Institute for
Interlaboratory Studies

Results of Proficiency Test
Liquefied Butane
June 2022

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 2021/2022 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 56 laboratories in 31 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 costs for the participating laboratories it was decided to prepare one Liquefied Butane Gas mixture. The mixture was divided over a batch of 59 cylinders. The cylinder size is a cost-effective one-liter cylinder with dip tube device. Each cylinder was uniquely numbered. The limited cylinder size is chosen to optimize transport and handling costs.
It was decided to send one cylinder labelled #22095, filled with approximately 200 grams of Liquefied Butane.
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 59 one-liter cylinders with an artificial Liquefied Butane Gas mixture was prepared and tested for homogeneity by EffecTech (Uttoxeter, United Kingdom) in conformance with ISO Guide 35 and ISO/IEC17025 (job 22/0390, starting in April 2022). Each cylinder was uniquely numbered and labelled #22095. 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 (D2163:14R19) in %mol/mol
Propane	0.0073	0.0465
Propene	0.0040	0.0404
iso-Butane	0.0604	0.2848
n-Butane	0.0495	0.0940
1-Butene	0.0123	0.0679
iso-Butene	0.0071	0.0787
trans-2-Butene	0.0114	0.0668
cis-2-Butene	0.0100	0.0978
1,3-Butadiene	0.0042	0.0379
iso-Pentane	0.0049	0.0344

Table 1: evaluation of the repeatabilities of subsamples #22095

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 L cylinder labelled #22095 was sent on May 11, 2022. 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: 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:

$z_{(target)}$ = (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. Nine 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 52 participants reported 694 numerical test results. Observed were 44 outlying test results, which is 6.3%. 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 AND PER PARAMETER

In this section the reported test results are discussed per component and per parameter. 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. D2163:14). When a method has been reapproved an "R" will be added and the year of approval (e.g. D2163:14R19).

Method ASTM D2163:14R19 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. For these components the mentioned reproducibility for n-Butane has been used in this report.

Three laboratories had at least four statistical outliers in the measured gas composition (of the ten test results, not counting n-Pentane which was not present in this sample). As the test results of each component of the composition are not independent, it was decided to exclude the remaining test results from these laboratories from statistical evaluation in the gas composition. Also, the reported test results for the parameters calculated from the gas composition were excluded from statistical evaluation for these laboratories.

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%. Five calculated results were found to be significantly different than 100%. It was decided to exclude the test results of these laboratories for all further statistical evaluations.

Propane: This determination was not problematic. Six statistical outliers were observed and six other test results were excluded. The calculated reproducibility after rejection of the suspect data is in agreement with the requirements of ASTM D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

Propene: This determination was not problematic. Five 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 D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

iso-Butane: This determination was not problematic. One statistical outlier was observed and seven other test results were excluded. The calculated reproducibility after rejection of the suspect data is in full agreement with the reproducibility of ASTM D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

n-Butane: This determination may be problematic depending on the requirements of the test method used. One statistical outlier was observed and seven other test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the reproducibility of ASTM D2163:14R19, but is in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

1-Butene: 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 requirements of ASTM D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

iso-Butene: 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 full agreement with the reproducibility of ASTM D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

trans-2-Butene: This determination was not problematic. One statistical outlier was 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 D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

cis-2-Butene: This determination was not problematic. Two statistical outliers were observed and four other test results were excluded. The calculated reproducibility after rejection of the suspect data is in full agreement with the reproducibility of ASTM D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

1,3-Butadiene: 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 D2163:14R19 and in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

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. Three statistical outliers were observed and six other test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the reproducibility of ASTM D2163:14R19 but is in agreement with the requirements of EN27941:93(liq) (identical to IP405 and ISO7941).

Molar Mass: This calculated parameter may not be problematic. Two statistical outliers were observed and one other test result was excluded. The calculated reproducibility after rejection of the suspect data is smaller than the reproducibility calculated by iis using the published relative molecular masses obtained from one test method (ISO8973:97/ IP432:00) over all reported component concentrations (0.053 *vs* 0.061). See also the discussion in paragraph 5.

Relative Density at 60/60 °F: This calculated parameter may be problematic. Four statistical outliers were observed and two other test results were excluded. The calculated reproducibility after rejection of the suspect data is larger than the reproducibility calculated by iis using the published relative density at 60/60 °F obtained from one test method (ASTM D2598:21) over all reported component concentrations (0.0026 *vs* 0.0005). See also the discussion in paragraph 5.

