



Institute for
Interlaboratory Studies

Results of Proficiency Test Liquefied Butane June 2023

Organized by: Institute for Interlaboratory Studies
Spijkenisse, the Netherlands

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1 INTRODUCTION

Since 2009 the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for the analysis of Liquefied Butane every year. During the annual proficiency testing program 2022/2023 it was decided to continue the round robin for the analysis of Liquefied Butane. For this round robin a co-operation with EffecTech (Uttoxeter, United Kingdom) was set up because iis has limited gas-handling facilities in place to prepare gas samples. EffecTech is fully equipped and has experience in the preparation of synthetic gas samples for PT purposes.

In this interlaboratory study 50 laboratories in 27 countries registered for participation, see appendix 2 for the number of participants per country. In this report the results of the Liquefied Butane proficiency test are presented and discussed. This report is also electronically available through the iis website www.iisnl.com.

2 SET UP

The Institute for Interlaboratory Studies (iis) in Spijkenisse, the Netherlands, was the organizer of this proficiency test (PT). To optimize the costs for the participating laboratories it was decided to prepare one Butane Liquefied Gas mixture. The mixture was divided over a batch of 55 cylinders. The cylinder size is a cost-effective one-liter cylinder. Each cylinder was uniquely numbered and labelled #23100. The limited cylinder size is chosen to optimize transport and handling costs.

Sample analyzes for fit-for-use and homogeneity testing were subcontracted to an ISO/IEC17025 accredited laboratory.

The participants were requested to report rounded and unrounded test results. The unrounded test results were preferably used for statistical evaluation.

2.1 QUALITY SYSTEM

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, has implemented a quality system based on ISO/IEC17043:2010. This ensures strict adherence to protocols for sample preparation and statistical evaluation and 100% confidentiality of participant's data. Feedback from the participants on the reported data is encouraged and customer's satisfaction is measured on regular basis by sending out questionnaires. EffecTech is accredited in conformance ISO17025:2017 by UKAS (no. 0590).

2.2 PROTOCOL

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5). This protocol is electronically available through the iis website www.iisnl.com, from the FAQ page.

2.3 CONFIDENTIALITY STATEMENT

All data presented in this report must be regarded as confidential and for use by the participating companies only. Disclosure of the information in this report is only allowed by means of the entire report. Use of the contents of this report for third parties is only allowed by written permission of the Institute for Interlaboratory Studies. Disclosure of the identity of one or more of the participating companies will be done only after receipt of a written agreement of the companies involved.

2.4 SAMPLES

One batch of 55 one-liter cylinders with an artificial Liquefied Butane mixture was prepared and tested for homogeneity by EffecTech (Uttoxeter, United Kingdom) in conformance with ISO Guide 35 and ISO/IEC17025 (job 23/0500, starting in April 2023). Each cylinder was uniquely numbered and labelled #23100. Every cylinder in the batch was analyzed using replicate measurements. The within bottle and between bottle variations were assessed in accordance with ISO Guide 35. This evaluation showed that all between bottle variations were small compared to the uncertainties on the reference values on each component.

The repeatabilities were calculated per component and compared with 0.3 times the corresponding reproducibility of the reference test method in agreement with the procedure of ISO13528, Annex B2 in the next table.

Component	r (observed) in %mol/mol	0.3 x R (reference) in %mol/mol	Reference Test method
Propane	0.0025	0.0410	ASTM D2163:23e1
Propene	0.0076	0.1212	ASTM D2163:23e1
iso-Butane	0.0422	0.2742	ASTM D2163:23e1
n-Butane	0.0270	0.0832	ASTM D2163:23e1
1-Butene	0.0037	0.0754	ASTM D2163:23e1
iso-Butene	0.0086	0.0842	ASTM D2163:23e1
trans-2-Butene	0.0066	0.0698	ASTM D2163:23e1
cis-2-Butene	0.0232	0.1010	ASTM D2163:23e1
1,3-Butadiene	0.0032	0.0375	ASTM D2163:23e1
iso-Pentane	0.0022	0.0140	ASTM D2163:23e1

Table 1: evaluation of the repeatabilities of subsamples #23100

The calculated repeatabilities are in agreement with 0.3 times the corresponding reproducibility of the reference test method. Therefore, homogeneity of the subsamples was assumed.

To each of the participating laboratories one 1 liter cylinder labelled #23100 was sent on June 7, 2023. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

EffecTech (Uttoxeter, United Kingdom) declares that the prepared gas cylinders have a shelf life of at least 6 months. This is sufficient for the proficiency testing purposes.

2.6 ANALYZES

The participants were requested to determine: Total of composition, Propane, Propene, iso-Butane, n-Butane, 1-Butene, iso-Butene, trans-2-Butene, cis-2-Butene, 1,3-Butadiene, n-Pentane, iso-Pentane, Molar Mass, Relative Density at 60/60 °F, Absolute and Relative Vapor Pressure at 100 °F (in psi) and at 40 °C (in kPa), Motor Octane Number (MON), Ideal Gross Heating Value and Ideal Net Heating Value both at 14.696 psia and 60 °F.

It was explicitly requested to treat the sample as if it was a routine sample and to report the test results using the indicated units on the report form and not to round the test results, but report as much significant figures as possible. It was also requested not to report 'less than' test results, which are above the detection limit, because such test results cannot be used for meaningful statistical evaluations.

To get comparable test results a detailed report form and a letter of instructions are prepared. On the report form the reporting units are given as well as the reference test methods (when applicable) that will be used during the evaluation. The detailed report form and the letter of instructions are both made available on the data entry portal www.kpmd.co.uk/sgs-iis/. The participating laboratories are also requested to confirm the sample receipt on this data entry portal. The letter of instructions can also be downloaded from the iis website www.iisnl.com.

3 RESULTS

During five weeks after sample dispatch, the test results of the individual laboratories were gathered via the data entry portal www.kpmd.co.uk/sgs-iis/. The reported test results are tabulated per determination in appendix 1 of this report. The laboratories are presented by their code numbers.

Directly after the deadline, a reminder was sent to those laboratories that had not reported test results at that moment. Shortly after the deadline, the available test results were screened for suspect data. A test result was called suspect in case the Huber Elimination Rule (a robust outlier test) found it to be an outlier. The laboratories that produced these suspect data were asked to check the reported test results (no reanalyzes). Additional or corrected test results are used for data analysis and the original test results are placed under 'Remarks' in the result tables in appendix 1. Test results that came in after the deadline were not taken into account in this screening for suspect data and thus these participants were not requested for checks.

3.1 STATISTICS

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5).

For the statistical evaluation the *unrounded* (when available) figures were used instead of the rounded test results. Test results reported as '<... ' or '>... ' were not used in the statistical evaluation.

First, the normality of the distribution of the various data sets per determination was checked by means of the Lilliefors-test, a variant of the Kolmogorov-Smirnov test and by the calculation of skewness and kurtosis. Evaluation of the three normality indicators in combination with the visual evaluation of the graphic Kernel density plot, lead to judgement of the normality being either 'unknown', 'OK', 'suspect' or 'not OK'. After removal of outliers, this check was repeated. If a data set does not have a normal distribution, the (results of the) statistical evaluation should be used with due care.

The assigned value is determined by consensus based on the test results of the group of participants after rejection of the statistical outliers and/or suspect data.

According to ISO13528 all (original received or corrected) results per determination were submitted to outlier tests. In the iis procedure for proficiency tests, outliers are detected prior to calculation of the mean, standard deviation and reproducibility. For small data sets, Dixon (up to 20 test results) or Grubbs (up to 40 test results) outlier tests can be used. For larger data sets (above 20 test results) Rosner's outlier test can be used. Outliers are marked by D(0.01) for the Dixon's test, by G(0.01) or DG(0.01) for the Grubbs' test and by R(0.01) for the Rosner's test. Stragglers are marked by D(0.05) for the Dixon's test, by G(0.05) or DG(0.05) for the Grubbs' test and by R(0.05) for the Rosner's test. Both outliers and stragglers were not included in the calculations of averages and standard deviations.

For each assigned value the uncertainty was determined in accordance with ISO13528. Subsequently the calculated uncertainty was evaluated against the respective requirement based on the target reproducibility in accordance with ISO13528. In this PT, the criterion of ISO13528, paragraph 9.2.1. was met for all evaluated tests, therefore, the uncertainty of all assigned values may be negligible and need not be included in the PT report.

Finally, the reproducibilities were calculated from the standard deviations by multiplying them with a factor of 2.8.

3.2 GRAPHICS

In order to visualize the data against the reproducibilities from literature, Gauss plots were made, using the sorted data for one determination (see appendix 1). On the Y-axis the reported test results are plotted. The corresponding laboratory numbers are on the X-axis. The straight horizontal line presents the consensus value (a trimmed mean). The four striped lines, parallel to the consensus value line, are the +3s, +2s, -2s and -3s target reproducibility limits of the selected reference test method. Outliers and other data, which were excluded from the calculations, are represented as a cross. Accepted data are represented as a triangle.

Furthermore, Kernel Density Graphs were made. This is a method for producing a smooth density approximation to a set of data that avoids some problems associated with histograms. Also, a normal Gauss curve (dotted line) was projected over the Kernel Density Graph (smooth line) for reference. The Gauss curve is calculated from the consensus value and the corresponding standard deviation.

3.3 Z-SCORES

To evaluate the performance of the participating laboratories the z-scores were calculated. As it was decided to evaluate the performance of the participants in this proficiency test (PT) against the literature requirements (derived from e.g. ISO or ASTM test methods), the z-scores were calculated using a target standard deviation. This results in an evaluation independent of the variation in this interlaboratory study.

The target standard deviation was calculated from the literature reproducibility by division with 2.8. In case no literature reproducibility was available, other target values were used, like Horwitz or an estimated reproducibility based on former iis proficiency tests.

When a laboratory did use a test method with a reproducibility that is significantly different from the reproducibility of the reference test method used in this report, it is strongly advised to recalculate the z-score, while using the reproducibility of the actual test method used, this in order to evaluate whether the reported test result is fit-for-use.

The z-scores were calculated according to:

$$Z_{(\text{target})} = (\text{test result} - \text{average of PT}) / \text{target standard deviation}$$

The $Z_{(\text{target})}$ scores are listed in the test result tables in appendix 1.

Absolute values for $z < 2$ are very common and absolute values for $z > 3$ are very rare. Therefore, the usual interpretation of z-scores is as follows:

	$ z < 1$	good
1 <	$ z < 2$	satisfactory
2 <	$ z < 3$	questionable
3 <	$ z $	unsatisfactory

4 EVALUATION

In this proficiency test some problems were encountered with the dispatch of the samples. Three participants reported test results after the final reporting date and four other participants did not report any test results. Not all participants were able to report all tests requested.

In total 46 participants reported 459 numerical test results for the composition. Observed were 24 outlying test results, which is 5.2%.

In proficiency tests outlier percentages of 3% - 7.5% are quite normal.

Not all data sets proved to have a normal Gaussian distribution. These are referred to as “not OK” or “suspect”. The statistical evaluation of these data sets should be used with due care, see also paragraph 3.1.

4.1 EVALUATION PER COMPONENT

In this section the reported test results are discussed per component. The test methods which were used by the various laboratories were taken into account for explaining the observed differences when possible and applicable. These test methods are also in the tables together with the original data in appendix 1. The abbreviations, used in these tables, are explained in appendix 3.

Method ASTM D2163:23e1 is used to evaluate the performance of the test results for the composition of Liquefied Butane. Although the reproducibility is given in %V/V following the Ideal Gas Law (or General Gas Equation) for the same temperature and pressure the reproducibility in %mol/mol will follow the same equation. In this test method no reproducibilities are mentioned for the following components: 1-Butene, iso-Butene, trans-2-Butene, cis-2-Butene and 1,3-Butadiene. Therefore, it is decided to use for these components the mentioned reproducibility for n-Butane.

