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

Key comparison CCQM-K23.b

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

NOMINAL VALUE : **0.01 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)

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

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

$k_{\mathrm{Lab}i}$ stated coverage factor

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

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

$u_{i\,\mathrm{ref}} = (u_{i\,\mathrm{prep}}^2 + u_{i\,\mathrm{ver}}^2)^{1/2}$ where $u_{i\,\mathrm{prep}}$ and $u_{i\,\mathrm{ver}}$ are the standard uncertainties of preparation and verification respectively for which the numerical values can be found in Table 10 of the Final Report.

Lab *i*	Cylinder number	$x_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$U_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$k_{\mathrm{Lab}i}$	$x_{i\,\mathrm{ref}}$ / (10^{-2} mol/mol)	$u_{i\,\mathrm{ref}}$ / (10^{-2} mol/mol)	Date of measurement
NPL	VSL205170	0.99302	0.00119	2	0.992473	0.000661	07 Sep 2005
SMU	VSL200238	0.99500	0.00560	2	0.999205	0.000665	13 Dec 2005
CMI	VSL200229	1.00100	0.02800	2	0.995562	0.000661	21 Sep 2005
VNIIM	VSL302766	1.00100	0.00500	2	1.004048	0.000665	05 Dec 2005
MKEH	VSL202794	0.98740	0.00180	2.87	0.984699	0.000655	03 Oct 2005
NMi-VSL	VSL133436	0.99600	0.00340	2	0.997206	0.000666	09 Sep 2005
CENAM	VSL302704	0.99300	0.01400	2	0.988737	0.000657	21 Dec 2005
CEM	VSL200231	0.98160	0.00440	2	0.980479	0.000653	20 Oct 2005
BAM	VSL200239	1.00261	0.00050	2	1.002064	0.000663	21 Sep 2005
NMIA	VSL200246	0.99820	0.00080	2.18	0.996129	0.000660	10 Sep 2005
IPQ	VSL200241	0.99570	0.00840	2	0.995839	0.000662	29 Sep 2005
INMETRO	VSL200236	1.00100	0.01000	2	0.997503	0.000661	17 Oct 2005
GUM	VSL200237	1.00420	0.00680	2	1.004261	0.000667	05 Jan 2006
NIM	VSL305182	0.99600	0.00500	2	0.998365	0.000669	06 Dec 2005
KRISS	VSL200230	0.99660	0.00319	2	0.997362	0.000662	27 Sep 2005
NMIJ	VSL200248	0.99888	0.00096	2	0.997976	0.000664	22 Dec 2005

Key comparison COOMET.QM-K23.b

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

NOMINAL VALUE : **0.01 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)

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

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

$k_{\mathrm{Lab}i}$ stated coverage factor

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

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

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

Lab *i*	Cylinder number	$x_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$U_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$k_{\mathrm{Lab}i}$	$x_{i\,\mathrm{ref}}$ / (10^{-2} mol/mol)	$u_{i\,\mathrm{prep}}$ / (10^{-2} mol/mol)	$u_{i\,\mathrm{ver}}$ / (10^{-2} mol/mol)	Date of measurement
VNIIM	D200273	0.9825	0.003	2	0.98172	0.0006	0.00069	2008
UkrCSM	D200292	0.993	0.0043	2	0.99569	0.0006	0.00070	2008
BelGIM	D200278	0.9993	0.0022	2	0.9967	0.0006	0.00070	2008
BAM	D200385	0.9903	0.005	2	0.98637	0.00059	0.00069	2008
SMU	D200368	0.9725	0.0049	2	0.9748	0.00058	0.00068	2008
CMI	D200383	0.990	0.016	2	0.99497	0.00059	0.00070	2008

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

MEASURAND :	**Amount of substance fraction of n-Butane in Natural gas type II**
NOMINAL VALUE :	**0.01 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, $x_{i\,ref}$, 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:
$D_i = (x_{Lab\,i} - x_{i\,ref})$ and U_i, its expanded uncertainty at a 95% level of confidence, both expressed in 10^{-2} mol/mol;
$U_i = 2[(U_{Lab\,i} / k_{Lab\,i})^2 + u_{i\,ref}^2]^{1/2}$, 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: $D_{ij} = D_i - D_j = (x_i - x_{i\,ref}) - (x_j - x_{j\,ref})$ and
U_{ij}, its expanded uncertainty at a 95% level of confidence, both expressed in 10^{-2} mol/mol;
$U_{ij} = 2[(U_{Lab\,i} / k_{Lab\,i})^2 + (U_{Lab\,j} / k_{Lab\,j})^2 + u_{i\,ref}^2 + u_{j\,ref}^2]^{1/2}$, using a coverage factor $k = 2$.
The pair-wise degrees of equivalence are not explicitely 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, $u_{i\,ref,}$ 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:
$D_i = (x_{Lab\,i} - x_{i\,ref})$ and its expanded uncertainty ($k = 2$), U_i,
with $U_i = [U_{Lab\,i}^2 + 2u_{ref}^2 + D_{VNIIM\ (CCQM\text{-}K23.b)}^2]^{1/2}$.
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 n-Butane in Natural gas type II**

NOMINAL VALUE : **0.01 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 (%)

