,01
Na ICP-MS	< 50	25	0,24	Mo ICP-MS	< 0,02	0,01	<< 0,01	Ta ICP-MS	< 0,001	0,0005	<< 0,01
Mg ICP-MS	< 0,1	0,05	<< 0,01	Tc THE	< 0,001	0,0005	<< 0,01	W ICP-MS	< 0,004	0,002	<< 0,01
Al ICP-MS	< 0,3	0,15	<< 0,01	Ru ICP-MS	< 0,06	0,03	<< 0,01	Re ICP-MS	< 0,001	0,0005	<< 0,01
Si ULV-EST	< 10	5	0,01	Rh ICP-MS	< 5	2,5	<< 0,01	Os ICP-MS	< 0,001	0,0005	<< 0,01
P ICP-MS	< 0,5	0,25	<< 0,01	Pd ICP-MS	< 0,001	0,0005	<< 0,01	Ir ICP-MS	< 0,001	0,0005	<< 0,01
S ULV-EST	< 20	10	0,04	Ag ICP-MS	< 0,006	0,003	<< 0,01	Pt ICP-MS	< 0,001	0,0005	<< 0,01
Cl	matrix			Cd ICP-MS	< 0,02	0,01	<< 0,01	Au ICP-MS	< 0,5	0,25	<< 0,01
Ar THE	< 0,5	0,25	<< 0,01	In ICP-MS	< 0,04	0,02	<< 0,01	Hg ICP-MS	< 0,01	0,005	<< 0,01
K	matrix			Sn ICP-MS	< 0,02	0,01	<< 0,01	Tl ICP-MS	< 0,005	0,0025	<< 0,01
Ca ICP-MS	< 2	1	<< 0,01	Sb ICP-MS	< 0,2	0,1	<< 0,01	Pb ICP-MS	< 0,08	0,04	<< 0,01
Sc ICP-MS	< 0,001	0,0005	<< 0,01	Te ICP-MS	< 0,06	0,03	<< 0,01	Bi ICP-MS	< 0,4	0,2	<< 0,01
Ti ICP-MS	< 0,02	0,01	<< 0,01	I ICP-MS	< 1	0,5	<< 0,01	Po THE	< 0,001	0,0005	<< 0,01
V ICP-MS	< 0,6	0,3	<< 0,01	Xe THE	< 0,001	0,0005	<< 0,01	At THE	< 0,001	0,0005	<< 0,01
Cr ICP-MS	< 0,5	0,25	<< 0,01	Cs ICP-MS	< 0,001	0,0005	<< 0,01	Rn THE	< 0,001	0,0005	<< 0,01
Mn ULV-EST	< 10	5	0,01	Ba ICP-MS	< 0,06	0,03	<< 0,01	Fr THE	< 0,001	0,0005	<< 0,01
Fe ULV-EST	< 10	5	0,01	La ICP-MS	< 0,006	0,003	<< 0,01	Ra THE	< 0,001	0,0005	<< 0,01
Co ICP-MS	< 0,02	0,01	<< 0,01	Ce ICP-MS	< 0,004	0,002	<< 0,01	Ac THE	< 0,001	0,0005	<< 0,01
Ni ICP-MS	< 0,6	0,3	<< 0,01	Pr ICP-MS	< 0,004	0,002	<< 0,01	Th ICP-MS	< 0,01	0,005	<< 0,01
Cu ICP-MS	< 0,1	0,05	<< 0,01	Nd ICP-MS	< 0,001	0,0005	<< 0,01	Pa THE	< 0,001	0,0005	<< 0,01
Zn ICP-MS	< 0,3	0,15	<< 0,01	Pm THE	< 0,001	0,0005	<< 0,01	U ICP-MS	< 0,001	0,0005	<< 0,01
Ga ICP-MS	< 0,1	0,05	<< 0,01	Sm ICP-MS	< 0,04	0,02	<< 0,01				

Value contributes > 10 % to combined uncertainty

References

1 Guide to the Expression of Uncertainty in measurement, ISO, Geneva, (1993).

2 IUPAC: 'Atomic weights of the elements 1995' Pure & Appl. Chem. 68 (1996), 2339-2359.

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