Institute for
Interlaboratory Studies

Results of Proficiency Test Liquefied Propane and Sulfur (total) in LPG October 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 Propane every year. From 2017 onwards a proficiency scheme for the analysis of Total Sulfur in LPG is also organized every year. During the annual proficiency testing program of 2023, it was decided to continue the round robin for both the analysis of Liquefied Propane and the analysis of Total Sulfur in LPG.

Because iis has limited gas-handling facilities in place to prepare gas samples, a co-operation with EffecTech (Uttoxeter, United Kingdom) was set up for the Liquefied Propane PT (iis23S04P) and a co-operation with Nippon Gases (Belgium) was set up for the Total Sulfur in LPG PT (iis23S04S). Both EffecTech and Nippon Gases are fully equipped and have experience in the preparation of gas mixtures.

In the interlaboratory studies for Liquefied Propane 66 laboratories in 31 countries and for Total Sulfur in LPG 40 laboratories in 25 countries registered for participation, see appendix 2 for the number of participants per country. In this report the results of the Liquefied Propane and Total Sulfur in LPG proficiency tests 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). In this proficiency test the participants received, depending on the registration, one or two different samples of Liquefied Propane, see table below.

Sample ID	PT ID	Quantity	Purpose
#23200	iis23S04P	1 L cylinder	Composition and Physical properties
#23201	iis23S04S	5 L cylinder	Total Sulfur

Table 1: Gas samples used in PTs Liquefied Propane and Sulfur (total) in LPG

To optimize the costs for the participating laboratories it was decided to prepare one Liquified Propane Gas mixture per PT. For the Liquefied Propane PT, the mixture was divided over a batch of 70 cost-effective one-liter cylinders with dip tube device. For the Total Sulfur PT, the mixture was divided over a batch of 42 cost-effective five-liter cylinders with dip tube device. Each of the cylinders was uniquely numbered. The limited cylinder size is chosen to optimize transport and handling costs.
Sample analyzes for fit-for-use and homogeneity testing were subcontracted to a laboratory that has performed the tests in accordance with for ISO/IEC17043 relevant requirements of ISO/IEC17025.
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).
Nippon Gases is accredited in conformance with ISO 9001:2015.

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

For the PT on Liquefied Propane a batch of 70 uniquely coded one-liter cylinders with an artificial Liquefied Propane mixture was prepared and tested for homogeneity by EffecTech (Uttoxeter, United Kingdom) in conformance with ISO guide 35 and ISO/IEC17025 (job 23/0902). Each cylinder (with dip tube device) was filled with approximately 200 grams of Liquefied Propane mixture and labelled #23200. 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 calculated 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.

	r (observed) in %mol/mol	0.3 x R (D2163:23) in %mol/mol
Ethane	0.0047	0.0741
Propane	0.0149	1.2439
Propene	0.0018	0.0761
iso-Butane	0.0067	0.0747

	r (observed) in %mol/mol	0.3 x R (D2163:23) in %mol/mol
n-Butane	0.0050	0.0562
1-Butene	0.0009	0.0199
iso-Butene	0.0009	0.0195
n-Pentane	0.0027	0.0240

Table 2: homogeneity test results of subsamples #23200

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.

For the PT on Total Sulfur in LPG a batch of 42 uniquely coded five-liter cylinders (with dip tube device) was prepared and tested for homogeneity by Nippon Gases (Belgium) (order/ref. nr. 453,750,001). Each cylinder was filled with approximately 1500 grams of LPG, spiked with Dimethyl Sulfide (DMS) and labelled #23201.

The repeatability of the determination of Total Sulfur was calculated and compared with 0.3 times the reproducibility of the reference test method in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Total Sulfur in mg/kg
r (observed)	3.2
reference test method	ASTM D6667:21 LP gases
0.3 x R (reference test method)	11.1

Table 3: evaluation of the repeatability of subsamples #23201

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

Depending on the registration of the participant the appropriate set of PT samples was sent on September 27, 2023. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

EffecTech (Uttoxeter, United Kingdom) and Nippon Gases (Belgium) declare 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 on sample #23200: Ethane, Propane, Propene, iso-Butane, n-Butane, 1-Butene, iso-Butene, n-Pentane, iso-Pentane, Molar Mass, Relative Density at 60/60 °F, Absolute and Relative Vapor Pressure at 100 °F, Absolute and Relative Vapor Pressure at 40 °C, Motor Octane Number (MON), Ideal Gross Heating Value and Ideal Net Heating Value at 14.696 psia and 60 °F.

On sample #23201 it was requested to determine Total Sulfur.

It was explicitly requested to treat the samples as if they were routine samples 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:

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

The $z_{(target)}$ 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. For the Liquefied Propane PT (iis23S04P) eight participants reported test results after the final reporting date and nine other participants did not report any test results. Not all participants were able to report all tests requested. In total 57 participants reported 463 numerical test results for the composition. Observed were 26 outlying test results, which is 5.6%.
For the Total Sulfur in LPG PT (iis23S04S) six participants reported test results after the final reporting date and eleven other participants did not report any test results. In total 29 participants reported 28 numerical test results. Observed were 2 outlying test results, which is 7.1%. 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 SAMPLE AND PER TEST

In this section the reported test results are discussed per sample and per test. 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.

In the iis PT reports ASTM test methods are referred to with a number (e.g. D2163) and an added designation for the year that the test method was adopted or revised (e.g. D2163:23e1).

Method ASTM D2163:23e1 is used to evaluate the performance of the test results for the composition of Liquefied Propane. 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 components 1-Butene and iso-Butene. Therefore, it is decided to use the mentioned reproducibility of n-Butane to calculate the reproducibilities of these two components.

Two 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 interdependent, it was decided to exclude the remaining test results from these participants from the statistical evaluations.

sample #23200

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.

Ethane: The group of participants met the target requirements. Five 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 EN27941:93(liq).

Propane: The group of participants met the target requirements. Three 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 EN27941:93(liq).

Propene: The group of participants met the target requirements. 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 requirements of ASTM D2163:23e1 and EN27941:93(liq).

iso-Butane: The group of participants may have had difficulty to meet the target requirements depending on 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 requirements of ASTM D2163:23e1 but is in agreement with EN27941:93(liq).

n-Butane: The group of participants may have had difficulty to meet the target requirements depending on 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 requirements of ASTM D2163:23e1 but is in agreement with EN27941:93(liq).

1-Butene: The group of participants met the target requirements. Two 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 EN27941:93(liq).

iso-Butene: The group of participants met the target requirements. Three statistical outliers were observed and two 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 EN27941:93(liq).

n-Pentane: The group of participants may have had difficulty to meet the target requirements depending on 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 requirements of ASTM D2163:23e1 but is in agreement with EN27941:93(liq).

iso-Pentane: Most of the laboratories agreed that the amount of iso-Pentane was below 0.01%mol/mol, therefore no z-scores are calculated.

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 Propane 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-nine participants reported a test result. For three test results iis calculated a different Molar Mass.

Relative Density at 60/60 °F: For the calculation of this parameter thirty-eight participants reported a test result. For one test result 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 twenty-five participants reported a test result. For one test result iis calculated a different absolute Vapor Pressure at 100 °F.

Rel. Vapor Pres. at 100 °F: For the calculation of this parameter twenty-nine 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-six participants reported a test result. No differences to iis calculations were found.

Rel. Vapor Pres. at 40 °C: For the calculation of this parameter twenty-six 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.
Method ASTM D2598:21 does not mention a MON factor for iso-Butene. Therefore, iis has used the factor 83.5 for iso-Butene which is the factor value of cis-2-Butene in ASTM D2598:21.
For the calculation of this parameter twenty-six participants reported a test result. For three test results iis calculated a different MON.

Ideal Gross Heating Value at 14.696 psia / 60 °F: For the calculation of this parameter twelve participants reported a test result. For three test results iis calculated a different Ideal Gross Heating Value at 14.696 psia / 60 °F.

Ideal Net Heating Value at 14.696 psia / 60 °F: For the calculation of this parameter eleven participants reported a test result. For two test results iis calculated a different Ideal Net Heating Value at 14.696 psia / 60 °F.

sample #23201

Total Sulfur: The group of participants met the target requirements. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of ASTM D6667:21 LP Gas.

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)
Ethane	%mol/mol	47	0.601	0.096	0.231
Propane	%mol/mol	51	92.560	0.895	4.144
Propene	%mol/mol	47	0.816	0.083	0.249
iso-Butane	%mol/mol	51	2.855	0.306	0.251
n-Butane	%mol/mol	51	2.054	0.278	0.190
1-Butene	%mol/mol	50	0.202	0.040	0.067
iso-Butene	%mol/mol	50	0.191	0.036	0.065
n-Pentane	%mol/mol	49	0.721	0.141	0.082
iso-Pentane	%mol/mol	37	<0.01	n.e.	n.e.

Table 4: reproducibilities of the composition of sample #23200

Component	unit	n	average	2.8 * sd	R(lit)
Total Sulfur	mg/kg	26	52.8	30.9	37.3

Table 5: reproducibility of Sulfur on sample #23201

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 OCTOBER 2023 WITH PREVIOUS PTS

	October 2023	October 2022	October 2021	October 2020	October 2019
Number of reporting laboratories	57	49	50	43	46
Number of numerical test results	463	599	617	550	574
Number of statistical outliers	26	41	45	35	48
Percentage of statistical outliers	5.6%	6.8%	7.3%	6.4%	8.4%

Table 6: comparison with previous proficiency tests for Liquefied Propane only

	October 2023	October 2022	October 2021	October 2020	October 2019
Number of reporting laboratories	29	30	32	28	13
Number of numerical test results	28	30	32	28	13
Number of statistical outliers	2	0	2	4	0
Percentage of statistical outliers	7.1%	0%	6.3%	14.3%	0%

Table 7: comparison with previous proficiency tests for Sulfur in LPG only

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	October 2023	October 2022	October 2021	October 2020	October 2019
Ethane	++	+	+/-	+	+
Propane	++	++	++	++	++
Propene	++	++	++	++	++
iso-Butane	-	-	-	-	+
n-Butane	-	-	-	-	+/-
1-Butene	+	+	+	--	++
iso-Butene	+	+/-	+	-	+
n-Pentane	-	--	--	(--)	+/-

Table 8: comparison of determinations on Liquefied Propane to the reference test methods

For results between brackets no z-scores are calculated.