Three participants had at least four statistical outliers in the test results of the composition. As the test results of each component of the composition are dependent, it was decided to exclude the remaining test results from these participants from the statistical evaluations.

Total of the composition results: The total of the test results of the composition per laboratory was calculated by iis. Since the composition is requested as normalized the total should be 100%. Three calculated results were found to be significantly different than 100%. Therefore, it was decided to exclude the test results of these participants for all further statistical evaluations.

Propane: This determination was not problematic. Four statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data is in agreement with the requirements of ASTM D2163:23e1 and in agreement with the requirements of EN27941:93(liq).

- Propene: This determination was not problematic. Four statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data is in agreement with the requirements of ASTM D2163:23e1 and in agreement with the requirements of EN27941:93(liq).
- iso-Butane: This determination may be problematic depending on the requirements of the test method used. One statistical outlier was observed and five other test results were excluded. The calculated reproducibility after rejection of the suspect data is in not agreement with the reproducibility of ASTM D2163:23e1 but is in agreement with the requirements of EN27941:93(liq).
- n-Butane: This determination may be problematic depending on the requirements of the test method used. Three statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the reproducibility of ASTM D2163:23e1 but is in agreement with the requirements of EN27941:93(liq).
- 1-Butene: This determination was not problematic. No statistical outliers were observed but six test results were excluded. The calculated reproducibility after rejection of the suspect data is in agreement with the requirements of ASTM D2163:23e1 and in agreement with the requirements of EN27941:93(liq).
- iso-Butene: This determination may be problematic depending on the requirements of the test method used. No statistical outliers were observed but six test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the reproducibility of ASTM D2163:23e1 but is in agreement with the requirements of EN27941:93(liq).
- trans-2-Butene: This determination was not problematic. Three statistical outliers were observed and four other test results were excluded. The calculated reproducibility after rejection of the suspect data is in agreement with the reproducibility of ASTM D2163:23e1 and in agreement with the requirements of EN27941:93(liq).
- cis-2-Butene: This determination may be problematic depending on the requirements of the test method used. Three statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data not in agreement with the reproducibility of ASTM D2163:23e1 but is in agreement with the requirements of EN27941:93(liq).

- 1,3-Butadiene: This determination was not problematic. Two statistical outliers were observed and five other test results were excluded. The calculated reproducibility after rejection of the suspect data is in agreement with the reproducibility of ASTM D2163:23e1 and in agreement with the requirements of EN27941:93(liq).
- n-Pentane: This determination may not be problematic. All reporting laboratories agreed that the amount of n-Pentane was lower than 0.1 %mol/mol, therefore no z-scores are calculated.
- iso-Pentane: This determination may be problematic depending on the requirements of the test method used. Four statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the reproducibility of ASTM D2163:23e1 but is in agreement with the requirements of EN27941:93(liq).

Calculated parameters

In principle no additional variation should be introduced when applying a calculation on the reported component concentrations. However, in practice a significant additional uncertainty is added in most cases. Not all methods mention a factor for each component of the Butane mixture for calculation of the physical properties. In these cases iis used a factor from a comparable component or an average value. These deviating factors are mentioned below the parameter's tables in appendix 1.

Molar Mass: For the calculation of this parameter twenty-two participants reported a test result. For five test results iis calculated a different Molar Mass.

Relative Density at 60/60 °F: For the calculation of this parameter twenty-six participants reported a test result. For three test results iis calculated a different Relative Density at 60/60 °F.

Different test methods for the calculation of the Vapor Pressure do exist. Specification EN589 refers to ISO8973 for the calculation of Vapor Pressure. In ISO8973 (identical to IP432) the Vapor Pressure is calculated from the mole fraction per component and a Vapor Pressure factor of that component. In ASTM D2598 the Vapor Pressure is calculated from the liquid volume percentage per component and a Vapor Pressure factor of that component.

Abs. Vapor Pres. at 100 °F: For the calculation of this parameter sixteen participants reported a test result. For three test results iis calculated a different absolute Vapor Pressure at 100 °F.

Rel. Vapor Pres. at 100 °F: For the calculation of this parameter seventeen participants reported a test result. For one test result iis calculated a different relative Vapor Pressure at 100 °F.

Abs. Vapor Pres. at 40 °C: For the calculation of this parameter twenty-one participants reported a test result. For two test results iis calculated a different absolute Vapor Pressure at 40 °C.

Rel. Vapor Pres. at 40 °C: For the calculation of this parameter twenty participants reported a test result. For one test result iis calculated a different relative Vapor Pressure at 40 °C.

MON: The calculation in Annex B from specification EN589 is used by iis on a molar basis while ASTM D2598 describes the calculation of MON on a liquid volume basis. Unfortunately, method EN589:18 does not mention a MON factor for 1,3-Butadiene. Therefore, iis did use an estimated value of 70 (in analogy of the MON factors of the other components). Method ASTM D2598:21 does not mention MON factors for iso-Butene, trans-2-Butene or 1,3-Butadiene. Therefore, iis has used the factor 83.5 for iso-Butene and trans-2-Butene, which is the factor value of cis-2-Butene in ASTM D2598:21 and the factor 70 (from EN589:18) for 1,3-Butadiene. For the calculation of this parameter twenty participants reported a test result. For five test results iis calculated a different MON.

Ideal Gross Heating Value at 14.696 psia / 60 °F: In this PT none of the participants reported to have used ISO6976, therefore the results for all participants were only calculated according to ASTM D3588. Six laboratories reported test results of which one test result was different to what iis has calculated.

Ideal Net Heating Value at 14.696 psia / 60 °F: In this PT none of the participants reported to have used ISO6976, therefore the results for all participants were only calculated according to ASTM D3588. Eight laboratories reported test results of which two test result were different to what iis has calculated.

4.2 PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES

A comparison has been made between the reproducibility as declared by the reference test method and the reproducibility as found for the group of participating laboratories. The number of significant test results, the average, the calculated reproducibility (2.8 * standard deviation) and the target reproducibility derived from reference methods are presented in the next table.

Component	unit	n	average	2.8 * sd	R(lit)
Propane	%mol/mol	39	0.693	0.076	0.135
Propene	%mol/mol	39	1.627	0.170	0.393
iso-Butane	%mol/mol	40	72.154	1.268	0.914
n-Butane	%mol/mol	40	4.834	0.325	0.280
1-Butene	%mol/mol	40	3.841	0.268	0.252
iso-Butene	%mol/mol	40	4.821	0.349	0.279
trans-2-Butene	%mol/mol	39	3.177	0.188	0.231

Component	unit	n	average	2.8 * sd	R(lit)
cis-2-Butene	%mol/mol	39	7.456	0.414	0.340
1,3-Butadiene	%mol/mol	39	0.805	0.070	0.125
n-Pentane	%mol/mol	35	<0.1	n.a.	n.a.
iso-Pentane	%mol/mol	39	0.621	0.066	0.047

Table 2: reproducibilities of the composition of sample #23100

Without further statistical calculations it can be concluded that for several tests there is a good compliance of the group of participants with the reference test methods. The problematic tests have been discussed in paragraph 4.1.

4.3 COMPARISON OF THE PROFICIENCY TEST OF JUNE 2023 WITH PREVIOUS PTS

	June 2023	June 2022	June 2021	July 2020	June 2019
Number of reporting laboratories	46	52	40	47	41
Number of test results	459	694	549	665	549
Number of statistical outliers	24	44	28	41	53
Percentage of statistical outliers	5.2%	6.3%	5.1%	6.2%	9.7%

Table 3: comparison with previous proficiency tests

In proficiency tests outlier percentages of 3% - 7.5% are quite normal.

The performance of the determinations of the proficiency tests was compared to the requirements of the reference test methods. The conclusions are given in the following table.

Component	June 2023	June 2022	June 2021	July 2020	June 2019
Propane	+	+	+	-	++
Propene	++	+	++	+	++
iso-Butane	-	+/-	+/-	-	-
n-Butane	-	-	-	+/-	-
1-Butene	+/-	+	+	-	+
iso-Butene	-	+/-	+	-	+
trans-2-Butene	+	+	+	+/-	+
cis-2-Butene	-	+/-	-	-	-
1,3-Butadiene	+	++	+	+	+
n-Pentane	n.e.	n.e.	n.e.	n.e.	n.e.
iso-Pentane	-	--	-	--	-

Table 4: comparison of determinations to the reference test methods

The following performance categories were used:

- ++ : group performed much better than the reference test method
- + : group performed better than the reference test method
- +/- : group performance equals the reference test method
- : group performed worse than the reference test method
- : group performed much worse than the reference test method
- n.e. : not evaluated

5 DISCUSSION

Because the majority of the reproducibility requirements of ASTM D2163 differ significantly from the reproducibility requirements of EN27941 (for liquid injection), the outcome of the evaluations will be strongly dependent on the reference test method selected for the evaluation.

The consensus values as determined in this PT are compared with the average values from the homogeneity testing by EfecTech (Uttoxeter, United Kingdom) in the following table. From this comparison it is clear that all consensus values as determined in this PT are very well in line with the values as determined during the preparation of the gas cylinders.

Component	Average values EfecTech in %mol/mol	Consensus values from PT results in %mol/mol	differences in %mol/mol	z-score
Propane	0.707	0.693	0.014	0.29
Propene	1.697	1.627	0.070	0.50
iso-Butane	72.220	72.154	0.066	0.20
n-Butane	4.752	4.834	-0.081	-0.81
1-Butene	3.814	3.841	-0.027	-0.31
iso-Butene	4.872	4.821	0.051	0.51
trans-2-Butene	3.215	3.177	0.038	0.46
cis-2-Butene	7.309	7.456	-0.147	-1.21
1,3-Butadiene	0.806	0.805	0.001	0.01
iso-Pentane	0.608	0.621	-0.013	-0.80

Table 5: comparison of consensus values with values determined by EfecTech (Uttoxeter, United Kingdom)

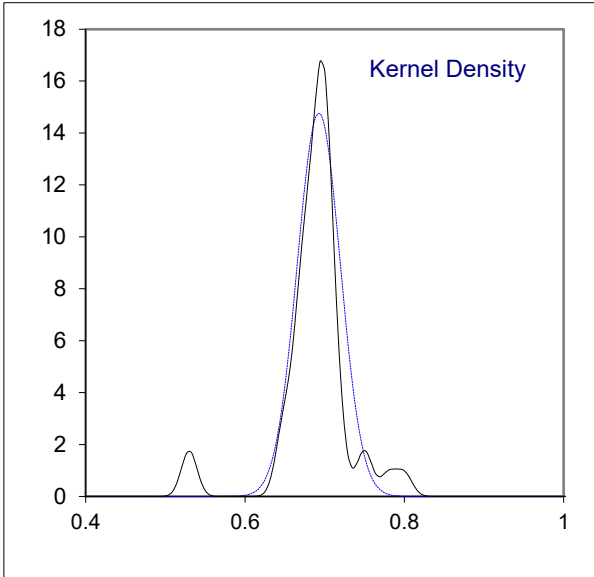
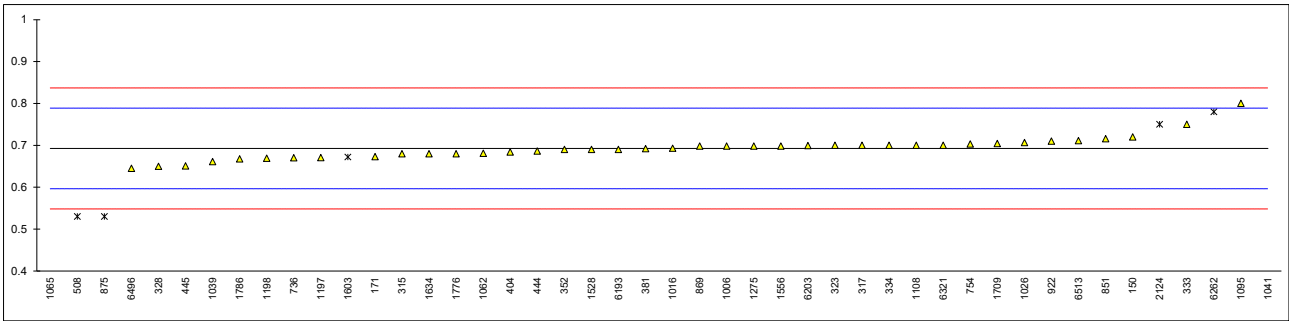
APPENDIX 1

