

CCQM-K23.b and COOMET.QM-K23.b

Key comparison CCQM-K23.b

**MEASURAND :** Amount-of-substance fraction of iso-Butane in Natural gas type II

**NOMINAL VALUE :** 0.008 mol/mol

**GAS MIXTURE :** Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.094 mol/mol), Propane (0.034 mol/mol), *n*-Butane (0.01 mol/mol), *iso*-Butane (0.008 mol/mol), Methane (0.754 mol/mol)

$x_{Lab\ i}$  result of measurement carried out by laboratory *i*

$U_{Lab\ i}$  stated uncertainty of laboratory *i* at a 95 % level of confidence

$k_{Lab\ i}$  stated coverage factor

$x_{i\ ref}$  amount of substance fraction in the cylinder sent to laboratory *i*, from preparation

$u_{i\ ref}$  combined standard uncertainty of  $x_{i\ ref}$

$u_{i\ ref} = (u_{i\ prep}^2 + u_{i\ ver}^2)^{1/2}$  where  $u_{i\ prep}$  and  $u_{i\ ver}$  are the standard uncertainties of preparation and verification respectively for which the numerical values can be found in Table 9 of the Final Report.

Lab <i>i</i>	Cylinder number	$x_{Lab\ i}$ / (10 <sup>-2</sup> mol/mol)	$U_{Lab\ i}$ / (10 <sup>-2</sup> mol/mol)	$k_{Lab\ i}$	$x_{i\ ref}$ / (10 <sup>-2</sup> mol/mol)	$u_{i\ ref}$ / (10 <sup>-2</sup> mol/mol)	Date of measurement
NPL	VSL205170	0.79907	0.00109	2	0.799604	0.000591	07 Sep 2005
SMU	VSL200238	0.79490	0.00370	2	0.796694	0.000592	13 Dec 2005
CMI	VSL200229	0.80300	0.02000	2	0.793793	0.000588	21 Sep 2005
VNIIM	VSL302766	0.77900	0.00500	2	0.781058	0.000585	05 Dec 2005
MKEH	VSL202794	0.80140	0.00100	2.37	0.801447	0.000589	03 Oct 2005
NMi-VSL	VSL133436	0.79670	0.00200	2	0.797880	0.000595	09 Sep 2005
CENAM	VSL302704	0.79600	0.01000	2	0.796186	0.000587	21 Dec 2005
CEM	VSL200231	0.78510	0.00380	2	0.784835	0.000582	20 Oct 2005
BAM	VSL200239	0.79670	0.00040	2	0.797899	0.000589	21 Sep 2005
NMIA	VSL200246	0.80130	0.00180	2.18	0.800407	0.000589	10 Sep 2005
IPQ	VSL200241	0.79490	0.00710	2	0.797190	0.000590	29 Sep 2005
INMETRO	VSL200236	0.80330	0.00900	2	0.799879	0.000589	17 Oct 2005
GUM	VSL200237	0.80110	0.00620	2	0.798744	0.000593	05 Jan 2006
NIM	VSL305182	0.78700	0.00390	2	0.788257	0.000594	06 Dec 2005
KRISS	VSL200230	0.80260	0.00313	2	0.801922	0.000591	27 Sep 2005
NMIJ	VSL200248	0.79880	0.00168	2	0.798739	0.000591	22 Dec 2005

**Key comparison COOMET.QM-K23.b**

**MEASURAND :** Amount-of-substance fraction of iso-Butane in Natural gas type II

**NOMINAL VALUE :** 0.008 mol/mol

**GAS MIXTURE :** Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.095 mol/mol), Propane (0.035 mol/mol), *n*-Butane (0.01 mol/mol), *iso*-Butane (0.008 mol/mol), Methane (balance)

$x_{Lab\ i}$  result of measurement carried out by laboratory *i* participant in COOMET.QM-K23.b

$U_{Lab\ i}$  expanded uncertainty of laboratory *i* participant in COOMET.QM-K23.b at a 95 % level of confidence

$k_{Lab\ i}$  stated coverage factor

$x_{i\ ref}$  amount of substance fraction in the cylinder sent to laboratory *i* participant in COOMET.QM-K23.b, from preparation

$u_{i\ ref}$  combined standard uncertainty of  $x_{i\ ref}$

$u_{i\ ref} = (u_{i\ prep}^2 + u_{i\ ver}^2)^{1/2}$  where  $u_{i\ prep}$  and  $u_{i\ ver}$  are the standard uncertainties of preparation and verification respectively

Lab <i>i</i>	Cylinder number	$x_{Lab\ i}$ / (10 <sup>-2</sup> mol/mol)	$U_{Lab\ i}$ / (10 <sup>-2</sup> mol/mol)	$k_{Lab\ i}$	$x_{i\ ref}$ / (10 <sup>-2</sup> mol/mol)	$u_{i\ prep}$ / (10 <sup>-2</sup> mol/mol)	$u_{i\ ver}$ / (10 <sup>-2</sup> mol/mol)	Date of measurement
VNIIM	D200273	0.7853	0.002	2	0.78627	0.0006	0.00055	2008
UkrCSM	D200292	0.7927	0.0054	2	0.78893	0.0006	0.00055	2008
BelGIM	D200278	0.7875	0.0034	2	0.78741	0.0006	0.00055	2008
BAM	D200385	0.8041	0.004	2	0.80445	0.00059	0.00056	2008
SMU	D200368	0.7785	0.0039	2	0.78031	0.00058	0.00055	2008
CMI	D200383	0.817	0.021	2	0.80428	0.00059	0.00056	2008