Component	October 2023	October 2022	October 2021	October 2020	October 2019
Total Sulfur	+	+	-	-	+

Table 9: comparison of determination on Sulfur in LPG to the reference test method

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 EffecTech (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.

Parameter	EffecTech in %mol/mol	Average PT in %mol/mol	Difference in %mol/mol	z-score
Ethane	0.666	0.601	0.065	0.78
Propane	92.639	92.560	0.078	0.05
Propene	0.838	0.816	0.022	0.24
iso-Butane	2.796	2.855	-0.059	-0.66
n-Butane	1.987	2.054	-0.067	-0.98
1-Butene	0.199	0.202	-0.003	-0.14
iso-Butene	0.189	0.191	-0.002	-0.09
n-Pentane	0.687	0.721	-0.034	-1.18

Table 10: comparison of consensus values to the values determined by EffecTech

The consensus values as determined in this PT are compared with the average values from the homogeneity testing by Nippon Gases (Belgium) in the following table.

Parameter	Nippon Gases in mg/kg	Average PT in mg/kg	Difference in mg/kg	z-score
Sulfur	52.267	52.782	0.515	-0.04

Table 11: comparison of consensus value to the value determined by Nippon Gases

From this comparison it is clear that the consensus values as determined in this PT are in line with the values as determined during the preparation of the gas cylinders.

APPENDIX 1

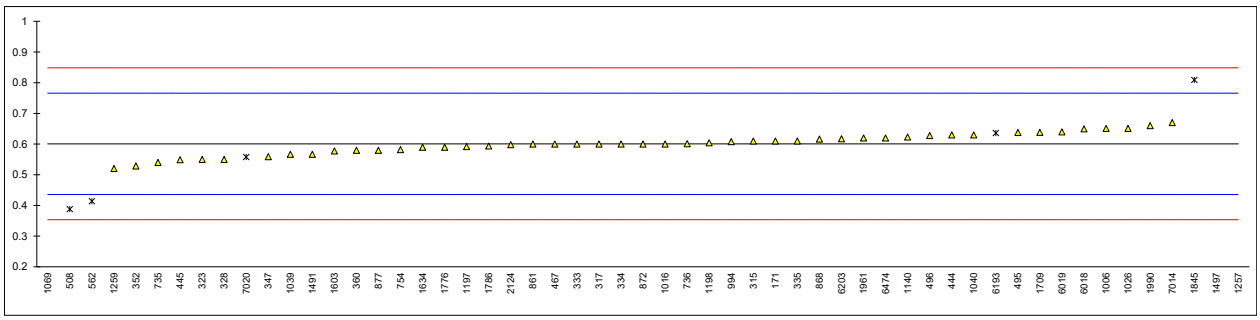
Total of reported composition test results (normalized); results in %mol/mol

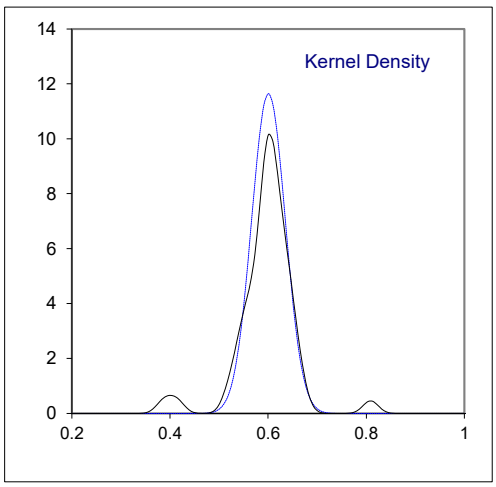
lab	method	iis calculated	remarks
150		-----	
171	D2163	99.97	
315	D2163	100.00	
317	D2163	100.00	
323	D2163	100.00	
328	D2163	100.00	
333	D2163	100.00	
334	D2163	100.00	
335	D2163	100.00	
347	D2163	100.00	
352	EN27941	100.04	
360	EN27941	100.00	
444	IP405	99.99	
445	D2163	100.00	
467	D2163	100.03	
495	D2163	100.00	
496	D2163	100.00	
508	D2163	100.00	
562	D2163	100.00	
735	D2163	100.01	
736	D2163	100.00	
754	D2163	100.00	
861	D2163	100.01	
868	D2163	100.00	
872	D2163	100.00	
877	D2163	100.00	
970		-----	
994	D2163	100.00	
1006	D2163	100.00	
1011		-----	
1012		-----	
1016	ISO7941	100.10	
1026	ISO7941	100.00	
1039	D2163	100.00	
1040	D2163	100.01	
1069	D2163Mod.	**99.38**	not 100% and excluded from evaluations
1140	D2163	100.00	
1191		-----	
1197	D2163	100.00	
1198	D2163	100.00	
1257	D2163	100.00	
1259	EN27941	100.00	
1491	ISO7941	100.00	
1497	D2163	100.00	
1603	In house	100.00	
1634	ISO7941	100.01	
1709	D2163	100.00	
1776	EN27941	100.02	
1786	D2163	100.00	
1845	D2163	100.00	
1961	EN27941	99.95	
1990	IP473	100.01	
2124	D2163	**98.78**	did not report Propene, 1-Butene and iso-Butene
6016		-----	
6018	ISO7941	100.00	
6019	ISO7941	100.00	
6193	EN15984	**99.35**	not 100% and excluded from evaluations
6203	EN27941	100.00	
6262		-----	
6364		-----	
6411		-----	
6433		-----	
6448		-----	
6474	D2163	100.00	
7014	D2163	100.00	
7020		**97.23**	not 100% and excluded from evaluations

Determination of Ethane on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.61		0.11	
315	D2163	0.61		0.11	
317	D2163	0.60		-0.01	
323	D2163	0.55		-0.62	
328	D2163	0.55		-0.62	
333	D2163	0.6		-0.01	
334	D2163	0.6		-0.01	
335	D2163	0.61		0.11	
347	D2163	0.559		-0.51	
352	EN27941	0.5285		-0.88	
360	EN27941	0.58		-0.25	
444	IP405	0.63		0.35	
445	D2163	0.549		-0.63	
467	D2163	0.60		-0.01	
495	D2163	0.638		0.45	
496	D2163	0.628		0.33	
508	D2163	0.388	R(0.01)	-2.58	
562	D2163	0.4138	R(0.01)	-2.26	
735	D2163	0.54		-0.74	
736	D2163	0.601		0.00	
754	D2163	0.582		-0.23	
861	D2163	0.60		-0.01	
868	D2163	0.616		0.18	
872	D2163	0.60		-0.01	
877	D2163	0.58		-0.25	
970		-----		-----	
994	D2163	0.6076		0.08	
1006	D2163	0.651		0.61	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	0.6		-0.01	
1026	ISO7941	0.6514		0.61	
1039	D2163	0.567		-0.41	
1040	D2163	0.63		0.35	
1069	D2163Mod.	0.0006	ex,C	-7.27	test result excluded, see §4.1 / first reported 0
1140	D2163	0.623		0.27	
1191		-----		-----	
1197	D2163	0.591911		-0.11	
1198	D2163	0.604301		0.04	
1257	D2163	2.2643	R(0.01)	20.14	
1259	EN27941	0.52		-0.98	
1491	ISO7941	0.567		-0.41	
1497	D2163	2.25260	C,R(0.01)	20.00	first reported 1.97911
1603	In house	0.5777		-0.28	
1634	ISO7941	0.59		-0.13	
1709	D2163	0.638466		0.46	
1776	EN27941	0.59		-0.13	
1786	D2163	0.593674		-0.09	
1845	D2163	0.809	R(0.01)	2.52	
1961	EN27941	0.62		0.23	
1990	IP473	0.66		0.72	
2124	D2163	0.5979		-0.04	
6016		-----		-----	
6018	ISO7941	0.6495		0.59	
6019	ISO7941	0.6399	C	0.47	first reported 0.52429
6193	EN15984	0.636	ex	0.43	test result excluded, see §4.1
6203	EN27941	0.617		0.20	
6262		-----	W	-----	test result withdrawn, reported 0.35
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	0.62		0.23	
7014	D2163	0.670		0.84	
7020		0.558	ex	-0.52	test result excluded, see §4.1

normality	OK	
n	47	
outliers	5 +3ex	
mean (n)	0.6008	
st.dev. (n)	0.03427	
R(calc.)	0.0959	
st.dev.(D2163:23e1)	0.08258	
R(D2163:23e1)	0.2312	compare: R(EN27941:93(liq)) = 0.2991


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1069 508 562 1259 352 735 445 323 328 7020 347 1039 1491 1603 360 877 754 1634 1776 1197 1786 2124 861 467 333 317 334 872 1016 736 1198 994 315 171 335 868 6203 1961 6474 1140 496 444 1040 6193 495 1709 6019 6018 1006 1026 1990 7014 1845 1497 1257