Total of reported composition (normalized) test results; results in %mol/mol

lab	method	value	mark	iis calc.	remarks
150		----		100.00	
171		----		100.00	
315		----		99.99	
317	D2163	100.00		100.00	
323		----		99.99	
328		100		99.99	
333	D2163	100		100.00	
334		----		100.00	
352	EN27941	100.0		100.07	
381		----		100.00	
404	EN27941	100.000		100.00	
444		100.00		100.00	
445	D2163	100.00		100.07	
508	D2163	100.00		100.00	
736	D2163	100.00		100.02	
754	D2163	100		100.00	
851	D2163	100.00		100.00	
869		----		100.00	
875		----		99.91	
922	D2163	100.00		100.00	
1006	D2163	100		100.00	
1012		----		----	
1016		----		100.00	
1026	ISO7941	100		100.00	
1039	EN27941	100.00		100.00	
1041	DIN51619	100.000		100.00	
1062		----		99.95	
1065	D2163	100.0		100.00	
1095	ISO7941	100		100.00	
1108	D2163	100.00		100.00	
1197		100.0000		100.00	
1198		100.0000		100.00	
1257		----		----	
1275	EN27941	100.002		100.00	
1528		----		100.00	
1556	EN27941	99.999		100.00	
1603	In house	100.00		99.86	not 100% (corrected 2 components) and excluded from evaluations
1634	ISO7941	100		100.02	
1709		----		100.00	
1720		----		----	
1776	EN27941	100.04		100.04	
1786		100.0000		100.00	
2124	D2163	99.7373		99.74	not 100% and excluded from evaluations
6193	EN15984	100.01		99.89	
6203		----		100.00	
6262	D2163	100		93.27	not 100% (corrected 1 component) and excluded from evaluations
6321	D2163	100.0		100.00	
6474		----		----	
6496	EN27941	100.00		100.00	
6513	EN27941	100		99.94	

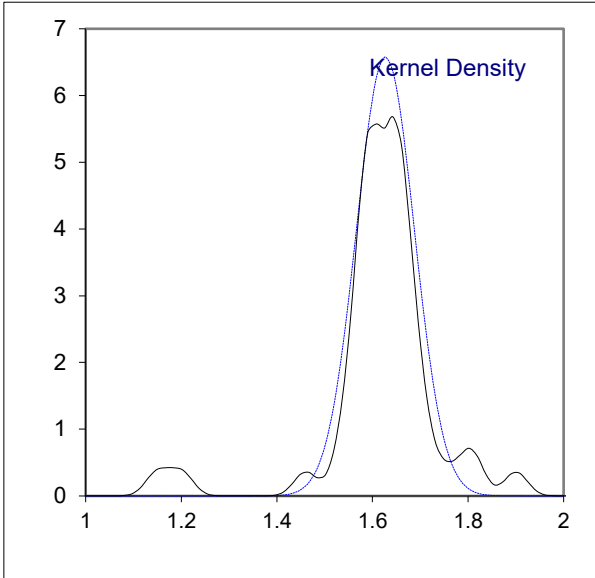
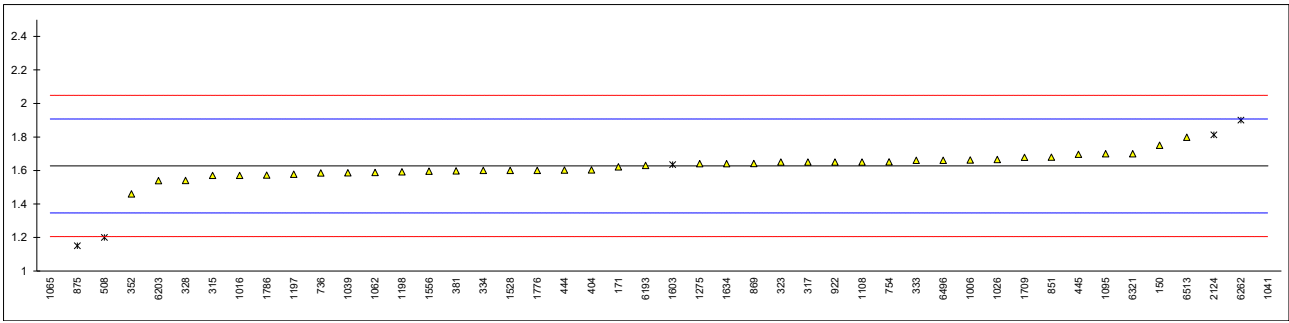
Determination of Propane on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	0.72		0.57	
171	D2163	0.6732		-0.41	
315	D2163	0.68		-0.26	
317	D2163	0.70		0.15	
323	D2163	0.70		0.15	
328		0.65		-0.89	
333	D2163	0.75		1.19	
334	D2163	0.7		0.15	
352	EN27941	0.69		-0.06	
381	DIN51619	0.692		-0.01	
404	EN27941	0.684		-0.18	
444		0.6865		-0.13	
445	D2163	0.651		-0.87	
508	D2163	0.53	R(0.01)	-3.38	
736	D2163	0.670		-0.47	
754	D2163	0.703		0.21	
851	D2163	0.715997	C	0.48	first reported: 0.702949
869	D2163	0.698		0.11	
875	D2163	0.53	R(0.01)	-3.38	
922	D2163	0.71		0.36	
1006	D2163	0.6980		0.11	
1012		-----		-----	
1016	ISO7941	0.693		0.01	
1026	ISO7941	0.70629		0.28	
1039	EN27941	0.661		-0.66	
1041	DIN51619	1.525	R(0.01)	17.30	
1062	D2163	0.6812		-0.24	
1065	D2163	0.112096	R(0.01)	-12.07	
1095	ISO7941	0.8		2.23	
1108	D2163	0.70		0.15	
1197		0.670374		-0.46	
1198		0.669025		-0.49	
1257		-----		-----	
1275	EN27941	0.698		0.11	
1528	EN27941	0.69		-0.06	
1556	EN27941	0.698		0.11	
1603	In house	0.6721	ex	-0.43	test result excluded, see §4.1
1634	ISO7941	0.68		-0.26	
1709	D2163	0.704303		0.24	
1720		-----		-----	
1776	EN27941	0.68		-0.26	
1786		0.667699		-0.52	
2124	D2163	0.7499	ex	1.19	test result excluded, see §4.1
6193	EN15984	0.69		-0.06	
6203	EN27941	0.699		0.13	
6262	D2163	0.78	ex	1.81	test result excluded, see §4.1
6321	D2163	0.7		0.15	
6474		-----		-----	
6496	EN27941	0.645	C	-0.99	first reported: 0.525
6513	EN27941	0.711		0.38	
	normality	not OK			
	n	39			
	outliers	4 (+3ex)			
	mean (n)	0.6927			
	st.dev. (n)	0.02702			
	R(calc.)	0.0756			
	st.dev.(D2163:23e1)	0.04810			
	R(D2163:23e1)	0.1347			
compare:					
	R(EN27941:93(liq))	1.3028			



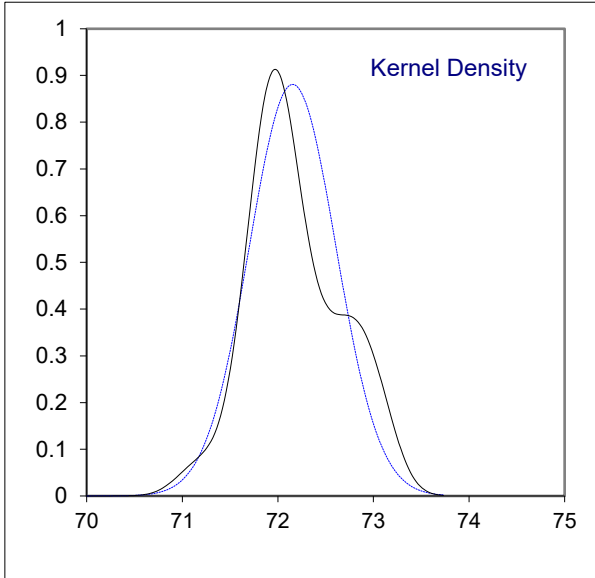
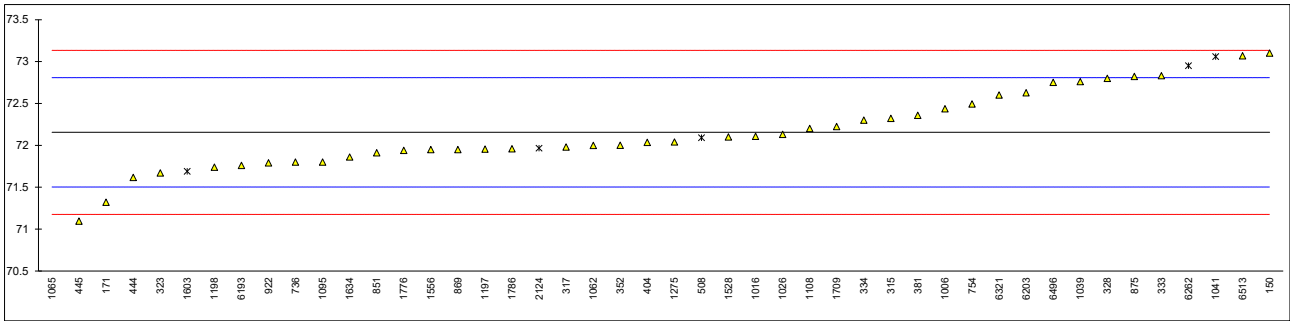
Determination of Propene on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	1.75		0.88	
171	D2163	1.6208		-0.04	
315	D2163	1.57		-0.41	
317	D2163	1.65		0.16	
323	D2163	1.65		0.16	
328		1.54		-0.62	
333	D2163	1.66		0.24	
334	D2163	1.6		-0.19	
352	EN27941	1.46		-1.19	
381	DIN51619	1.597		-0.21	
404	EN27941	1.603		-0.17	
444		1.6021		-0.18	
445	D2163	1.696		0.49	
508	D2163	1.20	R(0.01)	-3.04	
736	D2163	1.585		-0.30	
754	D2163	1.651		0.17	
851	D2163	1.678988	C	0.37	first reported: 1.670568
869	D2163	1.641		0.10	
875	D2163	1.15	R(0.01)	-3.40	
922	D2163	1.65		0.16	
1006	D2163	1.6628		0.26	
1012		-----		-----	
1016	ISO7941	1.570		-0.41	
1026	ISO7941	1.66526		0.27	
1039	EN27941	1.586		-0.29	
1041	DIN51619	4.498	R(0.01)	20.46	
1062	D2163	1.5877		-0.28	
1065	D2163	0.146001	R(0.01)	-10.55	
1095	ISO7941	1.7		0.52	
1108	D2163	1.65		0.16	
1197		1.577809		-0.35	
1198		1.591638		-0.25	
1257		-----		-----	
1275	EN27941	1.640		0.09	
1528	EN27941	1.60		-0.19	
1556	EN27941	1.596		-0.22	
1603	In house	1.6349	ex	0.06	test result excluded, see §4.1
1634	ISO7941	1.64		0.09	
1709	D2163	1.677762		0.36	
1720		-----		-----	
1776	EN27941	1.60		-0.19	
1786		1.572216		-0.39	
2124	D2163	1.8126	ex	1.32	test result excluded, see §4.1
6193	EN15984	1.63		0.02	
6203	EN27941	1.539		-0.63	
6262	D2163	1.90	ex	1.95	test result excluded, see §4.1
6321	D2163	1.7		0.52	
6474		-----		-----	
6496	EN27941	1.660	C	0.24	first reported: 1.145
6513	EN27941	1.798		1.22	
	normality	suspect			
	n	39			
	outliers	4 (+3ex)			
	mean (n)	1.6269			
	st.dev. (n)	0.06067			
	R(calc.)	0.1699			
	st.dev.(D2163:23e1)	0.14034			
	R(D2163:23e1)	0.3930			
compare:					
	R(EN27941:93(liq))	1.3652			