Abs. Vapor Pres. at 100 °F: This calculated parameter may be problematic depending on the test method used. Two statistical outliers were observed in the ISO8973 test results. The calculated reproducibility after rejection of the statistical outliers is smaller than the reproducibility calculated by iis using the published vapor pressure factors obtained from ISO8973:97 over all reported component concentrations (0.30 *vs* 0.58 psi).

In the ASTM D2598 test results one statistical outlier was observed and five other test results were excluded. The calculated reproducibility is larger than the reproducibility calculated by iis using the published vapor pressure factors obtained from ASTM D2598:21 over all reported component concentrations (0.65 *vs* 0.50 psi). See also the discussion in paragraph 5.

Rel. Vapor Pres. at 100 °F: This calculated parameter may not be problematic. One statistical outlier was observed in the ISO8973/IP432 test results. The calculated reproducibility after rejection of the statistical outlier is in line with the reproducibility calculated by iis using the published vapor pressure factors obtained from ISO8973:97 over all reported component concentrations (0.53 *vs* 0.58 psi).
In the ASTM D2598 test results one statistical outlier was observed and five other test results were excluded. The calculated reproducibility after rejection of the suspect data is smaller than the reproducibility calculated by iis using the published vapor pressure factors obtained from ASTM D2598:21 over all reported component concentrations (0.31 *vs* 0.50 psi). See also the discussion in paragraph 5.

Abs. Vapor Pres. at 40 °C: This calculated parameter may not be problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is smaller than the reproducibility calculated by iis using the published vapor pressure factors obtained from one test method (ISO8973:97) over all reported component concentrations (2.56 *vs* 4.11 kPa). See also the discussion in paragraph 5.

Rel. Vapor Pres. at 40 °C: This calculated parameter may not be problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is smaller than the reproducibility calculated by iis using the published vapor pressure factors obtained from one test method (ISO8973:97/IP432:00) over all reported component concentrations (2.80 *vs* 4.11 kPa). See also the discussion in paragraph 5.

MON: This calculated parameter may be problematic. No statistical outliers were observed in the EN589 test results but one test result was excluded. The calculated reproducibility after rejection of the suspect data is larger than the reproducibility calculated by iis using the published vapor pressure factors obtained from EN589:18 over all reported component concentrations (0.31 *vs* 0.20).
Two statistical outliers were observed in the ASTM D2598 test results and one other test result was excluded. The calculated reproducibility after rejection of the suspect data is larger than the reproducibility calculated by iis using the published vapor pressure factors obtained from D2598:21 over all reported component concentrations (0.49 *vs* 0.12).
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. The use of different factors than mentioned above for the calculation of MON may cause a higher variation in test results.

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 laboratories were only calculated according to ASTM D3588.
This calculated parameter may be problematic. One statistical outlier was observed and one other test result was excluded. The calculated reproducibility after rejection of the suspect data is larger than the reproducibility calculated by iis using the published Ideal Gross Heating Value factors obtained from one test method (ASTM D3588:98R17e01) over all reported component concentrations (9.0 *vs* 3.0 kJ/mol). Only a few laboratories reported test results which may explain the variation in the test results. See also the discussion in paragraph 5.

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 laboratories were only calculated according to ASTM D3588.
This calculated parameter may be problematic. Two statistical outliers were observed and one other test result was excluded. The calculated reproducibility after rejection of the suspect data is larger than the reproducibility calculated by iis using the published Ideal Net Heating Value factors obtained from one test method (e.g. ASTM D3588:98R17e01) over all reported component concentrations (4.3 *vs* 2.7 kJ/mol). Only a few laboratories reported test results which may explain the variation in the test results. See also the discussion in paragraph 5.

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(D2163)	R(EN27941) liq.-inj.
Propane	%mol/mol	39	1.271	0.115	0.206	1.305
Propene	%mol/mol	40	0.902	0.137	0.266	1.368
iso-Butane	%mol/mol	43	72.983	0.936	0.918	1.485
n-Butane	%mol/mol	43	6.337	0.370	0.316	0.990
1-Butene	%mol/mol	42	3.050	0.129	0.227	1.026
iso-Butene	%mol/mol	42	4.165	0.250	0.262	1.026
trans-2-Butene	%mol/mol	42	2.909	0.185	0.222	1.026
cis-2-Butene	%mol/mol	43	6.910	0.337	0.328	1.026
1,3-Butadiene	%mol/mol	41	0.820	0.059	0.126	1.064
n-Pentane	%mol/mol	41	<0.1	n.e.	n.e.	n.e.
iso-Pentane	%mol/mol	42	0.696	0.138	0.048	0.798

Table 2: reproducibilities of the composition of sample #22095

Without further statistical calculations it can be concluded that for many 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.