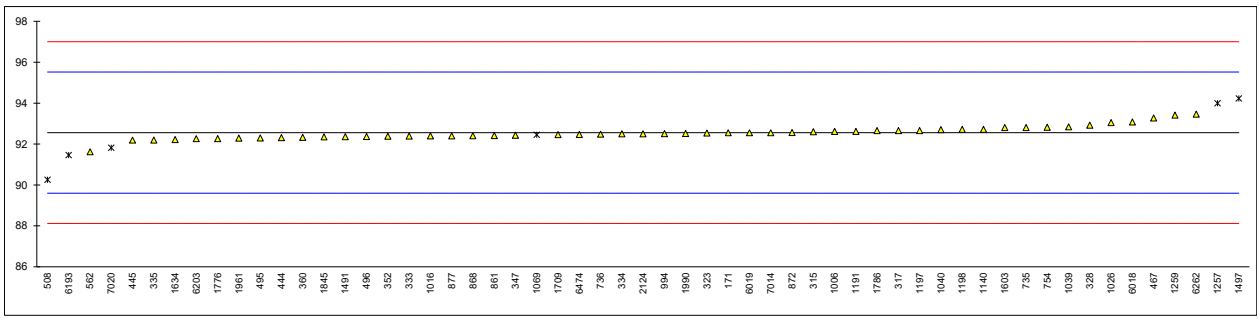

Kernel Density
14
12
10
8
6
4
2
0
0.2
0.4
0.6
0.8
1

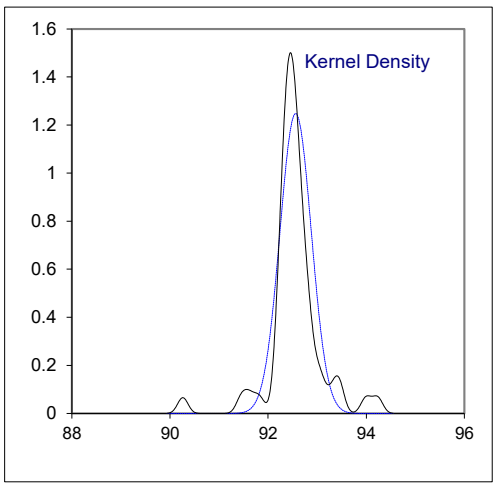
Determination of Propane on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	92.55		-0.01	
315	D2163	92.60		0.03	
317	D2163	92.66		0.07	
323	D2163	92.54		-0.01	
328	D2163	92.93		0.25	
333	D2163	92.39		-0.12	
334	D2163	92.5		-0.04	
335	D2163	92.2		-0.24	
347	D2163	92.431		-0.09	
352	EN27941	92.3823		-0.12	
360	EN27941	92.33	C	-0.16	first reported 92.18
444	IP405	92.31		-0.17	
445	D2163	92.196		-0.25	
467	D2163	93.28		0.49	
495	D2163	92.302		-0.17	
496	D2163	92.366		-0.13	
508	D2163	90.258	R(0.01)	-1.56	
562	D2163	91.6204		-0.64	
735	D2163	92.81		0.17	
736	D2163	92.479		-0.05	
754	D2163	92.823		0.18	
861	D2163	92.42		-0.09	
868	D2163	92.408		-0.10	
872	D2163	92.57		0.01	
877	D2163	92.40		-0.11	
970		-----		-----	
994	D2163	92.5077		-0.04	
1006	D2163	92.6142		0.04	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	92.4	C	-0.11	first reported 90.5
1026	ISO7941	93.04815		0.33	
1039	D2163	92.839		0.19	
1040	D2163	92.71		0.10	
1069	D2163Mod.	92.4541	ex	-0.07	test result excluded, see §4.1
1140	D2163	92.721		0.11	
1191	IP473	92.6189		0.04	
1197	D2163	92.660704		0.07	
1198	D2163	92.71977		0.11	
1257	D2163	93.9976	R(0.01)	0.97	
1259	EN27941	93.42		0.58	
1491	ISO7941	92.362		-0.13	
1497	D2163	94.23190	C,R(0.01)	1.13	first reported 94.66627
1603	In house	92.8040		0.16	
1634	ISO7941	92.22		-0.23	
1709	D2163	92.462247		-0.07	
1776	EN27941	92.27		-0.20	
1786	D2163	92.656959		0.07	
1845	D2163	92.357		-0.14	
1961	EN27941	92.29		-0.18	
1990	IP473	92.52		-0.03	
2124	D2163	92.5035		-0.04	
6016		-----		-----	
6018	ISO7941	93.0800		0.35	
6019	ISO7941	92.5523	C	-0.01	first reported 94.26349
6193	EN15984	91.456	ex	-0.75	test result excluded, see §4.1
6203	EN27941	92.260		-0.20	
6262	D2163	93.46		0.61	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	92.47		-0.06	
7014	D2163	92.553		0.00	
7020		91.820	ex	-0.50	test result excluded, see §4.1

	normality	not OK
	n	51
	outliers	3 +3ex
	mean (n)	92.5604
	st.dev. (n)	0.31965
	R(calc.)	0.8950
	st.dev.(D2163:23e1)	1.48000
	R(D2163:23e1)	4.1440

compare: R(EN27941:93(liq)) = 1.0197


98
96
94
92
90
88
86
508 6193 562 7020 445 335 1634 6203 1776 1961 495 444 360 1845 1491 496 352 333 1016 877 868 861 347 1069 1709 6474 736 334 2124 994 1990 323 171 6019 7014 872 315 1006 1191 1786 317 1197 1040 1198 1140 1603 735 754 1039 328 1026 6018 467 1259 6262 1257 1497

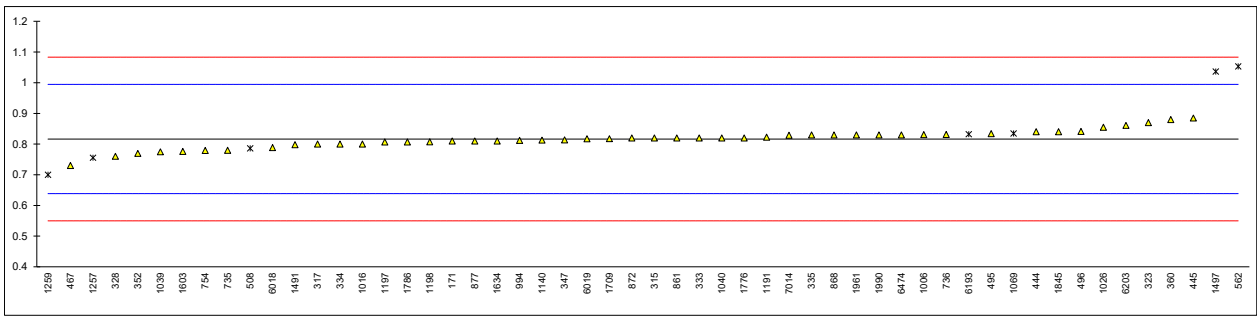

Kernel Density
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
88
90
92
94
96

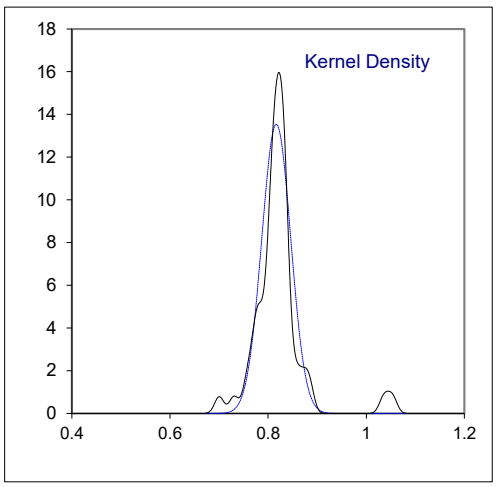
Determination of Propene on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.81		-0.07	
315	D2163	0.82		0.04	
317	D2163	0.80		-0.18	
323	D2163	0.87		0.60	
328	D2163	0.76		-0.63	
333	D2163	0.82		0.04	
334	D2163	0.8		-0.18	
335	D2163	0.83		0.15	
347	D2163	0.814		-0.03	
352	EN27941	0.7697		-0.52	
360	EN27941	0.88		0.71	
444	IP405	0.84		0.27	
445	D2163	0.885		0.77	
467	D2163	0.73		-0.97	
495	D2163	0.834		0.20	
496	D2163	0.841		0.28	
508	D2163	0.786	ex	-0.34	test result excluded, see §4.1
562	D2163	1.0531	R(0.01)	2.66	
735	D2163	0.78		-0.41	
736	D2163	0.831		0.16	
754	D2163	0.779		-0.42	
861	D2163	0.82		0.04	
868	D2163	0.830		0.15	
872	D2163	0.82		0.04	
877	D2163	0.81		-0.07	
970		-----		-----	
994	D2163	0.8121		-0.05	
1006	D2163	0.8305		0.16	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	0.8		-0.18	
1026	ISO7941	0.85475		0.43	
1039	D2163	0.775		-0.46	
1040	D2163	0.82		0.04	
1069	D2163Mod.	0.8347	ex	0.21	test result excluded, see §4.1
1140	D2163	0.813		-0.04	
1191	IP473	0.82275		0.07	
1197	D2163	0.806691		-0.11	
1198	D2163	0.807415		-0.10	
1257	D2163	0.7556	ex	-0.68	test result excluded, see §4.1
1259	EN27941	0.70	R(0.05)	-1.31	
1491	ISO7941	0.798		-0.21	
1497	D2163	1.03610	C,R(0.01)	2.47	first reported 1.05271
1603	In house	0.7761		-0.45	
1634	ISO7941	0.81		-0.07	
1709	D2163	0.817536		0.01	
1776	EN27941	0.82		0.04	
1786	D2163	0.806869		-0.11	
1845	D2163	0.840		0.27	
1961	EN27941	0.83		0.15	
1990	IP473	0.83		0.15	
2124		-----		-----	
6016		-----		-----	
6018	ISO7941	0.7882		-0.32	
6019	ISO7941	0.8172	C	0.01	first reported 0.61926
6193	EN15984	0.832	ex	0.18	test result excluded, see §4.1
6203	EN27941	0.861		0.50	
6262		-----	W	-----	test result withdrawn, reported 0.60
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	0.83		0.15	
7014	D2163	0.829		0.14	
7020		-----		-----	

	normality	suspect
	n	47
	outliers	3 +4ex
	mean (n)	0.8164
	st.dev. (n)	0.02948
	R(calc.)	0.0825
	st.dev.(D2163:23e1)	0.08903
	R(D2163:23e1)	0.2493

compare: R(EN27941:93(liq)) = 0.2137

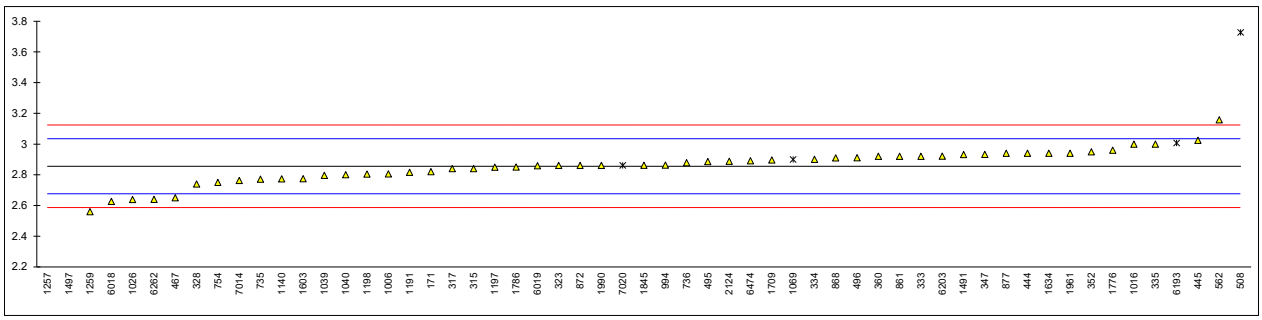

1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
1259 467 1257 328 352 1039 1603 754 735 508 6018 1491 317 334 1016 1197 1786 1198 171 877 1634 994 1140 347 6019 1709 872 315 861 333 1040 1776 1191 7014 335 868 1961 1990 6474 1006 736 6193 495 1069 444 1845 496 1026 6203 323 360 445 1497 562