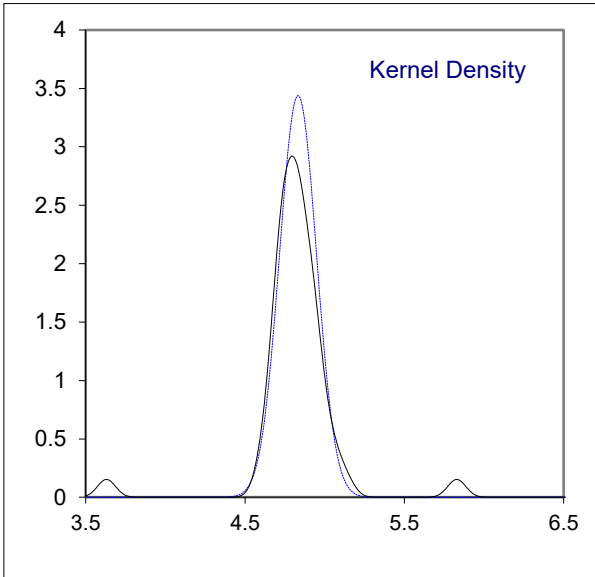
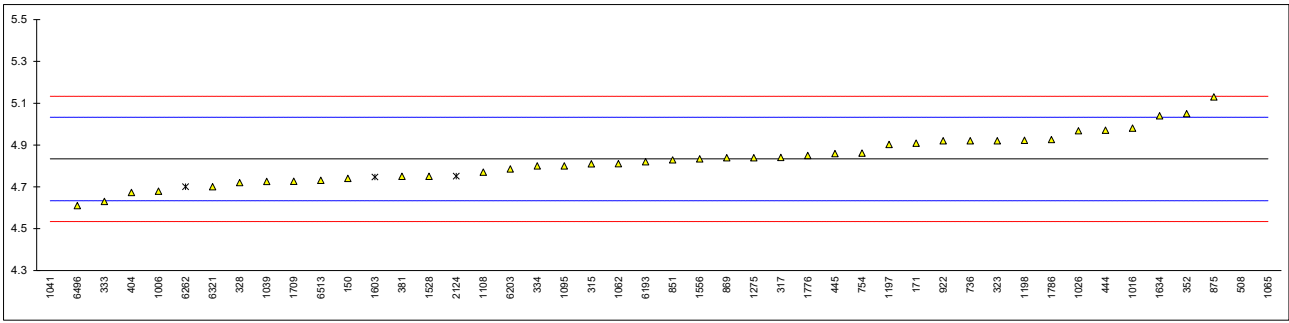
Determination of iso-Butane on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	73.10		2.90	
171	D2163	71.3221		-2.55	
315	D2163	72.32		0.51	
317	D2163	71.98		-0.53	
323	D2163	71.67		-1.48	
328		72.80		1.98	
333	D2163	72.83		2.07	
334	D2163	72.3		0.45	
352	EN27941	72.00		-0.47	
381	DIN51619	72.356		0.62	
404	EN27941	72.033		-0.37	
444		71.6169		-1.65	
445	D2163	71.094	C	-3.25	first reported: 71.012
508	D2163	72.09	ex	-0.20	test result excluded, see §4.1
736	D2163	71.80	C	-1.09	first reported: 72.121
754	D2163	72.493		1.04	
851	D2163	71.91029	C	-0.75	first reported: 71.889075
869	D2163	71.949		-0.63	
875	D2163	72.82		2.04	
922	D2163	71.79		-1.12	
1006	D2163	72.4357		0.86	
1012		-----		-----	
1016	ISO7941	72.106		-0.15	
1026	ISO7941	72.12982		-0.08	
1039	EN27941	72.760		1.86	
1041	DIN51619	73.058	ex	2.77	test result excluded, see §4.1
1062	D2163	71.9972		-0.48	
1065	D2163	64.026997	R(0.01)	-24.91	
1095	ISO7941	71.8		-1.09	
1108	D2163	72.20		0.14	
1197		71.954616		-0.61	
1198		71.737979		-1.28	
1257		-----		-----	
1275	EN27941	72.039		-0.35	
1528	EN27941	72.10		-0.17	
1556	EN27941	71.948		-0.63	
1603	In house	71.69	ex,C	-1.42	test result excluded, see §4.1, first reported: 72.48
1634	ISO7941	71.86		-0.90	
1709	D2163	72.224865		0.22	
1720		-----		-----	
1776	EN27941	71.94		-0.66	
1786		71.957532		-0.60	
2124	D2163	71.9658	ex	-0.58	test result excluded, see §4.1
6193	EN15984	71.76		-1.21	
6203	EN27941	72.626		1.45	
6262	D2163	72.95	ex	2.44	test result excluded, see §4.1
6321	D2163	72.6		1.37	
6474		-----		-----	
6496	EN27941	72.750	C	1.83	first reported: 72.740
6513	EN27941	73.068		2.80	
	normality	OK			
	n	40			
	outliers	1 (+5ex)			
	mean (n)	72.1545			
	st.dev. (n)	0.45291			
	R(calc.)	1.2681			
	st.dev.(D2163:23e1)	0.32631			
	R(D2163:23e1)	0.9137			
compare:					
	R(EN27941:93(liq))	1.4826			



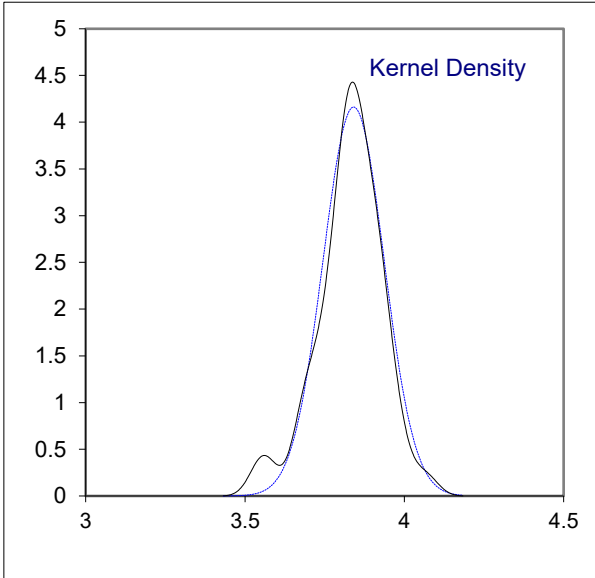
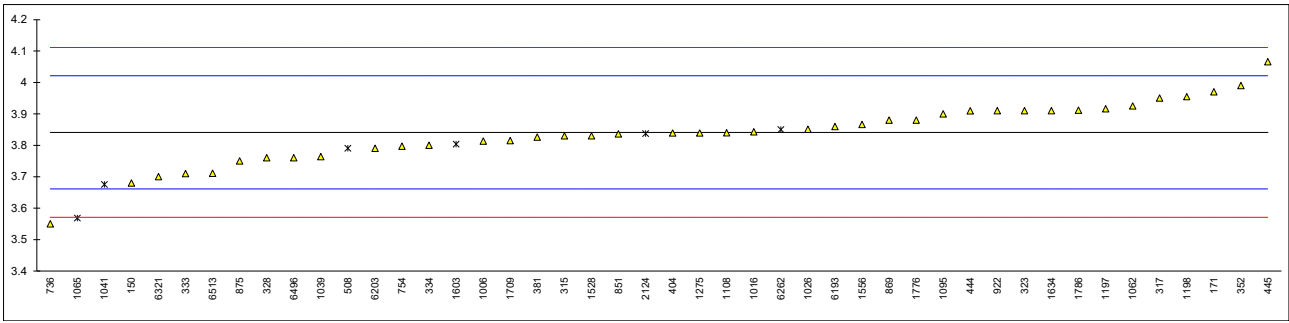
Determination of n-Butane on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	4.74		-0.94	
171	D2163	4.9088		0.75	
315	D2163	4.81		-0.24	
317	D2163	4.84		0.07	
323	D2163	4.92		0.87	
328		4.72		-1.14	
333	D2163	4.63		-2.04	
334	D2163	4.8		-0.34	
352	EN27941	5.05		2.17	
381	DIN51619	4.750		-0.84	
404	EN27941	4.673		-1.61	
444		4.9708		1.37	
445	D2163	4.859		0.26	
508	D2163	5.83	R(0.01)	9.98	
736	D2163	4.920		0.87	
754	D2163	4.861		0.28	
851	D2163	4.828707	C	-0.05	first reported: 4.812283
869	D2163	4.839		0.05	
875	D2163	5.13		2.97	
922	D2163	4.92		0.87	
1006	D2163	4.6796		-1.54	
1012		----		----	
1016	ISO7941	4.980		1.47	
1026	ISO7941	4.96775		1.34	
1039	EN27941	4.726		-1.08	
1041	DIN51619	3.631	R(0.01)	-12.04	
1062	D2163	4.8109		-0.23	
1065	D2163	7.7083	R(0.01)	28.79	
1095	ISO7941	4.8		-0.34	
1108	D2163	4.77		-0.64	
1197		4.902724		0.69	
1198		4.922264		0.89	
1257		----		----	
1275	EN27941	4.839		0.05	
1528	EN27941	4.75		-0.84	
1556	EN27941	4.834		0.00	
1603	In house	4.7470	ex	-0.87	test result excluded, see §4.1
1634	ISO7941	5.04		2.07	
1709	D2163	4.726148		-1.08	
1720		----		----	
1776	EN27941	4.85		0.17	
1786		4.925686		0.92	
2124	D2163	4.7510	ex	-0.83	test result excluded, see §4.1
6193	EN15984	4.82		-0.14	
6203	EN27941	4.785		-0.49	
6262	D2163	4.70	ex	-1.34	test result excluded, see §4.1
6321	D2163	4.7		-1.34	
6474		----		----	
6496	EN27941	4.610	C	-2.24	first reported: 4.625
6513	EN27941	4.731		-1.03	
	normality	OK			
	n	40			
	outliers	3 (+3ex)			
	mean (n)	4.8335			
	st.dev. (n)	0.11597			
	R(calc.)	0.3247			
	st.dev.(D2163:23e1)	0.09986			
	R(D2163:23e1)	0.2796			
compare:					
	R(EN27941:93(liq))	0.9884			