Parameter	unit	n	average	2.8 * sd	R(all calc)*
Molar Mass	g/mol	20	57.51	0.05	0.06
Rel. Density 60/60 °F		23	0.5720	0.0026	0.0005
Abs. VP 100 °F ISO/IP	psi	9	70.96	0.30	0.58
Abs. VP 100 °F D2598	psi	5	70.42	0.65	0.50
Rel. VP 100 °F ISO/IP	psi	11	56.20	0.53	0.58
Rel. VP 100 °F D2598	psi	5	55.81	0.31	0.50

Parameter	unit	n	average	2.8 * sd	R(all calc)*
Abs. VP 40 °C	kPa	20	515.0	2.6	4.1
Rel. VP 40 °C	kPa	21	413.5	2.8	4.1
MON EN589		10	92.69	0.31	0.20
MON D2598		6	88.49	0.49	0.12
IGHV D3588	kJ/mol	5	2834	9	3
INHV D3588	kJ/mol	4	2619	4	3

Table 3: reproducibilities of calculated physical properties of sample #22095

*) calculated by iis using all reported component concentrations

Without further statistical calculations it can be concluded that for a number of tests there is a good compliance of the group of participating laboratories with the reproducibilities calculated over all reported test results of this PT.

4.3 COMPARISON OF THE PROFICIENCY TEST OF JUNE 2022 WITH PREVIOUS PTS

	June 2022	June 2021	July 2020	June 2019	June 2018
Number of reporting laboratories	52	40	47	41	51
Number of test results	694	549	665	549	660
Number of statistical outliers	44	28	41	53	45
Percentage of statistical outliers	6.3%	5.1%	6.2%	9.7%	6.8%

Table 4: 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 2022	June 2021	July 2020	June 2019	June 2018
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 5: 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.

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. See the differences between the values from the test results as reported by the participating laboratories (each using its own calculation procedure) and the values as calculated by iis using one calculation procedure for each set of laboratory test results (see table 3). 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 test method or an average value (see paragraph 4.1 and appendix 1).

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.
For the 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.
The calculation of Gross and Net Heating Values is described in ASTM D3588 and ISO6976 (on a molar basis).
Also, the selection of the tables for the component factors to be used for the calculations may cause additional uncertainty.
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.

Component	Average values by EffecTech in %mol/mol	Consensus values from participants test results in %mol/mol	differences in %mol/mol	z-score
Propane	1.306	1.271	0.035	0.47
Propene	0.953	0.902	0.051	0.53
iso-Butane	73.09	72.98	0.113	0.34
n-Butane	6.225	6.337	-0.112	-0.99
1-Butene	3.018	3.050	-0.032	-0.40

Component	Average values by EffecTech in %mol/mol	Consensus values from participants test results in %mol/mol	differences in %mol/mol	z-score
iso-Butene	4.196	4.165	0.031	0.33
trans-2-Butene	2.914	2.909	0.005	0.06
cis-2-Butene	6.803	6.910	-0.107	-0.92
1,3-Butadiene	0.827	0.820	0.007	0.17
iso-Pentane	0.667	0.696	-0.029	-1.69

Table 6: comparison of consensus values with values determined by EffecTech (Uttoxeter, United Kingdom)

APPENDIX 1

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

lab	method	value	mark	iis calc.	remarks
150		-----		-----	
171	D2163	100.0		100.00	
315	D2163	100.00		100.00	
317	D2163	100.0		100.00	
323	D2163	100		99.96	
328	D2163	100.00		99.98	
333	D2163	100.00		100.00	
334	D2163	100.00		100.00	
352	EN27941	100.0		100.10	
357	D2163	100.000	C	100.00	first reported 99.996
404	EN27941	100.00		100.00	
444	ISO7941	100.00		**99.83**	not 100% and excluded from evaluations
445	D2163	100.0		100.00	
508	D2163	100.00000		100.00	
736	GOST10676	100.000		100.00	
754	D2163	100		100.00	
851	D2163	100.00		100.00	
869		-----		-----	
875	D2163	100		100.08	
922	D2163	100		100.00	
1006		-----		100.00	
1011		-----		99.99	
1026	ISO7941	100		100.00	
1039		-----		**99.89**	not 100% and excluded from evaluations
1040	DIN51619	100.00		100.00	
1041	DIN51619	100		100.00	
1062	D2163	100.0000		99.99	
1065		-----		-----	
1069	D4423	100.000		100.00	
1108	D2163	100.00		100.01	
1135		-----		100.00	
1140	ISO7941	100.00		100.00	
1191		-----		**97.09**	did not report trans-2- Butene
1197	D2163	100.00		100.00	
1198	D2163	100.0000		100.00	
1340	EN27941	100.00		100.00	
1357		-----		-----	
1474	D2163	100.00		100.00	
1556		-----		100.00	
1603		-----		**99.74**	not 100% and excluded from evaluations
1634	ISO7941	100		100.01	
1650		-----		100.02	
1677		-----		100.00	
1709		-----		100.00	
1720		-----		-----	
1741		-----		100.00	
1776		-----		100.01	
1786	D2163	100.0000		100.00	
6193	EN15984	100.01		100.06	
6262	D2163	100		100.00	
6315	DIN51619	100.0		100.00	
6321	D2163	99.966		99.97	
6411		-----		**86.26**	not 100% and excluded from evaluations
6433		-----		**80.32**	not 100% and excluded from evaluations
6463	D2163	100.000000		100.00	
6474	D2163	99.999		100.00	