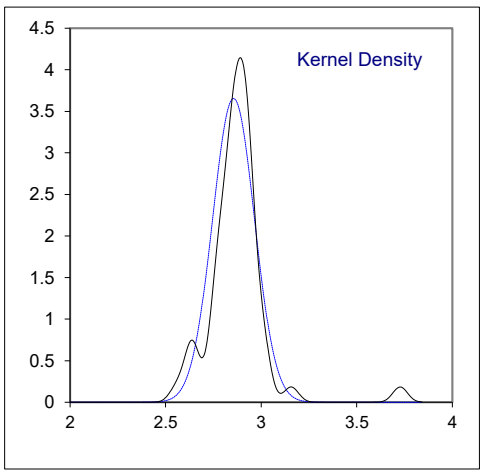

Kernel Density
18
16
14
12
10
8
6
4
2
0
0.4
0.6
0.8
1
1.2

Determination of iso-Butane on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	2.82		-0.39	
315	D2163	2.84		-0.17	
317	D2163	2.84		-0.17	
323	D2163	2.86		0.05	
328	D2163	2.74		-1.29	
333	D2163	2.92		0.72	
334	D2163	2.9		0.50	
335	D2163	3.00		1.61	
347	D2163	2.933		0.87	
352	EN27941	2.9494		1.05	
360	EN27941	2.92		0.72	
444	IP405	2.94		0.94	
445	D2163	3.024		1.88	
467	D2163	2.65		-2.29	
495	D2163	2.886		0.34	
496	D2163	2.911		0.62	
508	D2163	3.727	R(0.01)	9.72	
562	D2163	3.1570		3.36	
735	D2163	2.77		-0.95	
736	D2163	2.878		0.25	
754	D2163	2.750		-1.17	
861	D2163	2.92		0.72	
868	D2163	2.910		0.61	
872	D2163	2.86		0.05	
877	D2163	2.94		0.94	
970		-----		-----	
994	D2163	2.8622		0.08	
1006	D2163	2.8055		-0.56	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	3.0		1.61	
1026	ISO7941	2.63895		-2.41	
1039	D2163	2.796		-0.66	
1040	D2163	2.80		-0.62	
1069	D2163Mod.	2.8994	ex	0.49	test result excluded, see §4.1
1140	D2163	2.773		-0.92	
1191	IP473	2.8156		-0.44	
1197	D2163	2.849005		-0.07	
1198	D2163	2.804546		-0.57	
1257	D2163	1.3818	R(0.01)	-16.43	
1259	EN27941	2.56		-3.29	
1491	ISO7941	2.931		0.84	
1497	D2163	1.38770	C,R(0.01)	-16.37	first reported 1.32463
1603	In house	2.7741		-0.91	
1634	ISO7941	2.94		0.94	
1709	D2163	2.895892		0.45	
1776	EN27941	2.96		1.17	
1786	D2163	2.849513		-0.06	
1845	D2163	2.861		0.06	
1961	EN27941	2.94		0.94	
1990	IP473	2.86		0.05	
2124	D2163	2.8877		0.36	
6016		-----		-----	
6018	ISO7941	2.6265		-2.55	
6019	ISO7941	2.8584	C	0.03	first reported 1.99376
6193	EN15984	3.006	ex	1.68	test result excluded, see §4.1
6203	EN27941	2.921		0.73	
6262	D2163	2.64		-2.40	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	2.89		0.39	
7014	D2163	2.763		-1.03	
7020		2.860	ex	0.05	test result excluded, see §4.1

	normality	suspect	
	n	51	
	outliers	3 +3ex	
	mean (n)	2.8553	
	st.dev. (n)	0.10913	
	R(calc.)	0.3056	
	st.dev.(D2163:23e1)	0.08966	
	R(D2163:23e1)	0.2510	compare: R(EN27941:93(liq)) = 0.3868

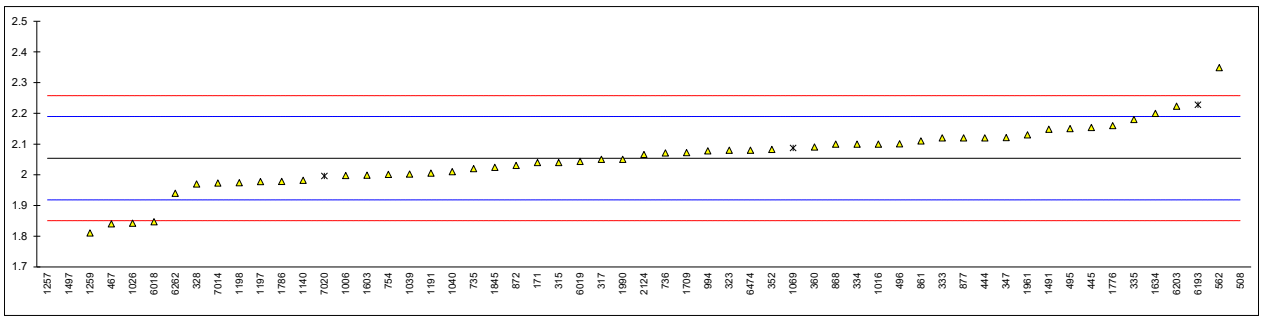

3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
1257 1497 1259 6018 1026 6262 467 328 754 7014 735 1140 1803 1039 1040 1198 1006 1191 171 317 315 1197 1786 6019 323 872 1990 7020 1845 994 736 495 2124 6474 1709 1069 334 868 496 360 861 333 6203 1491 347 877 444 1634 1961 352 1776 1016 335 6193 445 562 508

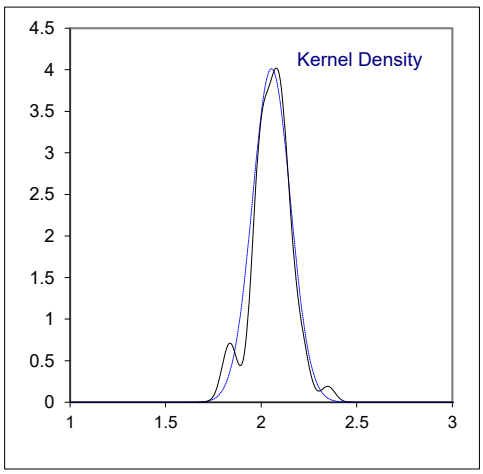

Kernel Density
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2
2.5
3
3.5
4

Determination of n-Butane on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	2.04		-0.20	
315	D2163	2.04		-0.20	
317	D2163	2.05		-0.06	
323	D2163	2.08		0.38	
328	D2163	1.97		-1.24	
333	D2163	2.12		0.97	
334	D2163	2.1		0.68	
335	D2163	2.18		1.86	
347	D2163	2.121		0.99	
352	EN27941	2.0826		0.42	
360	EN27941	2.09		0.53	
444	IP405	2.12		0.97	
445	D2163	2.154		1.47	
467	D2163	1.84		-3.15	
495	D2163	2.150		1.41	
496	D2163	2.101		0.69	
508	D2163	3.151	R(0.01)	16.15	
562	D2163	2.3490		4.34	
735	D2163	2.02		-0.50	
736	D2163	2.071		0.25	
754	D2163	2.001		-0.78	
861	D2163	2.11		0.83	
868	D2163	2.100		0.68	
872	D2163	2.03		-0.35	
877	D2163	2.12		0.97	
970		-----		-----	
994	D2163	2.0775		0.35	
1006	D2163	1.9974		-0.83	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	2.1		0.68	
1026	ISO7941	1.84201		-3.12	
1039	D2163	2.002		-0.76	
1040	D2163	2.01		-0.65	
1069	D2163Mod.	2.0871	ex	0.49	test result excluded, see §4.1
1140	D2163	1.982		-1.06	
1191	IP473	2.0053		-0.72	
1197	D2163	1.977448		-1.13	
1198	D2163	1.973898		-1.18	
1257	D2163	0.7629	R(0.01)	-19.00	
1259	EN27941	1.81		-3.59	
1491	ISO7941	2.148		1.38	
1497	D2163	0.76920	C,R(0.01)	-18.91	first reported 0.71694
1603	In house	1.9984		-0.82	
1634	ISO7941	2.20		2.15	
1709	D2163	2.071753		0.26	
1776	EN27941	2.16		1.56	
1786	D2163	1.977884		-1.12	
1845	D2163	2.024		-0.44	
1961	EN27941	2.13		1.12	
1990	IP473	2.05		-0.06	
2124	D2163	2.0661		0.18	
6016		-----		-----	
6018	ISO7941	1.8468		-3.05	
6019	ISO7941	2.0432	C	-0.16	first reported 1.64010
6193	EN15984	2.228	ex	2.56	test result excluded, see §4.1
6203	EN27941	2.223		2.49	
6262	D2163	1.94		-1.68	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	2.08		0.38	
7014	D2163	1.973		-1.19	
7020		1.996	ex	-0.85	test result excluded, see §4.1

	normality	suspect	
	n	51	
	outliers	3 +3ex	
	mean (n)	2.0539	
	st.dev. (n)	0.09942	
	R(calc.)	0.2784	
	st.dev.(D2163:23e1)	0.06794	
	R(D2163:23e1)	0.1902	compare: R(EN27941:93(liq)) = 0.3868


2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1257 1497 1259 467 1026 6018 6262 328 7014 1198 1197 1786 1140 7020 1006 1603 754 1039 1191 1040 735 1845 872 171 315 6019 317 1990 2124 736 1709 994 323 6474 352 1069 360 868 334 1016 496 861 333 877 444 347 1961 1491 495 445 1776 335 1634 6203 6193 562 508