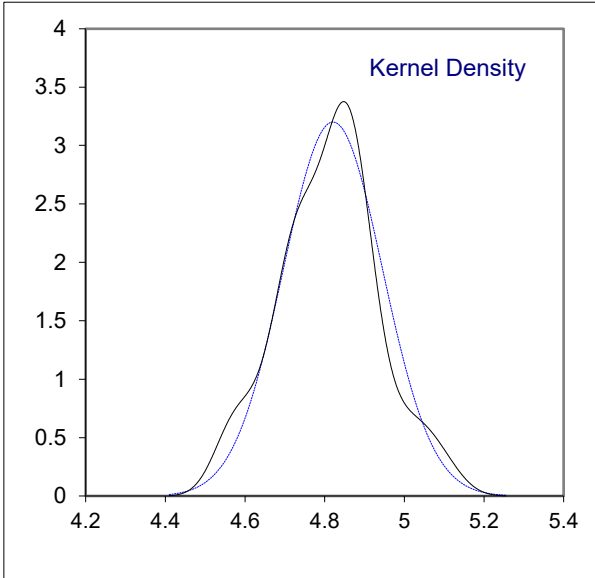
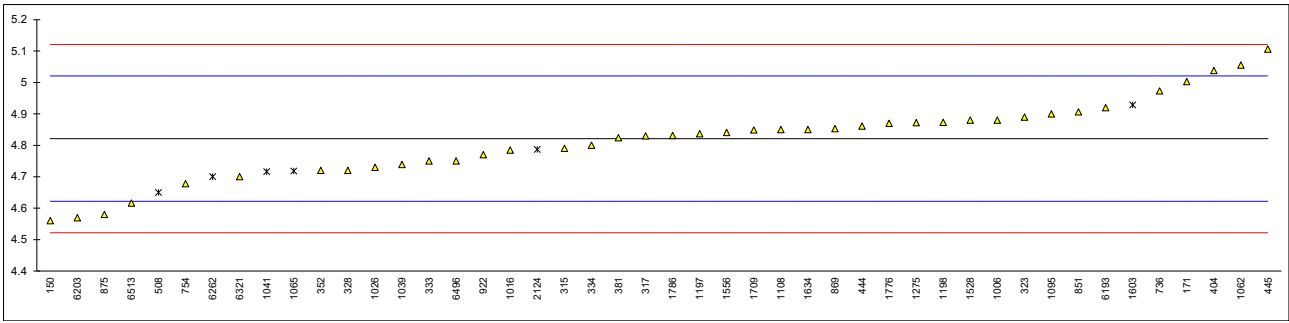
Determination of 1-Butene on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	3.68		-1.79	
171	D2163	3.9701		1.43	
315	D2163	3.83		-0.12	
317	D2163	3.95		1.21	
323	D2163	3.91		0.77	
328		3.76		-0.90	
333	D2163	3.71		-1.46	
334	D2163	3.8		-0.46	
352	EN27941	3.99		1.65	
381	DIN51619	3.826		-0.17	
404	EN27941	3.839		-0.02	
444		3.9095		0.76	
445	D2163	4.066		2.50	
508	D2163	3.79	ex	-0.57	test result excluded, see §4.1
736	D2163	3.55	C	-3.23	first reported: 3.210
754	D2163	3.797		-0.49	
851	D2163	3.835882	C	-0.06	first reported: 3.850716
869	D2163	3.880		0.43	
875	D2163	3.75		-1.01	
922	D2163	3.91		0.77	
1006	D2163	3.8132		-0.31	
1012		----		----	
1016	ISO7941	3.843		0.02	
1026	ISO7941	3.8511		0.11	
1039	EN27941	3.764		-0.86	
1041	DIN51619	3.675	ex	-1.84	test result excluded, see §4.1
1062	D2163	3.9249		0.93	
1065	D2163	3.568032	ex	-3.03	test result excluded, see §4.1
1095	ISO7941	3.9		0.65	
1108	D2163	3.84		-0.01	
1197		3.91631		0.84	
1198		3.954448		1.26	
1257		----		----	
1275	EN27941	3.839		-0.02	
1528	EN27941	3.83		-0.12	
1556	EN27941	3.866		0.28	
1603	In house	3.8038	ex	-0.41	test result excluded, see §4.1
1634	ISO7941	3.91		0.77	
1709	D2163	3.814778		-0.29	
1720		----		----	
1776	EN27941	3.88		0.43	
1786		3.911752		0.78	
2124	D2163	3.8373	ex	-0.04	test result excluded, see §4.1
6193	EN15984	3.86		0.21	
6203	EN27941	3.790		-0.57	
6262	D2163	3.85	ex	0.10	test result excluded, see §4.1
6321	D2163	3.7		-1.57	
6474		----		----	
6496	EN27941	3.760	C	-0.90	first reported: 3.880
6513	EN27941	3.711		-1.44	
	normality	suspect			
	n	40			
	outliers	0 (+6ex)			
	mean (n)	3.8411			
	st.dev. (n)	0.09589			
	R(calc.)	0.2685			
	st.dev.(D2163:23e1)	0.09005			
	R(D2163:23e1)	0.2521			
compare:					
	R(EN27941:93(liq))	1.0239			



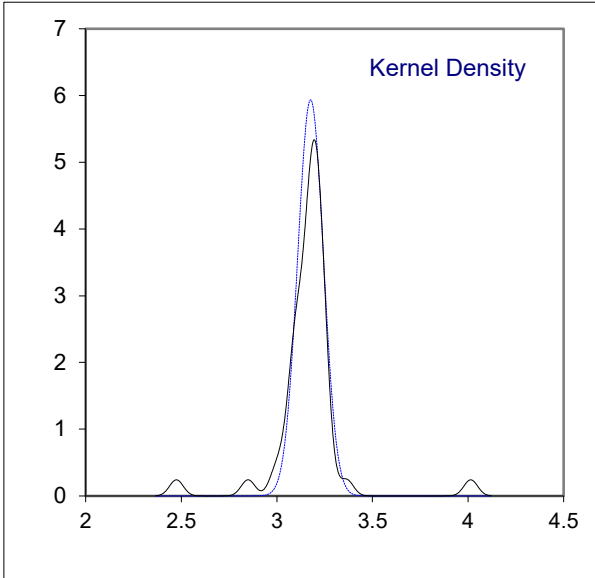
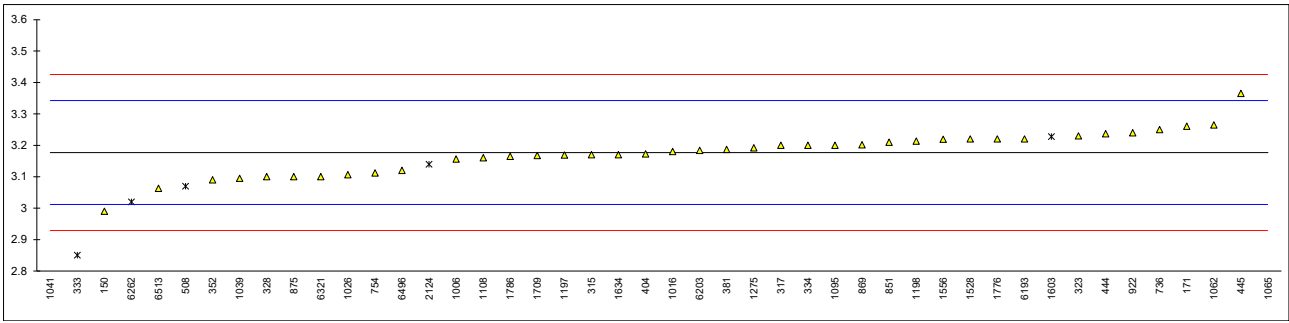
Determination of iso-Butene on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	4.56		-2.62	
171	D2163	5.0023		1.82	
315	D2163	4.79		-0.31	
317	D2163	4.83		0.09	
323	D2163	4.89		0.69	
328		4.72		-1.01	
333	D2163	4.75		-0.71	
334	D2163	4.8		-0.21	
352	EN27941	4.72		-1.01	
381	DIN51619	4.824		0.03	
404	EN27941	5.038		2.17	
444		4.8611		0.40	
445	D2163	5.106		2.86	
508	D2163	4.65	ex	-1.72	test result excluded, see §4.1
736	D2163	4.973		1.52	
754	D2163	4.678		-1.44	
851	D2163	4.906448	C	0.85	first reported: 4.472063
869	D2163	4.853		0.32	
875	D2163	4.58		-2.42	
922	D2163	4.77		-0.51	
1006	D2163	4.8802		0.59	
1012		-----		-----	
1016	ISO7941	4.785		-0.36	
1026	ISO7941	4.72986		-0.92	
1039	EN27941	4.739		-0.82	
1041	DIN51619	4.716	ex	-1.05	test result excluded, see §4.1
1062	D2163	5.0554		2.35	
1065	D2163	4.718338	ex	-1.03	test result excluded, see §4.1
1095	ISO7941	4.9		0.79	
1108	D2163	4.85		0.29	
1197		4.836481		0.15	
1198		4.87303		0.52	
1257		-----		-----	
1275	EN27941	4.872		0.51	
1528	EN27941	4.88		0.59	
1556	EN27941	4.841		0.20	
1603	In house	4.9285	ex	1.08	test result excluded, see §4.1
1634	ISO7941	4.85		0.29	
1709	D2163	4.848611		0.27	
1720		-----		-----	
1776	EN27941	4.87		0.49	
1786		4.831475		0.10	
2124	D2163	4.7870	ex	-0.34	test result excluded, see §4.1
6193	EN15984	4.92		0.99	
6203	EN27941	4.569		-2.53	
6262	D2163	4.70	ex	-1.22	test result excluded, see §4.1
6321	D2163	4.7		-1.22	
6474		-----		-----	
6496	EN27941	4.750	C	-0.71	first reported: 4.910
6513	EN27941	4.616		-2.06	
	normality	OK			
	n	40			
	outliers	0 (+6ex)			
	mean (n)	4.8212			
	st.dev. (n)	0.12461			
	R(calc.)	0.3489			
	st.dev.(D2163:23e1)	0.09974			
	R(D2163:23e1)	0.2793			
compare:					
	R(EN27941:93(liq))	1.0239			