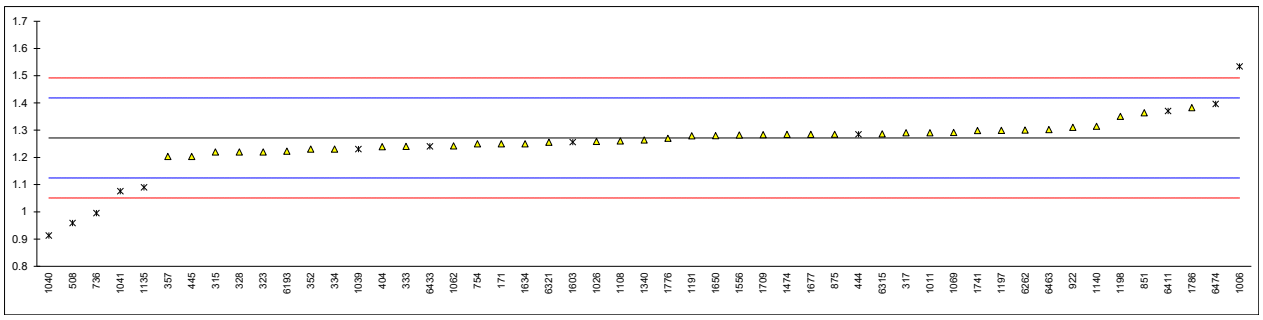
Determination of Propane on sample #22095; results in %mol/mol

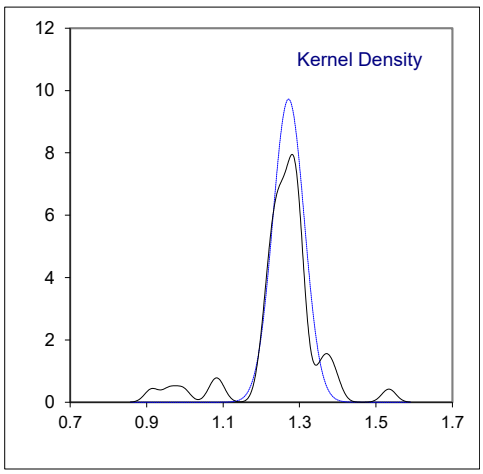
lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	1.25		-0.29	
315	D2163	1.22		-0.70	
317	D2163	1.29		0.25	
323	D2163	1.22		-0.70	
328	D2163	1.22		-0.70	
333	D2163	1.24		-0.43	
334	D2163	1.23		-0.56	
352	EN27941	1.23		-0.56	
357	D2163	1.203	C	-0.93	first reported 0.926
404	EN27941	1.239		-0.44	
444	ISO7941	1.2846	ex,C	0.18	test result excluded, see §4.1 / first reported 1.60
445	D2163	1.203		-0.93	
508	D2163	0.95898	R(0.01)	-4.25	
736	GOST10676	0.995	R(0.01)	-3.76	
754	D2163	1.25		-0.29	
851	D2163	1.363596		1.25	
869		-----		-----	
875	D2163	1.2845		0.18	
922	D2163	1.31	C	0.53	first reported 1.41
1006	D2163	1.534	C,R(0.01)	3.57	first reported 1.652
1011		1.29		0.25	
1026	ISO7941	1.25840		-0.18	
1039	EN27941	1.23	ex	-0.56	test result excluded, see §4.1
1040	DIN51619	0.913	R(0.01)	-4.87	
1041	DIN51619	1.076	C,R(0.05)	-2.65	first reported 1.075
1062	D2163	1.2421		-0.40	
1065		-----		-----	
1069	D4423	1.291		0.27	
1108	D2163	1.26		-0.15	
1135	D2163	1.09	C,R(0.01)	-2.46	first reported 2.35
1140	ISO7941	1.314		0.58	
1191	IP473	1.279192		0.11	
1197	D2163	1.2988		0.37	
1198	D2163	1.3507		1.08	
1340	EN27941	1.264		-0.10	
1357		-----		-----	
1474	D2163	1.284		0.17	
1556	EN27941	1.282		0.15	
1603	In house	1.2558	ex	-0.21	test result excluded, see §4.1
1634	ISO7941	1.25		-0.29	
1650	D2163	1.28		0.12	
1677	D2163	1.284		0.17	
1709	D2163	1.283		0.16	
1720		-----		-----	
1741	EN27941	1.298		0.36	
1776	EN27941	1.27		-0.02	
1786	D2163	1.38283		1.52	
6193	EN15984	1.2225		-0.66	
6262	D2163	1.3002		0.39	
6315	DIN51619	1.2865		0.21	
6321	D2163	1.255		-0.22	
6411	D2163	1.37	ex	1.34	test result excluded, see §4.1
6433	D2163	1.24	ex	-0.43	test result excluded, see §4.1
6463	D2163	1.302274		0.42	
6474	D2163	1.396	ex	1.69	test result excluded, see §4.1