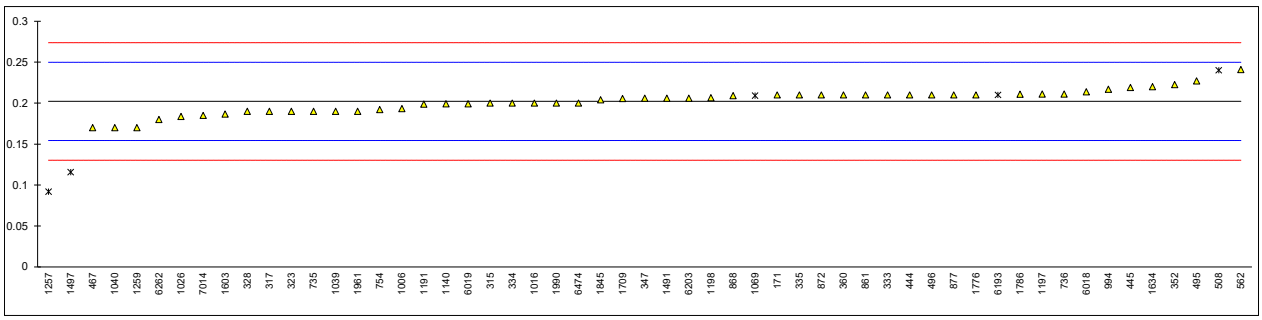

Kernel Density
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1
1.5
2
2.5
3

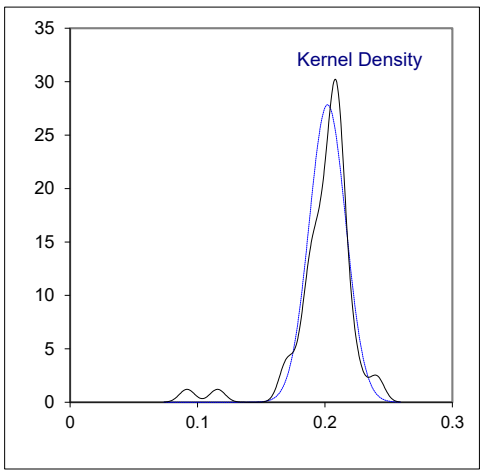
Determination of 1-Butene on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.21		0.33	
315	D2163	0.20		-0.09	
317	D2163	0.19		-0.50	
323	D2163	0.19		-0.50	
328	D2163	0.19		-0.50	
333	D2163	0.21		0.33	
334	D2163	0.2		-0.09	
335	D2163	0.21		0.33	
347	D2163	0.206		0.16	
352	EN27941	0.2227		0.86	
360	EN27941	0.21		0.33	
444	IP405	0.21		0.33	
445	D2163	0.219		0.71	
467	D2163	0.17		-1.34	
495	D2163	0.227		1.04	
496	D2163	0.210		0.33	
508	D2163	0.240	ex	1.58	test result excluded, see §4.1
562	D2163	0.2410		1.63	
735	D2163	0.19		-0.50	
736	D2163	0.211		0.37	
754	D2163	0.192		-0.42	
861	D2163	0.21		0.33	
868	D2163	0.209		0.29	
872	D2163	0.21		0.33	
877	D2163	0.21		0.33	
970		-----		-----	
994	D2163	0.2169		0.62	
1006	D2163	0.1932		-0.37	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	0.2		-0.09	
1026	ISO7941	0.18376		-0.77	
1039	D2163	0.190		-0.50	
1040	D2163	0.17		-1.34	
1069	D2163Mod.	0.2090	ex	0.29	test result excluded, see §4.1
1140	D2163	0.199		-0.13	
1191	IP473	0.1987		-0.14	
1197	D2163	0.210968		0.37	
1198	D2163	0.206554		0.19	
1257	D2163	0.0918	R(0.01)	-4.61	
1259	EN27941	0.17		-1.34	
1491	ISO7941	0.206		0.16	
1497	D2163	0.11570	C,R(0.01)	-3.61	first reported 0.08716
1603	In house	0.1866		-0.65	
1634	ISO7941	0.22		0.75	
1709	D2163	0.205630		0.15	
1776	EN27941	0.21		0.33	
1786	D2163	0.210951		0.37	
1845	D2163	0.204		0.08	
1961	EN27941	0.19		-0.50	
1990	IP473	0.20		-0.09	
2124		-----		-----	
6016		-----		-----	
6018	ISO7941	0.2138		0.49	
6019	ISO7941	0.1991	C	-0.12	first reported 0.14930
6193	EN15984	0.210	ex	0.33	test result excluded, see §4.1
6203	EN27941	0.206		0.16	
6262	D2163	0.18		-0.92	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	0.2		-0.09	
7014	D2163	0.185		-0.71	
7020		-----		-----	

normality	OK
n	50
outliers	2 +3ex
mean (n)	0.2021
st.dev. (n)	0.01434
R(calc.)	0.0401
st.dev.(D2163:23e1)	0.02393
R(D2163:23e1)	0.0670

compare: R(EN27941:93(liq)) = 0.1603

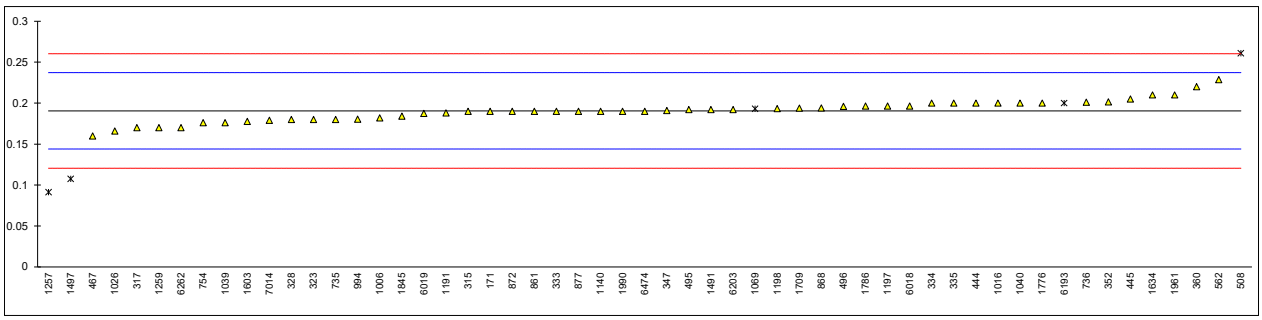

0.3
0.25
0.2
0.15
0.1
0.05
0
1257 1497 467 1040 1259 6262 1026 7014 1603 328 317 323 735 1039 1961 754 1006 1191 1140 6019 315 334 1016 1990 6474 1845 1709 347 1491 6203 1198 868 1069 171 335 872 360 861 333 444 496 877 1776 6193 1786 1197 736 6018 994 445 1634 352 495 508 562

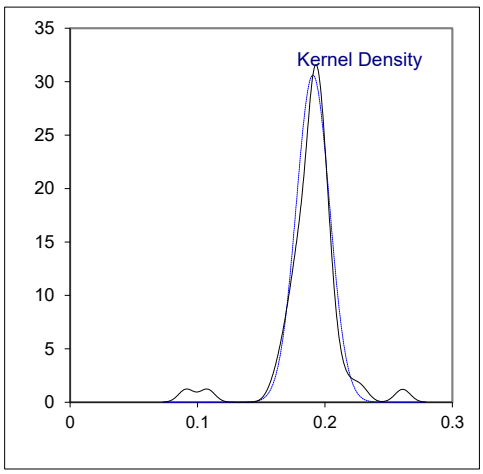

Kernel Density
35
30
25
20
15
10
5
0
0
0.1
0.2
0.3

Determination of iso-Butene on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.19		-0.02	
315	D2163	0.19		-0.02	
317	D2163	0.17		-0.88	
323	D2163	0.18		-0.45	
328	D2163	0.18		-0.45	
333	D2163	0.19		-0.02	
334	D2163	0.2		0.41	
335	D2163	0.2		0.41	
347	D2163	0.191		0.02	
352	EN27941	0.2014		0.47	
360	EN27941	0.22	C	1.27	first reported 0.27
444	IP405	0.20		0.41	
445	D2163	0.205		0.62	
467	D2163	0.16		-1.31	
495	D2163	0.192		0.06	
496	D2163	0.196		0.24	
508	D2163	0.261	R(0.01)	3.02	
562	D2163	0.2287		1.64	
735	D2163	0.18		-0.45	
736	D2163	0.201		0.45	
754	D2163	0.176		-0.62	
861	D2163	0.19		-0.02	
868	D2163	0.194		0.15	
872	D2163	0.19		-0.02	
877	D2163	0.19		-0.02	
970		-----		-----	
994	D2163	0.1804		-0.43	
1006	D2163	0.1819		-0.37	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	0.2		0.41	
1026	ISO7941	0.16585		-1.06	
1039	D2163	0.176		-0.62	
1040	D2163	0.20		0.41	
1069	D2163Mod.	0.1931	ex	0.11	test result excluded, see §4.1
1140	D2163	0.190		-0.02	
1191	IP473	0.1880		-0.11	
1197	D2163	0.196354		0.25	
1198	D2163	0.193192		0.12	
1257	D2163	0.0911	R(0.01)	-4.27	
1259	EN27941	0.17		-0.88	
1491	ISO7941	0.192		0.06	
1497	D2163	0.10750	C,R(0.01)	-3.56	first reported 0.08307
1603	In house	0.1777		-0.55	
1634	ISO7941	0.21		0.84	
1709	D2163	0.193853		0.14	
1776	EN27941	0.20		0.41	
1786	D2163	0.196342		0.25	
1845	D2163	0.184		-0.28	
1961	EN27941	0.21		0.84	
1990	IP473	0.19		-0.02	
2124		-----		-----	
6016		-----		-----	
6018	ISO7941	0.1964		0.25	
6019	ISO7941	0.1874	C	-0.13	first reported 0.14437
6193	EN15984	0.200	ex	0.41	test result excluded, see §4.1
6203	EN27941	0.192		0.06	
6262	D2163	0.17		-0.88	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	0.19		-0.02	
7014	D2163	0.179		-0.49	
7020		-----		-----	

	normality	suspect	
	n	50	
	outliers	3 +2ex	
	mean (n)	0.1905	
	st.dev. (n)	0.01303	
	R(calc.)	0.0365	
	st.dev.(D2163:23e1)	0.02330	
	R(D2163:23e1)	0.0653	compare: R(EN27941:93(liq)) = 0.1603