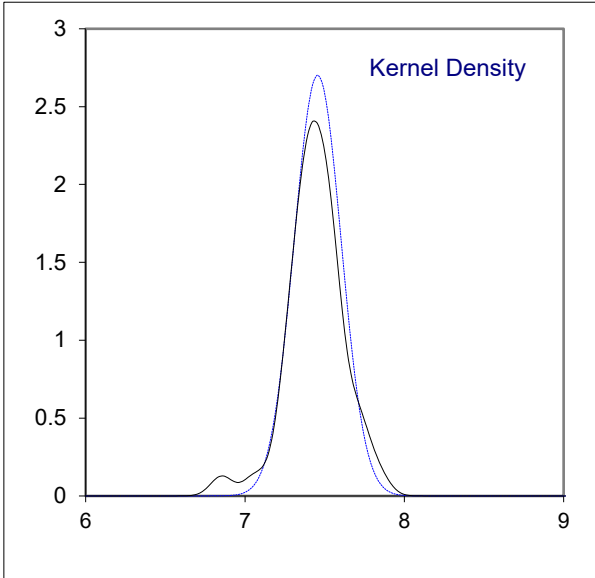
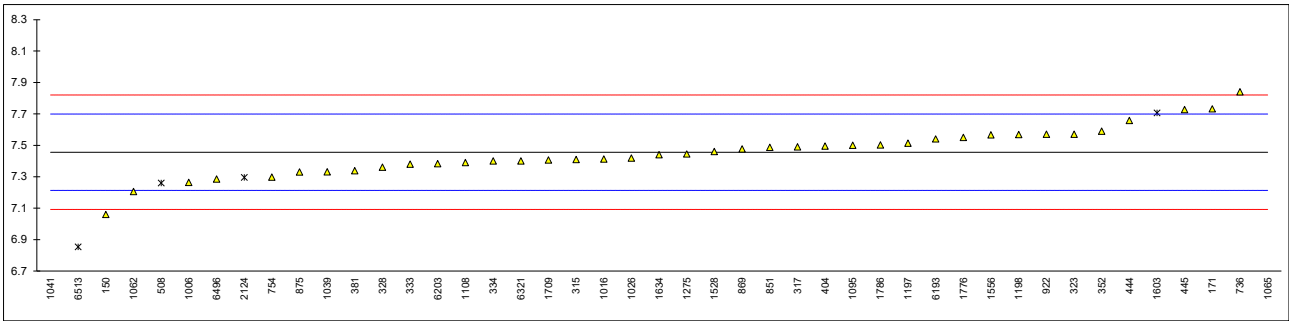
Determination of trans-2-Butene on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	2.99		-2.26	
171	D2163	3.2607		1.01	
315	D2163	3.17		-0.08	
317	D2163	3.20		0.28	
323	D2163	3.23		0.64	
328		3.10		-0.93	
333	D2163	2.85	R(0.01)	-3.95	
334	D2163	3.2		0.28	
352	EN27941	3.09		-1.05	
381	DIN51619	3.187		0.12	
404	EN27941	3.173		-0.05	
444		3.2365		0.72	
445	D2163	3.365		2.27	
508	D2163	3.07	ex	-1.29	test result excluded, see §4.1
736	D2163	3.250		0.88	
754	D2163	3.112		-0.79	
851	D2163	3.209568	C	0.39	first reported: 3.175173
869	D2163	3.202		0.30	
875	D2163	3.10		-0.93	
922	D2163	3.24		0.76	
1006	D2163	3.1563		-0.25	
1012		----		----	
1016	ISO7941	3.180		0.04	
1026	ISO7941	3.1064		-0.85	
1039	EN27941	3.095		-0.99	
1041	DIN51619	2.475	R(0.01)	-8.49	
1062	D2163	3.2648		1.06	
1065	D2163	4.014740	R(0.01)	10.13	
1095	ISO7941	3.2		0.28	
1108	D2163	3.16		-0.21	
1197		3.168723		-0.10	
1198		3.213497		0.44	
1257		----		----	
1275	EN27941	3.192		0.18	
1528	EN27941	3.22		0.52	
1556	EN27941	3.219		0.51	
1603	In house	3.2272	ex,C	0.61	test result excluded, see §4.1, first reported: 2.5802
1634	ISO7941	3.17		-0.08	
1709	D2163	3.167375		-0.12	
1720		----		----	
1776	EN27941	3.22		0.52	
1786		3.165214		-0.14	
2124	D2163	3.1395	ex	-0.45	test result excluded, see §4.1
6193	EN15984	3.22		0.52	
6203	EN27941	3.184		0.09	
6262	D2163	3.02	ex	-1.90	test result excluded, see §4.1
6321	D2163	3.1		-0.93	
6474		----		----	
6496	EN27941	3.120	C	-0.69	first reported: 3.220
6513	EN27941	3.063		-1.38	
	normality	suspect			
	n	39			
	outliers	3 (+4ex)			
	mean (n)	3.1770			
	st.dev. (n)	0.0672			
	R(calc.)	0.1882			
	st.dev.(D2163:23e1)	0.08267			
	R(D2163:23e1)	0.2315			
compare:					
	R(EN27941:93(liq))	1.0239			



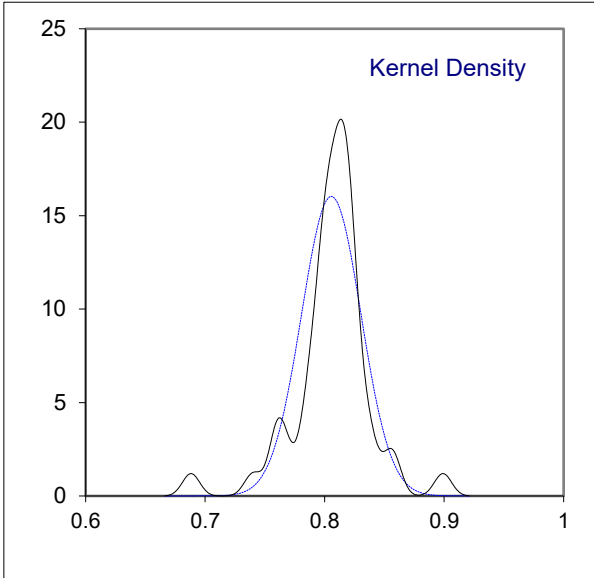
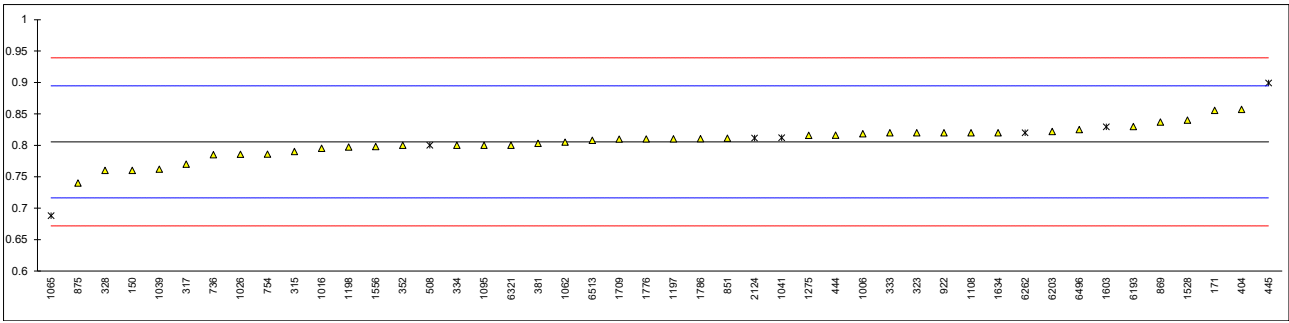
Determination of cis-2-Butene on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	7.06		-3.26	
171	D2163	7.7319		2.27	
315	D2163	7.41		-0.38	
317	D2163	7.49		0.28	
323	D2163	7.57		0.94	
328		7.36		-0.79	
333	D2163	7.38		-0.63	
334	D2163	7.4		-0.46	
352	EN27941	7.59		1.10	
381	DIN51619	7.338		-0.97	
404	EN27941	7.495		0.32	
444		7.6579		1.66	
445	D2163	7.727		2.23	
508	D2163	7.26	ex	-1.62	test result excluded, see §4.1
736	D2163	7.840		3.16	
754	D2163	7.298		-1.30	
851	D2163	7.486836	C	0.25	first reported: 7.99511
869	D2163	7.476		0.16	
875	D2163	7.33		-1.04	
922	D2163	7.57		0.94	
1006	D2163	7.2641		-1.58	
1012		----		----	
1016	ISO7941	7.413		-0.36	
1026	ISO7941	7.41847		-0.31	
1039	EN27941	7.331		-1.03	
1041	DIN51619	5.395	R(0.01)	-16.98	
1062	D2163	7.2056		-2.07	
1065	D2163	12.90547	R(0.01)	44.90	
1095	ISO7941	7.5		0.36	
1108	D2163	7.39		-0.55	
1197		7.513485		0.47	
1198		7.568181		0.92	
1257		----		----	
1275	EN27941	7.445		-0.09	
1528	EN27941	7.46		0.03	
1556	EN27941	7.566		0.90	
1603	In house	7.7053	ex	2.05	test result excluded, see §4.1
1634	ISO7941	7.44		-0.13	
1709	D2163	7.406821		-0.41	
1720		----		----	
1776	EN27941	7.55		0.77	
1786		7.50264		0.38	
2124	D2163	7.2953	ex	-1.33	test result excluded, see §4.1
6193	EN15984	7.54		0.69	
6203	EN27941	7.383		-0.60	
6262		----	W	----	test result withdrawn, reported: 6.73
6321	D2163	7.4		-0.46	
6474		----		----	
6496	EN27941	7.285	C	-1.41	first reported: 7.525
6513	EN27941	6.854	R(0.05)	-4.96	
	normality	suspect			
	n	39			
	outliers	3 (+3ex)			
	mean (n)	7.4562			
	st.dev. (n)	0.14769			
	R(calc.)	0.4135			
	st.dev.(D2163:23e1)	0.12137			
	R(D2163:23e1)	0.3398			
compare:					
	R(EN27941:93(liq))	1.0239			



Determination of 1,3-Butadiene on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	0.76		-1.02	
171	D2163	0.8556		1.12	
315	D2163	0.79		-0.35	
317	D2163	0.77		-0.80	
323	D2163	0.82		0.33	
328		0.76		-1.02	
333	D2163	0.82		0.33	
334	D2163	0.8		-0.12	
352	EN27941	0.8		-0.12	
381	DIN51619	0.803		-0.06	
404	EN27941	0.857		1.16	
444		0.8162		0.24	
445	D2163	0.899	R(0.05)	2.10	
508	D2163	0.80	ex	-0.12	test result excluded, see §4.1
736	D2163	0.785		-0.46	
754	D2163	0.786		-0.44	
851	D2163	0.811276	C	0.13	first reported: 0.801432
869	D2163	0.837		0.71	
875	D2163	0.74		-1.47	
922	D2163	0.82		0.33	
1006	D2163	0.8184		0.29	
1012		-----		-----	
1016	ISO7941	0.795		-0.24	
1026	ISO7941	0.78566		-0.44	
1039	EN27941	0.762		-0.98	
1041	DIN51619	0.812	ex	0.15	test result excluded, see §4.1
1062	D2163	0.8049		-0.01	
1065	D2163	0.688079	R(0.01)	-2.63	
1095	ISO7941	0.8		-0.12	
1108	D2163	0.82		0.33	
1197		0.810212		0.11	
1198		0.797353		-0.18	
1257		-----		-----	
1275	EN27941	0.816		0.24	
1528	EN27941	0.84		0.77	
1556	EN27941	0.798		-0.17	
1603	In house	0.8294	ex	0.54	test result excluded, see §4.1
1634	ISO7941	0.82		0.33	
1709	D2163	0.809826		0.10	
1720		-----		-----	
1776	EN27941	0.81		0.10	
1786		0.810561		0.11	
2124	D2163	0.8116	ex	0.14	test result excluded, see §4.1
6193	EN15984	0.83		0.55	
6203	EN27941	0.822		0.37	
6262	D2163	0.82	ex	0.33	test result excluded, see §4.1
6321	D2163	0.8		-0.12	
6474		-----		-----	
6496	EN27941	0.825	C	0.44	first reported: 0.810
6513	EN27941	0.808		0.06	
	normality	OK			
	n	39			
	outliers	2 (+5ex)			
	mean (n)	0.8055			
	st.dev. (n)	0.02489			
	R(calc.)	0.0697			
	st.dev.(D2163:23e1)	0.04458			
	R(D2163:23e1)	0.1248			
compare:					
	R(EN27941:93(liq))	1.0620			