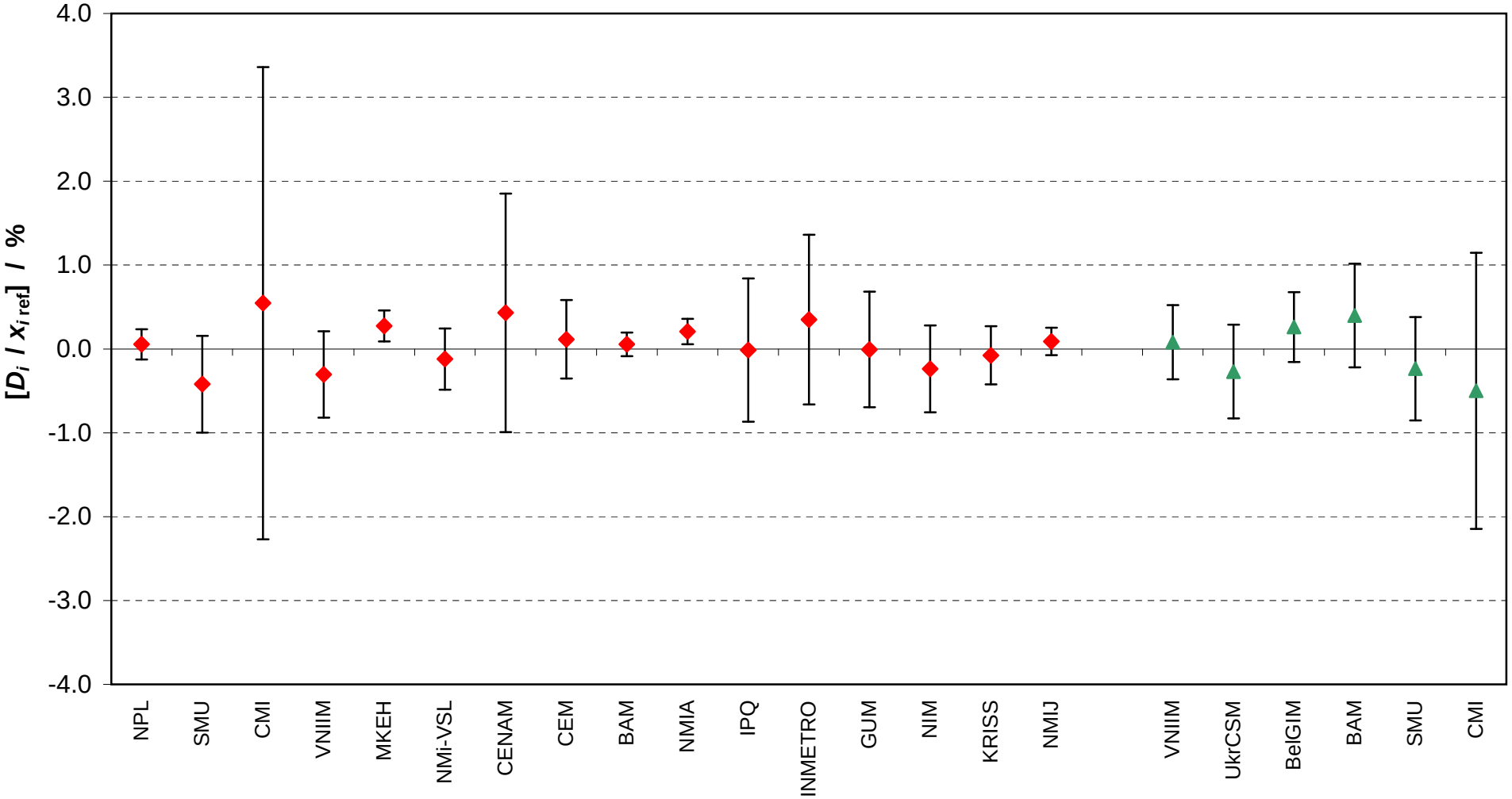
Lab *i* ⇩	D_i / (10^{-2} mol/mol)	U_i / (10^{-2} mol/mol)	$D_i / x_{i\,ref}$ / %	$U_i / x_{i\,ref}$ / %
NPL	**0.0005**	0.0018	**0.06**	0.18
SMU	**-0.0042**	0.0058	**-0.42**	0.58
CMI	**0.0054**	0.0280	**0.55**	2.82
VNIIM	**-0.0030**	0.0052	**-0.30**	0.52
MKEH	**0.0027**	0.0018	**0.27**	0.18
NMi-VSL	**-0.0012**	0.0037	**-0.12**	0.37
CENAM	**0.0043**	0.0141	**0.43**	1.42
CEM	**0.0011**	0.0046	**0.11**	0.47
BAM	**0.0005**	0.0014	**0.05**	0.14
NMIA	**0.0021**	0.0015	**0.21**	0.15
IPQ	**-0.0001**	0.0085	**-0.01**	0.85
INMETRO	**0.0035**	0.0101	**0.35**	1.01
GUM	**-0.0001**	0.0069	**-0.01**	0.69
NIM	**-0.0024**	0.0052	**-0.24**	0.52
KRISS	**-0.0008**	0.0035	**-0.08**	0.35
NMIJ	**0.0009**	0.0016	**0.09**	0.16
VNIIM*	**0.0008**	0.0043	**0.08**	0.44
UkrCSM*	**-0.0027**	0.0056	**-0.27**	0.56
BelGIM*	**0.0026**	0.0042	**0.26**	0.42
BAM*	**0.0039**	0.0061	**0.40**	0.62
SMU*	**-0.0023**	0.0060	**-0.24**	0.62
CMI*	**-0.0050**	0.0164	**-0.50**	1.65

* indicates participants in COOMET.QM-K23.b

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

Nominal value 0.01 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