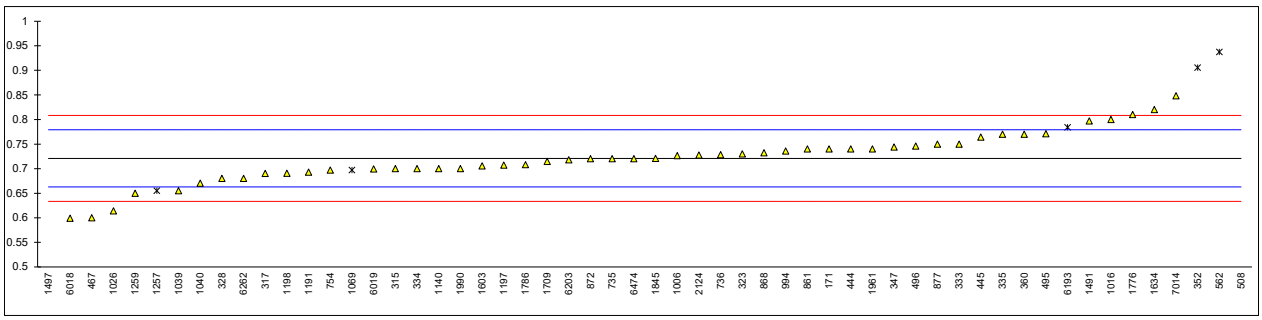

0.3
0.25
0.2
0.15
0.1
0.05
0
1257 1497 467 1026 317 1259 6262 754 1039 1803 7014 328 323 735 994 1006 1845 6019 1191 315 171 872 861 333 877 1140 1990 6474 347 495 1491 6203 1069 1198 1709 868 496 1786 1197 6018 334 335 444 1016 1040 1776 6193 736 352 445 1634 1961 360 562 508

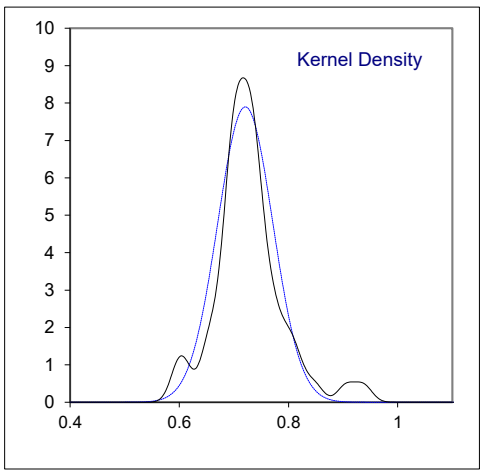

Kernel Density
35
30
25
20
15
10
5
0
0
0.1
0.2
0.3

Determination of n-Pentane on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.74		0.65	
315	D2163	0.70		-0.72	
317	D2163	0.69		-1.06	
323	D2163	0.73		0.31	
328	D2163	0.68		-1.41	
333	D2163	0.75		0.99	
334	D2163	0.7		-0.72	
335	D2163	0.77		1.68	
347	D2163	0.744		0.79	
352	EN27941	0.9055	C,R(0.05)	6.33	first reported 0.8635
360	EN27941	0.77	C	1.68	first reported 0.87
444	IP405	0.74		0.65	
445	D2163	0.764		1.47	
467	D2163	0.60		-4.15	
495	D2163	0.771		1.72	
496	D2163	0.746		0.86	
508	D2163	1.186	R(0.01)	15.96	
562	D2163	0.9373	R(0.05)	7.42	
735	D2163	0.72		-0.03	
736	D2163	0.728		0.24	
754	D2163	0.697		-0.82	
861	D2163	0.74		0.65	
868	D2163	0.732		0.38	
872	D2163	0.72		-0.03	
877	D2163	0.75		0.99	
970		-----		-----	
994	D2163	0.7356		0.50	
1006	D2163	0.7262		0.18	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	0.8		2.71	
1026	ISO7941	0.61389		-3.68	
1039	D2163	0.655		-2.27	
1040	D2163	0.67		-1.75	
1069	D2163Mod.	0.6971	ex	-0.82	test result excluded, see §4.1
1140	D2163	0.700		-0.72	
1191	IP473	0.6928		-0.97	
1197	D2163	0.70692		-0.48	
1198	D2163	0.690324		-1.05	
1257	D2163	0.6549	ex	-2.27	test result excluded, see §4.1
1259	EN27941	0.65		-2.44	
1491	ISO7941	0.797		2.61	
1497	D2163	0.09930	C,R(0.01)	-21.33	first reported 0.09011
1603	In house	0.7054		-0.54	
1634	ISO7941	0.82		3.40	
1709	D2163	0.714623		-0.22	
1776	EN27941	0.81		3.05	
1786	D2163	0.707808		-0.45	
1845	D2163	0.721		0.00	
1961	EN27941	0.74		0.65	
1990	IP473	0.70		-0.72	
2124	D2163	0.7274	C	0.22	first reported as iso-Pentane
6016		-----		-----	
6018	ISO7941	0.5988		-4.19	
6019	ISO7941	0.6991	C	-0.75	first reported 0.66392
6193	EN15984	0.784	ex	2.16	test result excluded, see §4.1
6203	EN27941	0.718		-0.10	
6262	D2163	0.68		-1.41	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	0.72		-0.03	
7014	D2163	0.848		4.36	
7020		-----		-----	

normality	OK	
n	49	
outliers	4 +3ex	
mean (n)	0.7210	
st.dev. (n)	0.05050	
R(calc.)	0.1414	
st.dev.(D2163:23e1)	0.02914	
R(D2163:23e1)	0.0816	compare: R(EN27941:93(liq)) = 0.3116


1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
1497 6018 467 1026 1259 1257 1039 1040 328 6262 317 1198 1191 754 1069 6019 315 334 1140 1990 1603 1197 1786 1709 6203 872 735 6474 1845 1006 2124 736 323 868 994 861 171 444 1961 347 496 877 333 445 335 360 495 6193 1491 1016 1776 1634 7014 352 562 508


Kernel Density
10
9
8
7
6
5
4
3
2
1
0
0.4
0.6
0.8
1

Determination of iso-Pentane on sample #23200; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	<0.01		-----	
315	D2163	<0.01		-----	
317	D2163	<0.01		-----	
323	D2163	<0.01		-----	
328	D2163	<0.01		-----	
333	D2163	<0.01		-----	
334	D2163	<0.1		-----	
335	D2163	< 0.01		-----	
347		-----		-----	
352		-----		-----	
360	EN27941	< 0.1		-----	
444	IP405	<0.01		-----	
445	D2163	0.002		-----	
467	D2163	<0,01		-----	
495	D2163	<0.010		-----	
496	D2163	0.000		-----	
508	D2163	0.000		-----	
562		-----		-----	
735	D2163	<0.1		-----	
736		-----		-----	
754	D2163	<0.01		-----	
861	D2163	<0.01		-----	
868	D2163	<0.001		-----	
872	D2163	<0.01		-----	
877	D2163	<0.01		-----	
970		-----		-----	
994	D2163	<0.01		-----	
1006	D2163	<0.01		-----	
1011		-----		-----	
1012		-----		-----	
1016	ISO7941	<0.1		-----	
1026	ISO7941	0.00125		-----	
1039		-----		-----	
1040	D2163	0.00		-----	
1069	D2163Mod.	0		-----	
1140	D2163	0.000		-----	
1191	IP473	0		-----	
1197	D2163	0.0000		-----	
1198	D2163	0.0000		-----	
1257		-----		-----	
1259	EN27941	<0,1		-----	
1491	ISO7941	0		-----	
1497		-----		-----	
1603		-----		-----	
1634	ISO7941	0		-----	
1709	D2163	<0.01		-----	
1776		-----		-----	
1786	D2163	0.0000		-----	
1845	D2163	0		-----	
1961		-----		-----	
1990		-----		-----	
2124	D2163	<0.0010		-----	
6016		-----		-----	
6018	ISO7941	<0.1		-----	
6019	ISO7941	<0.01	C	-----	first reported 0.00121
6193	EN15984	0		-----	
6203	EN27941	<0.1		-----	
6262	D2163	0.00		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2163	0		-----	
7014		-----		-----	
7020		-----		-----	
	n	37			
	mean (n)	<0.01			

Determination of Molar Mass on sample #23200; results in g/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2421	45.3041	E	-----	calculation difference, iis calculated 44.9178
315	ISO8973	44.92		-----	
317	INH-001	44.92		-----	
323	D2598	44.94		-----	
328		-----		-----	
333		-----		-----	
334		-----		-----	
335		-----		-----	
347		-----		-----	
352		-----		-----	
360	ISO8973	44.97	C	-----	first reported 45.00
444		-----		-----	
445	D2163	44.994		-----	
467	ISO8973	44.83		-----	
495	D2163	44.96		-----	
496	D2163	44.952		-----	
508	D2598	45.17	E	-----	calculation difference, iis calculated 45.38
562		-----		-----	
735	D2421	44.926		-----	
736	ISO8973	44.9424		-----	
754	D2421	44.9044		-----	
861	D2598	44.96		-----	
868	D2598	44.95		-----	
872	D2421	44.93		-----	
877	D2163	44.97		-----	
970		-----		-----	
994	D2163	44.9410		-----	
1006		-----		-----	
1011		-----		-----	
1012		-----		-----	
1016	EN27941	44.9711		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140	D2163	44.9		-----	
1191	IP473	44.9052		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259	ISO8973	44.84		-----	
1491		-----		-----	
1497	IP432	44.1173	C	-----	first reported 44.1303
1603		-----		-----	
1634		-----		-----	
1709		-----		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990		-----	W	-----	test result withdrawn, reported 45.09
2124	GPA2261	45.25	E	-----	calculation difference, iis calculated 44.37
6016		-----		-----	
6018		44.83		-----	
6019	ISO8973	44.92	C	-----	first reported 44.74
6193		-----		-----	
6203	ISO8973	44.964		-----	
6262	D2163	44.91		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D3588	44.94		-----	
7014		-----		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on molecular masses given in table 2 of ASTM D2421:21e1.
NB. Effect of different factors of ASTM D2421:21e1 and ISO8973:97(amd.1-20)/IP432:00R17 on the calculation is very small.