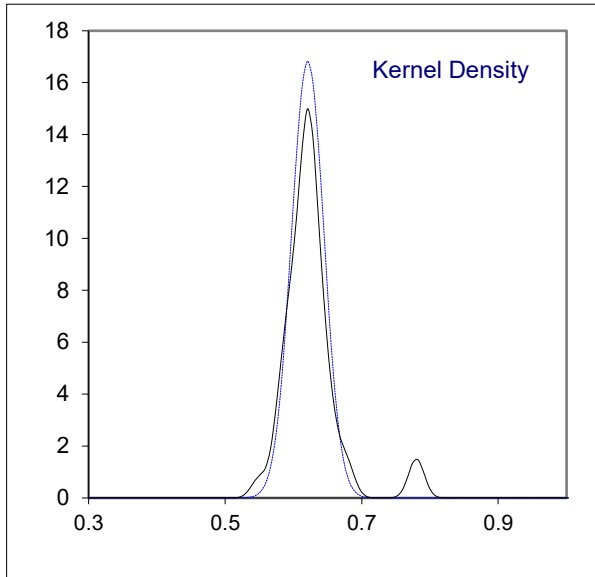
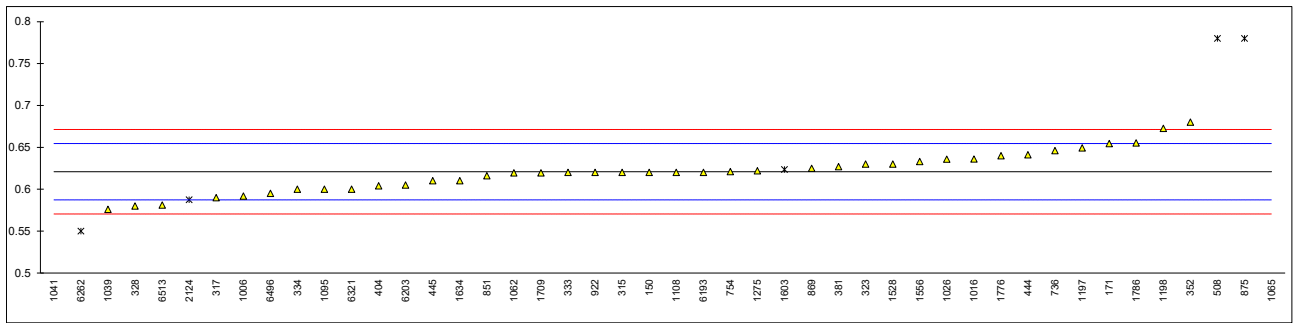


Determination of n-Pentane on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	0.02		----	
171	D2163	0.00		----	
315	D2163	<0.01		----	
317	D2163	<0.01		----	
323	D2163	< 0.01		----	
328		<0.01		----	
333	D2163	<0.01		----	
334	D2163	<0.1		----	
352		----		----	
381	DIN51619	<0,001		----	
404		----		----	
444		0.0016		----	
445	D2163	0.001		----	
508	D2163	0.00		----	
736	D2163	<0.01		----	
754	D2163	0.00		----	
851	D2163	<0.1		----	
869		----		----	
875		----		----	
922	D2163	<0.01		----	
1006	D2163	0		----	
1012		----		----	
1016	ISO7941	<0.1		----	
1026	ISO7941	0.0003		----	
1039		----		----	
1041	DIN51619	0.000		----	
1062	D2163	0		----	
1065		----		----	
1095	ISO7941	< 0.1		----	
1108	D2163	0.00		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275	EN27941	0		----	
1528	EN27941	<0.10		----	
1556		----		----	
1603	In house	< 0,01		----	
1634	ISO7941	0		----	
1709	D2163	<0.01		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124	D2163	<0.0010		----	
6193	EN15984	<0.1		----	
6203	EN27941	<0.01		----	
6262	D2163	0.00		----	
6321	D2163	<0.1		----	
6474		----		----	
6496	EN27941	<0.1		----	
6513	EN27941	0.00		----	
	n	35			
	mean (n)	<0.1			

Determination of iso-Pentane on sample #23100; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150	D2163	0.62		-0.06	
171	D2163	0.6545		2.00	
315	D2163	0.62		-0.06	
317	D2163	0.59		-1.84	
323	D2163	0.63		0.54	
328		0.58		-2.44	
333	D2163	0.62		-0.06	
334	D2163	0.6		-1.25	
352	EN27941	0.68		3.52	
381	DIN51619	0.627		0.36	
404	EN27941	0.604		-1.01	
444		0.6410		1.19	
445	D2163	0.610		-0.65	
508	D2163	0.78	R(0.01)	9.47	
736	D2163	0.646		1.49	
754	D2163	0.621		0.00	
851	D2163	0.616037	C	-0.29	first reported: 0.630634
869	D2163	0.625		0.24	
875	D2163	0.78	R(0.01)	9.47	
922	D2163	0.62		-0.06	
1006	D2163	0.5918		-1.73	
1012		-----		-----	
1016	ISO7941	0.636		0.90	
1026	ISO7941	0.63574		0.88	
1039	EN27941	0.576		-2.67	
1041	DIN51619	0.216	R(0.01)	-24.10	
1062	D2163	0.6195		-0.08	
1065	D2163	2.111932	R(0.01)	88.74	
1095	ISO7941	0.6		-1.25	
1108	D2163	0.62		-0.06	
1197		0.649265		1.69	
1198		0.672585		3.07	
1257		-----		-----	
1275	EN27941	0.622		0.06	
1528	EN27941	0.63		0.54	
1556	EN27941	0.633		0.72	
1603	In house	0.6235	ex	0.15	test result excluded, see §4.1
1634	ISO7941	0.61		-0.65	
1709	D2163	0.619511		-0.08	
1720		-----		-----	
1776	EN27941	0.64		1.14	
1786		0.655225		2.04	
2124	D2163	0.5873	ex	-2.00	test result excluded, see §4.1
6193	EN15984	0.62		-0.06	
6203	EN27941	0.605		-0.95	
6262	D2163	0.55	ex	-4.22	test result excluded, see §4.1
6321	D2163	0.6		-1.25	
6474		-----		-----	
6496	EN27941	0.595	C	-1.54	first reported: 0.620
6513	EN27941	0.581		-2.38	
	normality	OK			
	n	39			
	outliers	4 (+3ex)			
	mean (n)	0.6209			
	st.dev. (n)	0.02371			
	R(calc.)	0.0664			
	st.dev.(D2163:23e1)	0.01680			
	R(D2163:23e1)	0.0470			
compare:					
	R(EN27941:93(liq))	0.7962			



Determination of Molar Mass on sample #23100; results in g/mol

lab	method	value	mark	z(targ)	remarks
150		----		----	
171	D2598	57.5487	E	----	calculation difference, iis calculated: 57.4234
315	ISO8973	57.44		----	
317	INH-001	57.42		----	
323		----		----	
328		----		----	
333		----		----	
334		----		----	
352		----		----	
381	ISO8973	57.4389		----	
404	ISO8973	57.4257		----	
444		----		----	
445	D2163	57.401	C	----	first reported: 57.402
508	D2598	57.65	E	----	calculation difference, iis calculated: 57.56
736	ISO8973	57.44	C	----	first reported: 57.45
754	D2421	57.433		----	
851	D2598	57.41	C	----	first reported: 57.42
869	D2598	57.42		----	
875	D2421	57.44	E	----	calculation difference, iis calculated: 57.51
922		----		----	
1006		----		----	
1012		----		----	
1016	EN27941	57.4437		----	
1026		----		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108	ISO8973	57.43		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275	EN589	57.428		----	
1528	D2421	57.43		----	
1556	ISO8973	57.43		----	
1603		----		----	
1634		----		----	
1709		----		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124	GPA2145	58.09	E	----	calculation difference, iis calculated: 57.24
6193		----		----	
6203	ISO8973	57.449		----	
6262	D2163	57.384	E	----	calculation difference, iis calculated: 53.608
6321		----		----	
6474		----		----	
6496	ISO8973	57.435	C	----	first reported: 57.326
6513	ISO8973	57.42		----	

Remark:

Calculations by iis are based on relative molecular masses as given in table A.1 of ISO8973:97/IP432:00

NB. Effect of different factors of ISO8973:97/IP432:00 and ASTM D2421:21e1 on the calculation is very small.

Determination of Relative Density at 60/60 °F on sample #23100; unitless results

lab	method	value	mark	z(targ)	remarks
150		----		----	
171	D2598	0.57321		----	
315	D2598	0.568		----	lab did not include 1,3-Butadiene in calculation
317	D2598	0.572		----	
323	D2598	0.573		----	
328		----		----	
333		----		----	
334		----		----	
352	ISO8973	0.5728		----	
381	ISO8973	0.5726		----	
404	ISO8973	0.5728		----	
444		----		----	
445	IP432	0.5731	C	----	first reported: 0.5732
508	D2598	0.574	E	----	calculation difference, iis calculated: 0.5729
736	ISO8973	0.5729	C	----	first reported: 0.5728
754	D2598	0.5724		----	
851	D2598	0.5726	C	----	first reported: 0.5728
869	D2598	0.5727		----	
875	ISO8973	0.5728		----	
922	D2598	0.5728		----	
1006	D2598	0.5725		----	
1012		----		----	
1016	ISO8973	0.5729		----	
1026	ISO8973	572.6	E	----	calculation difference, iis calculated: 0.5725
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108		----		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275		----		----	
1528	ISO8973	0.5730		----	
1556	ISO8973	0.5728		----	
1603		----		----	
1634	ISO8973	0.5728		----	
1709	D2598	0.5726		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124	GPA2145	0.430	E	----	calculation difference, iis calculated 0.5724
6193		----		----	
6203	ISO8973	0.5726		----	
6262	D2598	0.5719	E	----	calculation difference, iis calculated: 0.5683
6321		----		----	
6474		----		----	
6496	ISO8973	0.572	C	----	first reported: 0.5730
6513		----		----	

Remark:

Calculations by iis are based on relative densities at 60 °F (15.6 °C) as given in table 1 of ASTM D2598:21

N.B. ASTM D2598:21 does not mention a relative density factor at 60 °F (15.6 °C) for 1,3-Butadiene. For this component the value of 0.6272 is taken from ASTM D2163:23

N.B. Effect of different factors from ASTM D2598:21 and ISO8973:97/IP432:00 on the calculation is very small

Determination of Abs. Vapor Pressure at 100 °F on sample #23100; results in psi

lab	method	value	mark	z(targ)	remarks
150	D2598	56	E	----	calculation difference, iis calculated: 72
171	D2598	70.54935		----	
315	ISO8973	71.4		----	
317	ISO8973	71.5		----	
323		----		----	
328		----		----	
333		----		----	
334		----		----	
352		----		----	
381		----		----	
404		----		----	
444		----		----	
445		----		----	
508	D2598	55	E	----	calculation difference, iis calculated: 70
736	ISO8973	71.1	C	----	first reported: 71.2
754	ISO8973	71.5369		----	
851	D2598	70.8	C	----	first reported: 70.7
869	D2598	70.7		----	
875		----		----	
922	D2598	70.87		----	
1006	D2598	70.9		----	
1012		----		----	
1016	EN589 Annex C	71.296		----	
1026	ISO8973	71.485		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108	ISO8973	71.4		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275		----		----	
1528		----		----	
1556		----		----	
1603		----		----	
1634		----		----	
1709		----		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124		----		----	
6193		----		----	
6203	ISO8973	71.36		----	
6262	D2598	71.846	E	----	calculation difference, iis calculated 73.08
6321		----		----	
6474		----		----	
6496		----		----	
6513		----		----	

Remarks:

Calculations by iis are based on Vapor Pressure factors at 100 °F (37.8 °C) as given in table A.1 of ISO8973:97/IP432:00 or on Vapor Pressure factors at 100 °F (37.8 °C) as given in table 1 of ASTM D2598:21.