## CCQM-K23.b and COOMET.QM-K23.b

### Key comparison CCQM-K23.b

**MEASURAND :** Amount-of-substance fraction of iso-Butane in Natural gas type II  
**NOMINAL VALUE :** 0.008 mol/mol  
**GAS MIXTURE :** Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.094 mol/mol), Propane (0.034 mol/mol), *n*-Butane (0.01 mol/mol), *iso*-Butane (0.008 mol/mol), Methane (0.754 mol/mol)

**Key comparison reference value: there is no single reference value for this comparison, the value obtained from preparation,  $x_{i\text{ref}}$ , is taken as the reference value for laboratory  $i$ .**

The degree of equivalence of each laboratory  $i$  with respect to the reference value is given by a pair of terms:

$D_i = (x_{\text{Lab}i} - x_{i\text{ref}})$  and  $U_i$ , its expanded uncertainty at a 95% level of confidence, both expressed in  $10^{-2}$  mol/mol;  
 $U_i = 2[(U_{\text{Lab}i} / k_{\text{Lab}i})^2 + u_{i\text{ref}}^2]^{1/2}$ , using a coverage factor  $k = 2$ .  $D_i$  and  $U_i$  are also given in relative terms.

The degree of equivalence between two laboratories is given by a pair of terms:  $D_{ij} = D_i - D_j = (x_i - x_{i\text{ref}}) - (x_j - x_{j\text{ref}})$  and

$U_{ij}$ , its expanded uncertainty at a 95% level of confidence, both expressed in  $10^{-2}$  mol/mol;  
 $U_{ij} = 2[(U_{\text{Lab}i} / k_{\text{Lab}i})^2 + (U_{\text{Lab}j} / k_{\text{Lab}j})^2 + u_{i\text{ref}}^2 + u_{j\text{ref}}^2]^{1/2}$ , using a coverage factor  $k = 2$ .

The pair-wise degrees of equivalence are not explicitly computed.

### Linking COOMET.QM.23.b to CCQM-K23.b

The pilot laboratory VNIIM is used as the linking laboratory. In order to link the results of COOMET.QM-K23.b to those of CCQM-K23.b, an uncertainty term is added to the standard uncertainty of the reference value,  $u_{i\text{ref}}$ , for the laboratory  $i$  participating in COOMET.QM-K23.b. This additional uncertainty term is equal to the absolute value of  $D_i$  obtained by VNIIM in CCQM-K23.b.

The degree of equivalence of a laboratory participant in COOMET.QM-K23.b with respect to the reference value is given by a pair of terms, both expressed in  $10^{-2}$  mol/mol:

$D_i = (x_{\text{Lab}i} - x_{i\text{ref}})$  and its expanded uncertainty ( $k = 2$ ),  $U_i$ ,  
with  $U_i = [U_{\text{Lab}i}^2 + 2u_{\text{ref}}^2 + D_{\text{VNIIM (CCQM-K23.b)}}^2]^{1/2}$ .  
 $D_i$  and  $U_i$  are also given in relative terms.

No pair-wise degrees of equivalence have been computed for participants in COOMET.QM-K23.b.

CCQM-K23.b and COOMET.QM-K23.b

**MEASURAND :** Amount-of-substance fraction of iso-Butane in Natural gas type II  
**NOMINAL VALUE :** 0.008 mol/mol  
**GAS MIXTURE :** Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.094 mol/mol), Propane (0.034 mol/mol), *n*-Butane (0.01 mol/mol), *iso*-Butane (0.008 mol/mol), Methane (0.754 mol/mol)

Degrees of equivalence, offset  $D_i$  and expanded uncertainty ( $k = 2$ )  $U_i$ , expressed in  $10^{-2}$  mol/mol, and given in relative terms (%)