Determination of Relative Density at 60/60 °F on sample #23200; unitless results

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2598	0.5118		-----	
315	D2598	0.512		-----	
317	D2598	0.512		-----	
323	D2598	0.512		-----	
328		-----		-----	
333		-----		-----	
334		-----		-----	
335		-----		-----	
347	D2598	0.5116		-----	
352	ISO8973	0.5122		-----	
360	D2598	0.5119	C	-----	first reported 0.5121
444		-----		-----	
445	D2598	0.5122		-----	
467	ISO8973	0.5113		-----	
495	D2598	0.5118		-----	
496	D2598	0.51175		-----	
508	D2598	0.513		-----	
562	D2598	0.5125		-----	
735	ISO8973	0.5118		-----	
736	ISO8973	0.51194		-----	
754	D2598	0.511		-----	
861	D2598	0.5118		-----	
868	D2598	0.5117		-----	
872	D2598	0.5116		-----	
877	D2598	0.5118		-----	
970		-----		-----	
994	D2598	0.5109		-----	
1006	D2598	0.5115		-----	
1011		-----		-----	
1012		-----		-----	
1016	ISO8973	0.5122		-----	
1026	ISO8973	0.5113	C	-----	first reported 511.3
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191	ISO8973	0.5117	C	-----	first reported 511.7
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259	ISO8973	0.511		-----	
1491	ISO8973	0.512		-----	
1497	IP432	0.5062	C	-----	first reported 0.5064
1603		-----		-----	
1634		-----		-----	
1709	D2598	0.5116		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990	D2598	0.5115		-----	
2124	GPA2261	0.503	E	-----	calculation difference, iis calculated 0.511
6016		-----		-----	
6018	ISO8973	0.5113		-----	
6019	ISO8973	0.5120	C	-----	first reported 0.5111
6193	ISO8973	0.5126		-----	
6203	ISO8973	0.5121		-----	
6262	D2598	0.5116		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2598	0.512		-----	
7014	D2598	0.5116		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on relative densities at 60/60 °F (15.6/15.6 °C) given in table 1 of ASTM D2598:21.
N.B. Effect of different factors from ASTM D2598:21 and ISO8973:97(amd.1-20)/IP432:00R17 on the calculation is very small.

Determination of Absolute Vapor Pressure at 100 °F on sample #23200; results in psi

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2598	182		-----	
315		-----		-----	
317	ISO8973	186.8		-----	
323		-----		-----	
328		-----		-----	
333		-----		-----	
334	ISO8973	187.0	C	-----	first reported 169.1
335		-----		-----	
347	D2598	181.9		-----	
352		-----		-----	
360	ISO8973	186.4	C	-----	first reported 186.2
444		-----		-----	
445	D2598	186	E	-----	calculation difference, iis calculated 182 acc. to D2598
467	ISO8973	187.5		-----	
495	D2598	182.1		-----	
496	D2598	182.17		-----	
508		-----		-----	
562		-----		-----	
735	ISO8973	186.53		-----	
736	ISO8973	186.854		-----	
754	ISO8973	186.911		-----	
861		-----		-----	
868	D2598	182.2		-----	
872	ISO8973	186.8		-----	
877	D2598	181.9		-----	
970		-----		-----	
994	ISO8973	186.854		-----	
1006	D2598	182.7		-----	
1011		-----		-----	
1012		-----		-----	
1016	EN589	186.4658		-----	
1026	ISO8973	188		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259		-----		-----	
1491		-----		-----	
1497	D1267	186.4423	ex,C	-----	fr. 185.1129
1603		-----		-----	
1634		-----		-----	
1709		-----		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990	D2598	182.65		-----	
2124		-----		-----	
6016		-----		-----	
6018	ISO8973	187.82	C	-----	first reported 1295 psi, iis assumed kPa and converted to psi
6019	ISO8973	187.10	C	-----	first reported 1297 kPa
6193		-----		-----	
6203	ISO8973	186.53		-----	
6262		-----		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2598	182.7		-----	
7014		-----		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on Vapor Pressure factors at 100 °F (37.8 °C) given in table A.1 of ISO8973:97(amd.1-20)/IP432:00R17.
Calculations by iis are based on Vapor Pressure factors at 100 °F (37.8 °C) as given in table 1 of ASTM D2598:21.
Lab 1497 test result excluded as this is a measured and not a calculated test result. iis calculated based on the reported composition 201.14 acc. to ISO8973.

Determination of Relative Vapor Pressure at 100 °F on sample #23200; results in psi

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2598	168		-----	
315		-----		-----	
317	ISO8973	172.2		-----	
323	D2598	167.4		-----	
328		-----		-----	
333		-----		-----	
334	ISO8973	172.3	C	-----	first reported 154.4
335		-----		-----	
347		-----		-----	
352		-----		-----	
360	ISO8973	171.8	C	-----	first reported 171.6
444		-----		-----	
445	D2598	171	E	-----	calc. diff., iis calc. 167 acc. to D2598 and 171 acc. to ISO8973
467	ISO8973	172.9		-----	
495	D2598	167.4		-----	
496	D2598	167.48		-----	
508		-----		-----	
562	D2598	165		-----	
735	ISO8973	171.83		-----	
736	ISO8973	171.902		-----	
754	ISO8973	172.215		-----	
861	D2598	167.3		-----	
868	D2598	167.5		-----	
872	ISO8973	172.1		-----	
877		-----		-----	
970		-----		-----	
994	ISO8973	171.902		-----	
1006	D2598	168		-----	
1011		-----		-----	
1012		-----		-----	
1016	EN589	171.7699		-----	
1026	ISO8973	173		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259		-----		-----	
1491		-----		-----	
1497		-----		-----	
1603		-----		-----	
1634		-----		-----	
1709	D2598	168		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990	D2598	167.95		-----	
2124	GPA2261	168.66		-----	
6016		-----		-----	
6018	ISO8973	173.03	C	-----	first reported 1193 psi, iis assumed kPa and converted to psi
6019	ISO8973	172.59	C	-----	first reported 1196 kPa
6193		-----		-----	
6203	ISO8973	171.87		-----	
6262	ISO8973	168.45		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2598	168		-----	
7014	D2598	167.88		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on Vapor Pressure factors at 100 °F (37.8 °C) given in table A.1 of ISO8973:97(amd.1-20)/IP432:00R17.
Calculations by iis are based on Vapor Pressure factors at 100 °F (37.8 °C) given in table 1 of ASTM D2598:21.

Determination of Absolute Vapor Pressure at 40 °C on sample #23200; results in kPa

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315	ISO8973	1325		-----	
317	ISO8973	1325	C	-----	first reported 192.2
323		-----		-----	
328	ISO8973	1324		-----	
333		-----		-----	
334	ISO8973	1324		-----	
335	ISO8973	1321		-----	
347		-----		-----	
352	ISO8973	1318		-----	
360	ISO8973	1321.7	C	-----	first reported 1320.0
444		-----		-----	
445	ISO8973	1319.0		-----	
467	ISO8973	1330		-----	
495	ISO8973	1324.7		-----	
496	ISO8973	1325.06		-----	
508		-----		-----	
562		-----		-----	
735	ISO8973	1322.67		-----	
736	ISO8973	1323.99		-----	
754	ISO8973	1325.209		-----	
861		-----		-----	
868		-----		-----	
872	ISO8973	1324		-----	
877		-----		-----	
970		-----		-----	
994	ISO8973	1323.996		-----	
1006		-----		-----	
1011		-----		-----	
1012		-----		-----	
1016		-----		-----	
1026	ISO8973	1332		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191	ISO8973	1328		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259	ISO8973	1328		-----	
1491		-----		-----	
1497	D1267	1327.7027	ex,C	-----	fr. 1317.75
1603		-----		-----	
1634		-----		-----	
1709		-----		-----	
1776	ISO8973	1321		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990		-----		-----	
2124		-----		-----	
6016		-----		-----	
6018	ISO8973	1332		-----	
6019	ISO8973	1326	C	-----	first reported 1333
6193	ISO8973	1313		-----	
6203	ISO8973	1324		-----	
6262	ISO8973	1316.79		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474		-----		-----	
7014		-----		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on Vapor Pressure factors at 40 °C given in table A.1 of ISO8973:97(amd.1-20)/IP432:00R17.
Lab 1497 test result excluded as this is a measured and not a calculated test result. iis calculated based on the reported composition 1429.0318 acc. to ISO8973.

Determination of Relative Vapor Pressure at 40 °C on sample #23200; results in kPa

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315	ISO8973	1224		-----	
317	ISO8973	1224	C	-----	first reported 1177.5
323		-----		-----	
328	ISO8973	1223		-----	
333		-----		-----	
334	ISO8973	1223		-----	
335	ISO8973	1220		-----	
347		-----		-----	
352	ISO8973	1217		-----	
360	ISO8973	1221.1	C	-----	first reported 1219.4
444	ISO8973	1222.4		-----	
445	ISO8973	1217.7		-----	
467	ISO8973	1229		-----	
495	ISO8973	1223.3		-----	
496	ISO8973	1223.73		-----	
508		-----		-----	
562	D2598	1297	E	-----	calculation difference, iis calculated 1207 acc. to ISO8973
735	ISO8973	1221.0		-----	
736	ISO8973	1222.70		-----	
754	ISO8973	1223.884		-----	
861		-----		-----	
868		-----		-----	
872	ISO8973	1223		-----	
877		-----		-----	
970		-----		-----	
994	ISO8973	1222.696		-----	
1006		-----		-----	
1011		-----		-----	
1012		-----		-----	
1016		-----		-----	
1026	ISO8973	1231		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259	ISO8973	1226		-----	
1491	ISO8973	1219		-----	
1497		-----		-----	
1603		-----		-----	
1634	ISO8973	1219		-----	
1709		-----		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961	ISO8973	1222		-----	
1990		-----		-----	
2124		-----		-----	
6016		-----		-----	
6018	ISO8973	1230		-----	
6019	ISO8973	1226	C	-----	first reported 1232
6193		-----		-----	
6203	ISO8973	1223		-----	
6262		-----		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474		-----		-----	
7014		-----		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on Vapor Pressure factors at 40 °C given in table A.1 of ISO8973:97(amd.1-20)/IP432:00R17.