normality	OK
n	39
outliers	6 +6ex
mean (n)	1.2713
st.dev. (n)	0.04101
R(calc.)	0.1148
st.dev.(D2163:14R19)	0.07358
R(D2163:14R19)	0.2060

Compare:

EN27941:93(liq)	1.3050

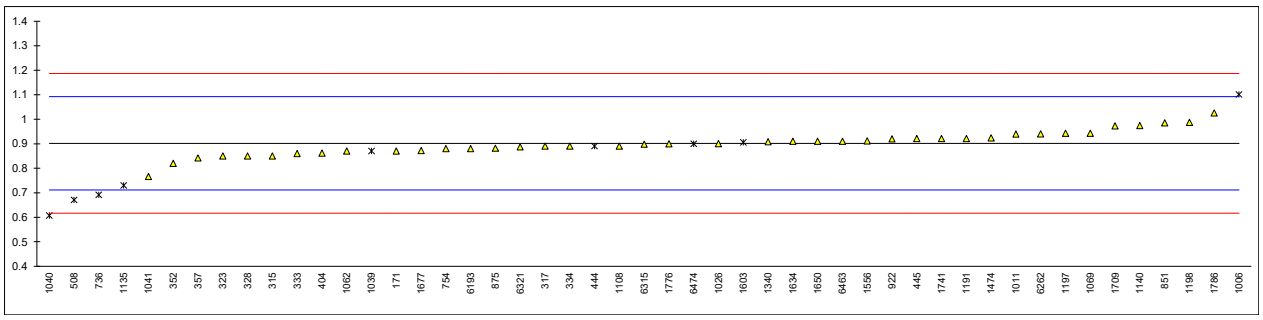

1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
1040 508 736 1041 1135 357 445 315 328 323 6193 352 334 1039 404 333 6433 1062 754 171 1634 6321 1603 1026 1108 1340 1776 1191 1650 1556 1709 1474 1677 875 444 6315 317 1011 1069 1741 1197 6262 6463 922 1140 1198 851 6411 1786 6474 1006