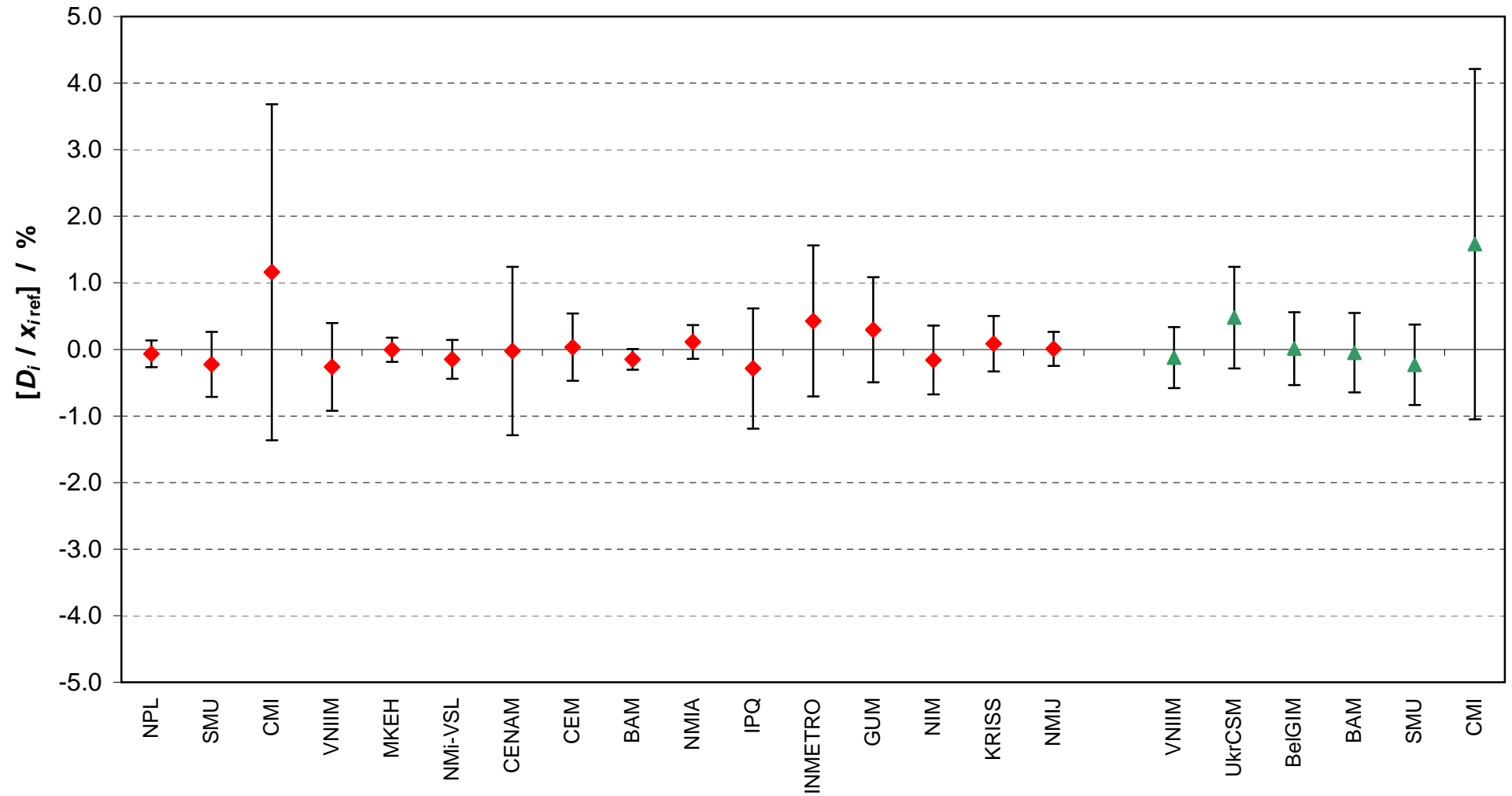
Lab <i>i</i>	$D_i$ / ( $10^{-2}$ mol/mol)	$U_i$ / ( $10^{-2}$ mol/mol)	$D_i / x_{i\text{ref}}$ / %	$U_i / x_{i\text{ref}}$ / %
NPL	-0.0005	0.0016	-0.07	0.20
SMU	-0.0018	0.0039	-0.23	0.49
CMI	0.0092	0.0200	1.16	2.52
VNIIM	-0.0021	0.0051	-0.26	0.66
MKEH	0.0000	0.0014	-0.01	0.18
NMi-VSL	-0.0012	0.0023	-0.15	0.29
CENAM	-0.0002	0.0101	-0.02	1.26
CEM	0.0003	0.0040	0.03	0.51
BAM	-0.0012	0.0012	-0.15	0.16
NMIA	0.0009	0.0020	0.11	0.25
IPQ	-0.0023	0.0072	-0.29	0.90
INMETRO	0.0034	0.0091	0.43	1.13
GUM	0.0024	0.0063	0.29	0.79
NIM	-0.0013	0.0041	-0.16	0.52
KRISS	0.0007	0.0033	0.08	0.42
NMIJ	0.0001	0.0021	0.01	0.26
VNIIM*	-0.0010	0.0036	-0.12	0.46
UkrCSM*	0.0038	0.0060	0.48	0.76
BelGIM*	0.0001	0.0043	0.01	0.55
BAM*	-0.0004	0.0048	-0.05	0.60
SMU*	-0.0018	0.0047	-0.23	0.60
CMI*	0.0127	0.0212	1.58	2.63

\* indicates participants in COOMET.QM-K23.b

# CCQM-K23.b and COOMET.QM-K23.b iso-Butane in Natural gas type II

Nominal value 0.008 mol/mol

Degrees of equivalence:  $D_i$  and expanded uncertainty  $U_i$  ( $k = 2$ ) given in relative terms



**Red diamonds:** participants in CCQM-K23.b  
**Green triangles:** participants in COOMET.QM-K23.b