For calculation of Vapor Pressure according to D2598, the factor for 1,3-Butadiene is taken from the GPSA data book (ed. 13) in psig (59.46 psia = 45 psig). The conversion from psia to psig was done as follows: $59.46 \text{ psia} - (101.325 \text{ kPa} * 0.145038) = 44.76 = 45 \text{ psig}$

Determination of Rel. Vapor Pressure at 100 °F on sample #23100; results in psi

lab	method	value	mark	z(targ)	remarks
150		----		----	
171	D2598	55.849		----	
315	ISO8973	56.7		----	
317	ISO8973	56.7		----	
323	D2598	56.1		----	
328		----		----	
333		----		----	
334		----		----	
352		----		----	
381		----		----	
404		----		----	
444		----		----	
445	IP432	56.6		----	
508		----		----	
736	ISO8973	56.4		----	
754	ISO8973	56.8410		----	
851	D2598	56.1	C	----	first reported: 56.0
869	D2598	56.0		----	
875		----		----	
922	D2598	56.17		----	
1006	D2598	56.2		----	
1012		----		----	
1016	EN589 Annexe C	56.60		----	
1026	ISO8973	56.789		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108	ISO8973	56.7		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275		----		----	
1528		----		----	
1556		----		----	
1603		----		----	
1634		----		----	
1709	D2598	56		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124		----		----	
6193		----		----	
6203	ISO8973	56.71		----	
6262	D2598	57.172	E	----	calculation difference, iis calculated: 58.381
6321		----		----	
6474		----		----	
6496		----		----	
6513		----		----	

Remarks:

Calculations by iis are based on Vapor Pressure factors at 100 °F (37.8 °C) as given in table A.1 of ISO8973:97/IP432:00 or on Vapor Pressure factors at 100 °F (37.8 °C) as given in table 1 of ASTM D2598:21.
 For calculation of Vapor Pressure according to D2598, the factor for 1,3-Butadiene is taken from the GPSA data book (ed. 13) in psig (59.46 psia = 45 psig). The conversion from psia to psig was done as follows: $59.46 \text{ psia} - (101.325 \text{ kPa} \cdot 0.145038) = 44.76 = 45 \text{ psig}$.

Determination of Abs. Vapor Pressure at 40 °C on sample #23100; results in kPa

lab	method	value	mark	z(targ)	remarks
150		----		----	
171		----		----	
315	ISO8973	518		----	
317	ISO8973	519		----	
323		----		----	
328	ISO8973	518		----	
333		----		----	
334		----		----	
352	ISO8973	516		----	
381	ISO8973	519		----	
404		----		----	
444		----		----	
445		----		----	
508		----		----	
736	ISO8973	517	C	----	first reported: 517.2
754	ISO8973	519.715		----	
851		----		----	
869		----		----	
875	EN589	520	E	----	calculation difference, iis calculated: 511
922		----		----	
1006		----		----	
1012		----		----	
1016		----		----	
1026	ISO8973	519.378		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095	ISO8973	520		----	
1108	ISO8973	519		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275	EN589	518.9		----	
1528	ISO8973	518		----	
1556	ISO8973	518.172		----	
1603		----		----	
1634	ISO8973	518.3		----	
1709		----		----	
1720		----		----	
1776	ISO8973	517.8		----	
1786		----		----	
2124		----		----	
6193	ISO8973	518		----	
6203	ISO8973	518.3		----	
6262	ISO8973	524.02	E	----	calculation difference, iis calculated: 502
6321		----		----	
6474		----		----	
6496	ISO8973	519.688	C	----	first reported: 511.953
6513	ISO8973	522.77		----	

Remark:

Calculations by iis are based on the Vapor Pressure factors at 40 °C as given in table A.1 of ISO8973:97/IP432:00

Determination of Rel. Vapor Pressure at 40 °C on sample #23100; results in kPa

lab	method	value	mark	z(targ)	remarks
150		----		----	
171		----		----	
315	ISO8973	417		----	
317	ISO8973	418		----	
323	ISO8973	417		----	
328	ISO8973	417		----	
333		----		----	
334		----		----	
352	ISO8973	415		----	
381	ISO8973	417		----	
404	ISO8973	417		----	
444		----		----	
445	IP432	416.69		----	
508		----		----	
736	ISO8973	416	C	----	first reported: 416.1
754	ISO8973	418.390		----	
851		----		----	
869		----		----	
875	EN589	418	E	----	calculation difference, iis calculated: 410
922		----		----	
1006		----		----	
1012		----		----	
1016		----		----	
1026	ISO8973	418.058		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095	ISO8973	419		----	
1108	ISO8973	418		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275		----		----	
1528	ISO8973	417		----	
1556	ISO8973	416.847		----	
1603		----		----	
1634	ISO8973	417		----	
1709		----		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124		----		----	
6193		----		----	
6203	ISO8973	417.0		----	
6262		----		----	
6321		----		----	
6474		----		----	
6496	ISO8973	418	C	----	first reported: 411
6513	ISO8973	421.45		----	

Remark:

Calculations by iis are based on the Vapor Pressure factors at 40 °C as given in table A.1 of ISO8973:97/IP432:00

Determination of Motor Octane Number, MON on sample #23100;

lab	method	value	mark	z(targ)	remarks
150		----		----	
171	D2598	87.798	E	----	calculation difference, iis calculated: 94.109
315		----		----	
317	EN589	91.6		----	lab did not include 1,3-Butadiene in calculation
323		----		----	
328	EN589	92.3		----	
333		----		----	
334		----		----	
352		----		----	
381	EN589	92.3		----	
404	EN589	92.2		----	
444		----		----	
445		----		----	
508	D2598	87.2	E	----	calculation difference, iis calculated: 94.2
736	D2598	85.4	C,E	----	first reported: 85.47, calc. difference, iis calculated: 94.189
754	EN589	92.439		----	
851	D2598	94.6	C	----	first reported: 94.5
869	D2598	94.6		----	
875	EN589	92.4		----	
922		----		----	
1006	D2598	92.3		----	iso-Butene, trans-2-Butene and 1,3-Butadiene not in calculation
1012		----		----	
1016		----		----	
1026	EN589	91.655105544		----	lab did not include 1,3-Butadiene in calculation
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108	EN589	92.23		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275	EN589	92.2		----	
1528	EN589	92.3		----	
1556		----		----	
1603		----		----	
1634		----		----	
1709		----		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124		----		----	
6193		----		----	
6203	EN589	92.3		----	
6262	D2598	82.25	E	----	calculation difference, iis calculated: 95.03
6321		----		----	
6474		----		----	
6496	EN589	92.3		----	
6513	EN589	95.67	E	----	calculation difference, iis calculated: 92.33

Remarks:

EN589 calculations by iis are based on MON factors given in table B.1 of EN589:18+A1:22. This method does not mention a MON factor for 1,3-Butadiene. For this component an estimated value of 70 is used in the calculations in analogy of the MON factors of the other components.

D2598 calculations by iis are based on MON factors given in table 1 of ASTM D2598:21. This method does not mention MON factors for iso-Butene, trans-2-Butene or 1,3-Butadiene. For iso-Butene and trans-2-Butene the value of 83.5 of cis-2-Butene is used in analogy of EN589 and for 1,3-Butadiene an estimated value of 70 is used in the calculations in analogy of the MON factors of the other components.

Determination of Ideal Gross Heating Value at 14.696 psia/60 °F on sample #23100; results in kJ/mol

lab	method	value	mark	z(targ)	remarks
150		----		----	
171		----		----	
315		----		----	
317		----		----	
323		----		----	
328		----		----	
333		----		----	
334		----		----	
352	D3588	2828.084		----	
381	D3588	2805		----	lab did not include 1,3-Butadiene in calculation
404		----		----	
444		----		----	
445		----		----	
508		----		----	
736		----		----	
754	D3588	2825.2		----	
851		----		----	
869		----		----	
875		----		----	
922		----		----	
1006		----		----	
1012		----		----	
1016		----		----	
1026		----		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108	D3588	2824.78		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275		----		----	
1528		----		----	
1556		----		----	
1603		----		----	
1634	D3588	2826.62		----	
1709		----		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124		----		----	
6193		----		----	
6203		----		----	
6262	D3588	2812.28	E	----	calculation difference, iis calculated: 2640.30
6321		----		----	
6474		----		----	
6496		----		----	
6513		----		----	

Remarks:

Calculated by iis based on the Ideal Gross Heating Value at 14.696 psia/60 °F factors given in table 1 of ASTM D3588:98R17e01. Unfortunately, this method does not mention an Ideal Gross Heating Value factor for 1,3-Butadiene. For the calculation, iis has used the factor 2542.03 from table 3 of ISO6976:16.

Determination of Ideal Net Heating Value at 14.696 psia/60 °F on sample #23100; results in kJ/mol

lab	method	value	mark	z(targ)	remarks
150		----		----	
171		----		----	
315		----		----	
317		----		----	
323		----		----	
328		----		----	
333		----		----	
334		----		----	
352	D3588	2616.317		----	
381	D3588	2595		----	lab did not include 1,3-Butadiene in calculation
404		----		----	
444		----		----	
445		----		----	
508		----		----	
736		----		----	
754	D3588	2613.8		----	
851		----		----	
869		----		----	
875		----		----	
922		----		----	
1006		----		----	
1012		----		----	
1016		----		----	
1026		----		----	
1039		----		----	
1041		----		----	
1062		----		----	
1065		----		----	
1095		----		----	
1108	D3588	2613.42		----	
1197		----		----	
1198		----		----	
1257		----		----	
1275		----		----	
1528	SR66	2604.05	E	----	calculation difference, iis calculated: 2613.57
1556		----		----	
1603		----		----	
1634	D3588	2614.90		----	
1709		----		----	
1720		----		----	
1776		----		----	
1786		----		----	
2124		----		----	
6193		----		----	
6203		----		----	
6262	D3588	2600.54	E	----	calculation difference: iis calculated: 2440.80
6321		----		----	
6474		----		----	
6496	In house	2611.53	C	----	first reported: 215.45
6513		----		----	

Remarks:

Calculated by iis based on the Ideal Net Heating Value at 14.696 psia/60 °F factors given in table 1 of ASTM D3588:98R17e01. Unfortunately, this method does not mention an Ideal Net Heating Value factor for 1,3-Butadiene. For the calculation, iis has used the factor 2408.8 from table 3 of ISO6976:16.

APPENDIX 2

Number of participants per country

1 lab in AUSTRALIA
3 labs in BELGIUM
1 lab in CHINA, People's Republic
1 lab in CROATIA
1 lab in DENMARK
3 labs in FRANCE
2 labs in GERMANY
1 lab in GREECE
1 lab in HONG KONG
1 lab in ISRAEL
1 lab in KAZAKHSTAN
3 labs in MALAYSIA
5 labs in NETHERLANDS
1 lab in NIGERIA
1 lab in PAKISTAN
1 lab in PANAMA
3 labs in PORTUGAL
4 labs in ROMANIA
2 labs in RUSSIAN FEDERATION
1 lab in SAUDI ARABIA
1 lab in SERBIA
1 lab in SUDAN
2 labs in SWEDEN
2 labs in TAIWAN
1 lab in UNITED ARAB EMIRATES
4 labs in UNITED KINGDOM
2 labs in UNITED STATES OF AMERICA

APPENDIX 3

Abbreviations

C	= final test result after checking of first reported suspect test result
D(0.01)	= outlier in Dixon's outlier test
D(0.05)	= straggler in Dixon's outlier test
G(0.01)	= outlier in Grubbs' outlier test
G(0.05)	= straggler in Grubbs' outlier test
DG(0.01)	= outlier in Double Grubbs' outlier test
DG(0.05)	= straggler in Double Grubbs' outlier test
R(0.01)	= outlier in Rosner's outlier test
R(0.05)	= straggler in Rosner's outlier test
E	= calculation difference between reported test result and result calculated by iis
W	= test result withdrawn on request of participant
ex	= test result excluded from statistical evaluation
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
fr.	= first reported
f+?	= possibly a false positive test result?
f-?	= possibly a false negative test result?
SDS	= Safety Data Sheet

Literature

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