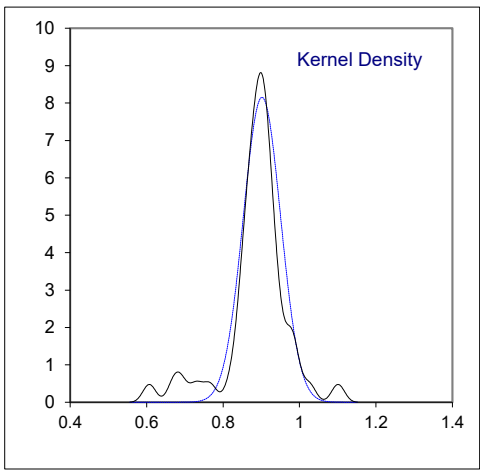

Kernel Density
12
10
8
6
4
2
0
0.7
0.9
1.1
1.3
1.5
1.7

Determination of Propene on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.87		-0.34	
315	D2163	0.85		-0.55	
317	D2163	0.89		-0.13	
323	D2163	0.85		-0.55	
328	D2163	0.85		-0.55	
333	D2163	0.86		-0.44	
334	D2163	0.89		-0.13	
352	EN27941	0.82		-0.86	
357	D2163	0.842	C	-0.63	first reported 0.648
404	EN27941	0.862		-0.42	
444	ISO7941	0.89	ex	-0.13	test result excluded, see §4.1
445	D2163	0.921		0.20	
508	D2163	0.67089	R(0.05)	-2.43	
736	GOST10676	0.691	R(0.05)	-2.22	
754	D2163	0.88		-0.23	
851	D2163	0.985189		0.88	
869		-----		-----	
875	D2163	0.8814		-0.22	
922	D2163	0.92		0.19	
1006	D2163	1.101	C,R(0.05)	2.09	first reported 1.276
1011		0.94		0.40	
1026	ISO7941	0.90013		-0.02	
1039	EN27941	0.87	ex	-0.34	test result excluded, see §4.1
1040	DIN51619	0.607	R(0.05)	-3.10	
1041	DIN51619	0.766	C	-1.43	first reported 0.765
1062	D2163	0.8699		-0.34	
1065		-----		-----	
1069	D4423	0.943		0.43	
1108	D2163	0.89		-0.13	
1135	D2163	0.73	C,R(0.05)	-1.81	first reported 1.87
1140	ISO7941	0.974		0.76	
1191	IP473	0.921159		0.20	
1197	D2163	0.9425		0.43	
1198	D2163	0.9867		0.89	
1340	EN27941	0.908		0.06	
1357		-----		-----	
1474	D2163	0.924		0.23	
1556	EN27941	0.911		0.10	
1603	In house	0.9050	ex	0.03	test result excluded, see §4.1
1634	ISO7941	0.91		0.09	
1650	D2163	0.91		0.09	
1677	D2163	0.872		-0.31	
1709	D2163	0.973		0.75	
1720		-----		-----	
1741	EN27941	0.921		0.20	
1776	EN27941	0.90		-0.02	
1786	D2163	1.025748		1.30	
6193	EN15984	0.88		-0.23	
6262	D2163	0.9406		0.41	
6315	DIN51619	0.898		-0.04	
6321	D2163	0.887		-0.16	
6411		-----		-----	
6433	D2163	Not Detected		-----	
6463	D2163	0.910113		0.09	
6474	D2163	0.90	ex	-0.02	test result excluded, see §4.1

	normality	suspect
	n	40
	outliers	5 +4ex
	mean (n)	0.9019
	st.dev. (n)	0.04894
	R(calc.)	0.1370
	st.dev.(D2163:14R19)	0.09508
	R(D2163:14R19)	0.2662
Compare:		
	EN27941:93(liq)	1.3675

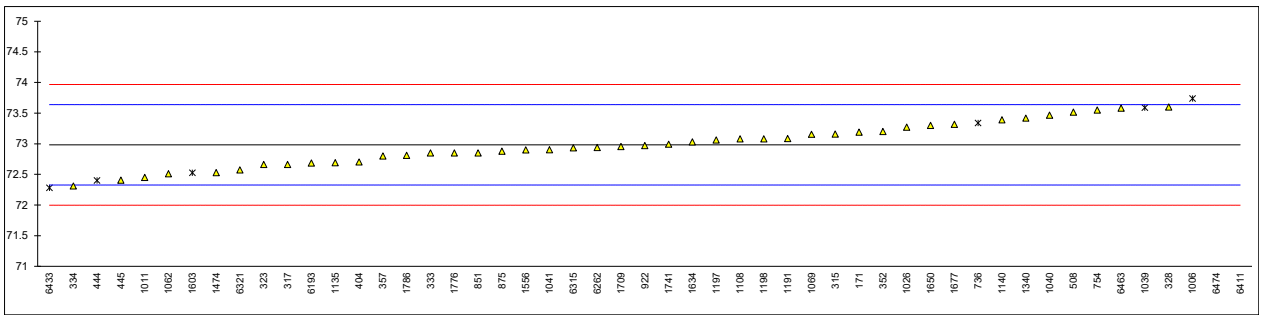

1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
1040 508 736 1135 1041 352 357 323 328 315 333 404 1062 1039 171 1677 754 6193 875 6321 317 334 444 1108 6315 1776 6474 1026 1603 1340 1634 1650 6463 1556 922 445 1741 1191 1474 1011 6262 1197 1069 1709 1140 851 1198 1786 1006