Determination of Motor Octane Number, MON on sample #23200;

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2598	96.5		-----	
315		-----		-----	
317	EN589	95.1		-----	
323		-----		-----	
328	EN589	95.1		-----	
333		-----		-----	
334	EN589	95.1		-----	
335		-----		-----	
347		-----		-----	
352		-----		-----	
360	EN589	95.07		-----	
444		-----		-----	
445	D2598	95.1		-----	
467	EN589	95.1		-----	
495	D2598	96.4		-----	
496	D2598	96.46		-----	
508	D2598	96.6	E	-----	calculation difference, iis calculated 96.2 acc. to D2598
562	D2598	96.1		-----	
735	EN589	95.1		-----	
736	EN589	95.10		-----	
754	EN589	95.12		-----	
861	D2598	97.0	E	-----	calculation difference, iis calculated 96.5 acc. to D2598
868	D2598	96.5		-----	
872	EN589	95.11		-----	
877	D2598	96.5		-----	
970		-----		-----	
994	EN589	95.1		-----	
1006	D2598	95.1		-----	
1011		-----		-----	
1012		-----		-----	
1016		-----		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259	EN589	95.1		-----	
1491	EN589	96.6		-----	
1497		-----		-----	
1603		-----		-----	
1634		-----		-----	
1709		-----		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990	D2598	96.3		-----	
2124		-----		-----	
6016		-----		-----	
6018		-----		-----	
6019		-----		-----	
6193		-----		-----	
6203	EN589	95.1		-----	
6262	D2598	96.3		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D2598	96.053	E	-----	calculation difference, iis calculated 96.483 acc. to D2598
7014		-----		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on MON factors given in table B.1 of EN589:18+A1:22(E).
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. For iso-Butene the value of 83.5 of cis-2-Butene 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 and 60 °F on sample #23200; results in kJ/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315		-----		-----	
317		-----		-----	
323		-----		-----	
328		-----		-----	
333		-----		-----	
334		-----		-----	
335		-----		-----	
347		-----		-----	
352	D3588	2262.5060		-----	
360	D3588	2260.83	C	-----	first reported 2262.39
444		-----		-----	
445		-----		-----	
467	ISO6976	2255		-----	
495		-----		-----	
496	D3588	2260.046		-----	
508		-----		-----	
562	D3588	2267.99		-----	
735		-----		-----	
736		-----		-----	
754		-----		-----	
861		-----		-----	
868		-----		-----	
872		-----		-----	
877		-----		-----	
970		-----		-----	
994		-----		-----	
1006		-----		-----	
1011		-----		-----	
1012		-----		-----	
1016		-----		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259		-----		-----	
1491		-----		-----	
1497	D3588	50.3413	C,E	-----	fr. 50.341 / calculation difference, iis calculated 2220.9615
1603		-----		-----	
1634	D3588	2262.51		-----	
1709		-----		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990	D3588	2258.84		-----	
2124		-----		-----	
6016		-----		-----	
6018	D3588	12016	E	-----	calculation difference, iis calculated 2255
6019	D3588	12014	C,E	-----	first reported 12018 / calculation difference, iis calculated 2259
6193		-----		-----	
6203		-----		-----	
6262	D3588	2265.88		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D3588	2259.429		-----	
7014		-----		-----	
7020		-----		-----	

Remark:
Calculations by iis are based on the Ideal Gross Heating Value at 14.696 psia/60 °F factors given in table 1 of ASTM D3588:98R17e1.

Determination of Ideal Net Heating Value at 14.696 psia and 60 °F on sample #23200; results in kJ/mol

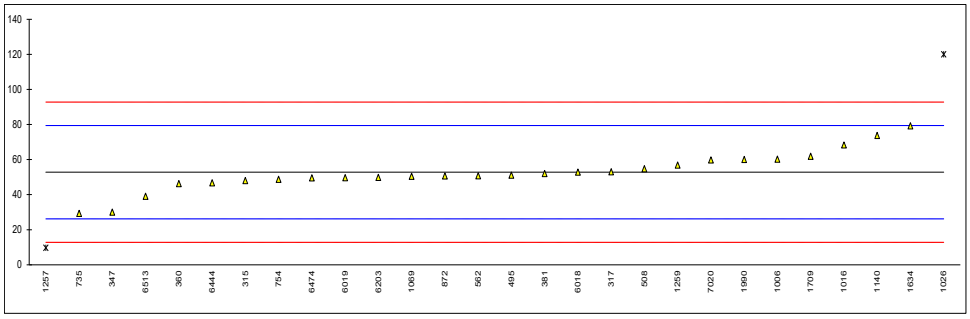
lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315		-----		-----	
317		-----		-----	
323		-----		-----	
328		-----		-----	
333		-----		-----	
334		-----		-----	
335		-----		-----	
347		-----		-----	
352	D3588	2082.5303		-----	
360	D3588	2080.84	C	-----	first reported 2082.31
444		-----		-----	
445		-----		-----	
467	ISO6976	2075		-----	
495		-----		-----	
496	D3588	2079.536		-----	
508		-----		-----	
562	D3588	2087.57		-----	
735		-----		-----	
736		-----		-----	
754		-----		-----	
861		-----		-----	
868		-----		-----	
872		-----		-----	
877		-----		-----	
970		-----		-----	
994		-----		-----	
1006		-----		-----	
1011		-----		-----	
1012		-----		-----	
1016		-----		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1069		-----		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1257		-----		-----	
1259		-----		-----	
1491		-----		-----	
1497		-----		-----	
1603		-----		-----	
1634	D3588	2082.41		-----	
1709		-----		-----	
1776		-----		-----	
1786		-----		-----	
1845		-----		-----	
1961		-----		-----	
1990	D3588	2078.95		-----	
2124		-----		-----	
6016		-----		-----	
6018	D3588	11059	E	-----	calculation difference, iis calculated 2075
6019	D3588	11058	C,E	-----	first reported 11060 / calculation difference, iis calculated 2079
6193		-----		-----	
6203		-----		-----	
6262	D3588	2085.45		-----	
6364		-----		-----	
6411		-----		-----	
6433		-----		-----	
6448		-----		-----	
6474	D3588	2079.539		-----	
7014		-----		-----	
7020		-----		-----	

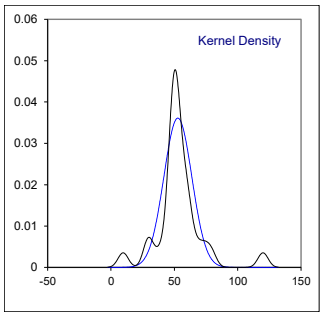
Remark:
Calculations by iis are based on the Ideal Net Heating Value at 14.696 psia/60 °F factors given in table 1 of ASTM D3588:98R17e1.

Determination of Total Sulfur on sample #23201; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315	D6667	48		-0.36	
317	D6667	53		0.02	
323		-----		-----	
337		-----		-----	
347	D6667	30		-1.71	
360	D6667	46.3		-0.49	
381	D6667	52		-0.06	
396		-----		-----	
445		-----		-----	
495	D6667	51.14		-0.12	
508	D6667	54.76		0.15	
562	D6667	50.682		-0.16	
735	D6667	29.305		-1.76	
754	D6667	48.74		-0.30	
872	D6667	50.63		-0.16	
1006	D6667	60.26		0.56	
1012		-----		-----	
1016	D6667	68.28		1.16	
1026	ISO20846	120	C,R(0.01)	5.05	first reported 114
1039		-----		-----	
1040	ISO20846	<1	f-	<-3.89	possibly a false negative test result?
1069	D6667Mod.	50.4		-0.18	
1140	D5504	73.66		1.57	
1257	D3246	9.598	R(0.05)	-3.24	
1259	D6667	56.89		0.31	
1634	D6667	79.175		1.98	
1709	D6667	61.811		0.68	
1720		-----		-----	
1990	D6667	60		0.54	
6016		-----		-----	
6018	D6667	52.80		0.00	
6019	D6667	49.68		-0.23	
6203	D6667	49.8		-0.22	
6262		-----		-----	
6444	D6667	46.7		-0.46	
6474	D6667	49.47		-0.25	
6513	D6228	39.119		-1.03	
7020	D6667	59.73		0.52	

normality	suspect
n	26
outliers	2
mean (n)	52.782
st.dev. (n)	11.0524
R(calc.)	30.947
st.dev.(D6667:21 LP gas)	13.3096
R(D6667:21 LP gas)	37.267





APPENDIX 2

Number of participants per country

Liquefied Propane iis23S04P

2 labs in ALGERIA
1 lab in AUSTRALIA
1 lab in AZERBAIJAN
2 labs in BELGIUM
1 lab in BULGARIA
1 lab in CHILE
3 labs in CHINA, People's Republic
1 lab in CROATIA
1 lab in DENMARK
1 lab in EGYPT
2 labs in FINLAND
4 labs in FRANCE
4 labs in GERMANY
2 labs in IRAN, Islamic Republic of
3 labs in KAZAKHSTAN
1 lab in KENYA
4 labs in MALAYSIA
5 labs in NETHERLANDS
1 lab in NIGERIA
1 lab in OMAN
1 lab in PANAMA
6 labs in PORTUGAL
1 lab in ROMANIA
2 labs in RUSSIAN FEDERATION
1 lab in SAUDI ARABIA
1 lab in SPAIN
4 labs in SWEDEN
2 labs in TAIWAN
2 labs in UNITED ARAB EMIRATES
3 labs in UNITED KINGDOM
2 labs in UNITED STATES OF AMERICA

Sulfur (total) in LPG iis23S04S

2 labs in BELGIUM
1 lab in BULGARIA
1 lab in CHILE
2 labs in CROATIA
1 lab in FINLAND
1 lab in FRANCE
2 labs in GERMANY
1 lab in IRAN, Islamic Republic of
1 lab in ITALY
2 labs in KAZAKHSTAN
1 lab in MALAYSIA
6 labs in NETHERLANDS
1 lab in NIGERIA
1 lab in PANAMA
3 labs in PORTUGAL
1 lab in ROMANIA
2 labs in RUSSIAN FEDERATION
1 lab in SAUDI ARABIA
1 lab in SERBIA
1 lab in SPAIN
1 lab in SUDAN
2 labs in TAIWAN
1 lab in UNITED ARAB EMIRATES
2 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

1 iis Interlaboratory Studies, Protocol for the Organisation, Statistics & Evaluation, June 2018
2 ISO5725:86
3 ISO5725 parts 1-6:94
4 ISO13528:05
5 M. Thompson and R. Wood, J. AOAC Int, 76, 926, (1993)
6 W.J. Youden and E.H. Steiner, Statistical Manual of the AOAC, (1975)
7 P.L. Davies, Fr. Z. Anal. Chem, 331, 513, (1988)
8 J.N. Miller, Analyst, 118, 455, (1993)
9 Analytical Methods Committee, Technical Brief, No 4, January 2001
10 P.J. Lowthian and M. Thompson, The Royal Society of Chemistry, Analyst, 127, 1359-1364, (2002)
11 W. Horwitz and R. Albert, J. AOAC Int, 79.3, 589-621, (1996)
12 Bernard Rosner, Percentage Points for a Generalized ESD Many-Outlier Procedure, Technometrics, 25(2), 165-172, (1983)