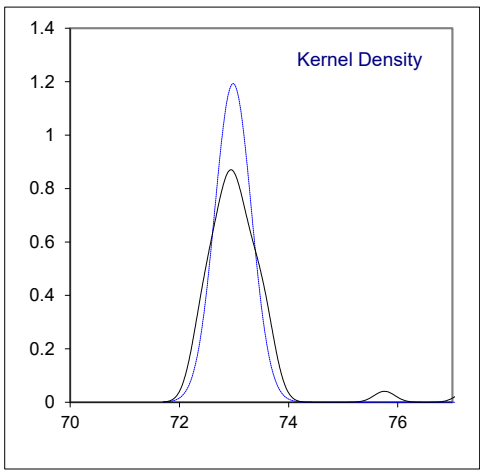

Kernel Density
10
9
8
7
6
5
4
3
2
1
0
0.4
0.6
0.8
1
1.2
1.4

Determination of iso-Butane on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	73.19		0.63	
315	D2163	73.16		0.54	
317	D2163	72.66		-0.98	
323	D2163	72.66		-0.98	
328	D2163	73.60		1.88	
333	D2163	72.85		-0.40	
334	D2163	72.31		-2.05	
352	EN27941	73.20		0.66	
357	D2163	72.800	C	-0.56	first reported 73.085
404	EN27941	72.702		-0.86	
444	ISO7941	72.40	ex	-1.78	test result excluded, see §4.1
445	D2163	72.404		-1.77	
508	D2163	73.51748		1.63	
736	GOST10676	73.337	ex	1.08	test result excluded, see §4.1
754	D2163	73.55		1.73	
851	D2163	72.850423		-0.40	
869		-----		-----	
875	D2163	72.8792		-0.32	
922	D2163	72.97	C	-0.04	first reported 72.78
1006	D2163	73.737	ex,C	2.30	test result excluded, see §4.1 / first reported 73.799
1011		72.45		-1.62	
1026	ISO7941	73.27017		0.88	
1039	EN27941	73.59	ex	1.85	test result excluded, see §4.1
1040	DIN51619	73.466		1.47	
1041	DIN51619	72.902	C	-0.25	first reported 72.833
1062	D2163	72.5114		-1.44	
1065		-----		-----	
1069	D4423	73.153		0.52	
1108	D2163	73.08		0.30	
1135	D2163	72.69	C	-0.89	first reported 74.96
1140	ISO7941	73.390		1.24	
1191	IP473	73.083696		0.31	
1197	D2163	73.0623		0.24	
1198	D2163	73.0801		0.30	
1340	EN27941	73.417		1.33	
1357		-----		-----	
1474	D2163	72.527		-1.39	
1556	EN27941	72.90		-0.25	
1603	In house	72.5254	ex	-1.39	test result excluded, see §4.1
1634	ISO7941	73.03		0.14	
1650	D2163	73.30		0.97	
1677	D2163	73.317		1.02	
1709	D2163	72.953		-0.09	
1720		-----		-----	
1741	EN27941	72.991		0.03	
1776	EN27941	72.85		-0.40	
1786	D2163	72.809839		-0.53	
6193	EN15984	72.686		-0.90	
6262	D2163	72.9377		-0.14	
6315	DIN51619	72.9335		-0.15	
6321	D2163	72.574		-1.25	
6411	D2163	77.27	ex	13.08	test result excluded, see §4.1
6433	D2163	72.28	ex	-2.14	test result excluded, see §4.1
6463	D2163	73.583046		1.83	
6474	D2163	75.757	R(0.01)	8.46	

	normality	OK
	n	43
	outliers	1 +7ex
	mean (n)	72.9826
	st.dev. (n)	0.33435
	R(calc.)	0.9362
	st.dev.(D2163:14R19)	0.32780
	R(D2163:14R19)	0.9178
Compare:		
	EN27941:93(liq)	1.4851

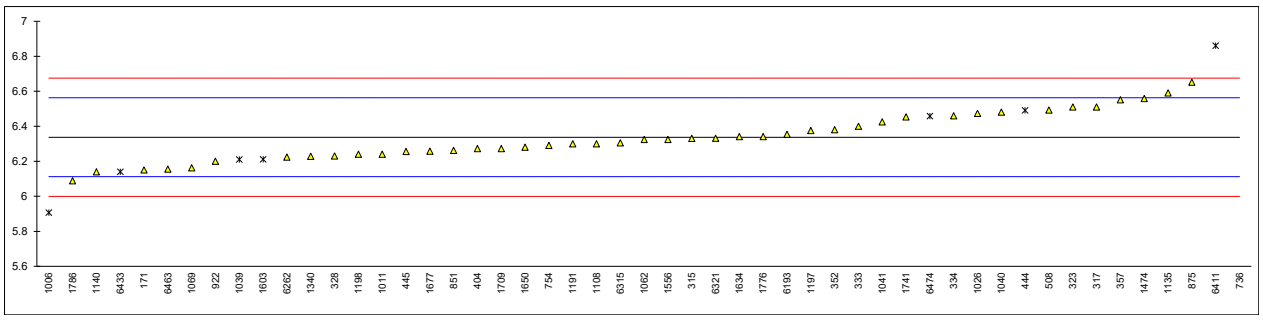

75
74.5
74
73.5
73
72.5
72
71.5
71
6433 334 444 445 1011 1062 1603 1474 6321 323 317 6193 1135 404 357 1786 333 1776 851 875 1556 1041 6315 6262 1709 922 1741 1634 1197 1108 1198 1191 1069 315 171 352 1026 1650 1677 736 1140 1340 1040 508 754 6463 1039 328 1006 6474 6411

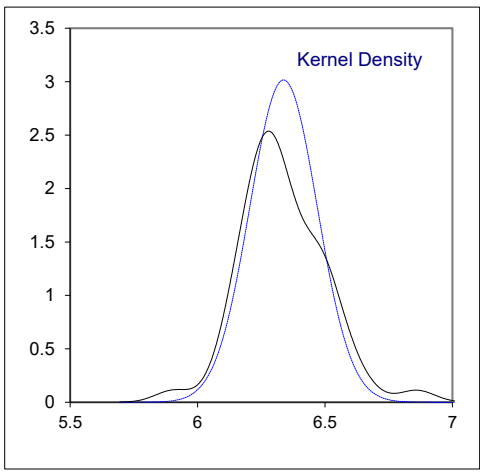

Kernel Density
1.4
1.2
1
0.8
0.6
0.4
0.2
0
70
72
74
76

Determination of n-Butane on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	6.15		-1.66	
315	D2163	6.33		-0.06	
317	D2163	6.51		1.53	
323	D2163	6.51		1.53	
328	D2163	6.23		-0.95	
333	D2163	6.40		0.56	
334	D2163	6.46		1.09	
352	EN27941	6.38		0.38	
357	D2163	6.551		1.89	
404	EN27941	6.272		-0.58	
444	ISO7941	6.49	ex	1.35	test result excluded, see §4.1
445	D2163	6.256		-0.72	
508	D2163	6.49274		1.38	
736	GOST10676	7.731	R(0.01)	12.36	
754	D2163	6.29		-0.42	
851	D2163	6.261302		-0.67	
869		-----		-----	
875	D2163	6.6517		2.79	
922	D2163	6.20	C	-1.22	first reported 6.28
1006	D2163	5.906	ex,C	-3.82	test result excluded, see §4.1 / first reported 5.747
1011		6.24		-0.86	
1026	ISO7941	6.47363		1.21	
1039	EN27941	6.21	ex	-1.13	test result excluded, see §4.1
1040	DIN51619	6.481		1.27	
1041	DIN51619	6.425	C	0.78	first reported 6.419
1062	D2163	6.3239		-0.12	
1065		-----		-----	
1069	D4423	6.163		-1.55	
1108	D2163	6.30		-0.33	
1135	D2163	6.59	C	2.24	first reported 5.20
1140	ISO7941	6.140		-1.75	
1191	IP473	6.299331		-0.34	
1197	D2163	6.3748		0.33	
1198	D2163	6.2398		-0.86	
1340	EN27941	6.228		-0.97	
1357		-----		-----	
1474	D2163	6.558		1.96	
1556	EN27941	6.324		-0.12	
1603	In house	6.2106	ex	-1.12	test result excluded, see §4.1
1634	ISO7941	6.34		0.02	
1650	D2163	6.28		-0.51	
1677	D2163	6.257		-0.71	
1709	D2163	6.272		-0.58	
1720		-----		-----	
1741	EN27941	6.453		1.03	
1776	EN27941	6.34		0.02	
1786	D2163	6.087879		-2.21	
6193	EN15984	6.354		0.15	
6262	D2163	6.2232		-1.01	
6315	DIN51619	6.305		-0.29	
6321	D2163	6.331		-0.06	
6411	D2163	6.86	ex	4.63	test result excluded, see §4.1
6433	D2163	6.14	ex	-1.75	test result excluded, see §4.1
6463	D2163	6.155360		-1.61	
6474	D2163	6.458	ex	1.07	test result excluded, see §4.1

	normality	OK
	n	43
	outliers	1 +7ex
	mean (n)	6.3373
	st.dev. (n)	0.13228
	R(calc.)	0.3704
	st.dev.(D2163:14R19)	0.11280
	R(D2163:14R19)	0.3158
Compare:		
	EN27941:93(liq)	0.9901

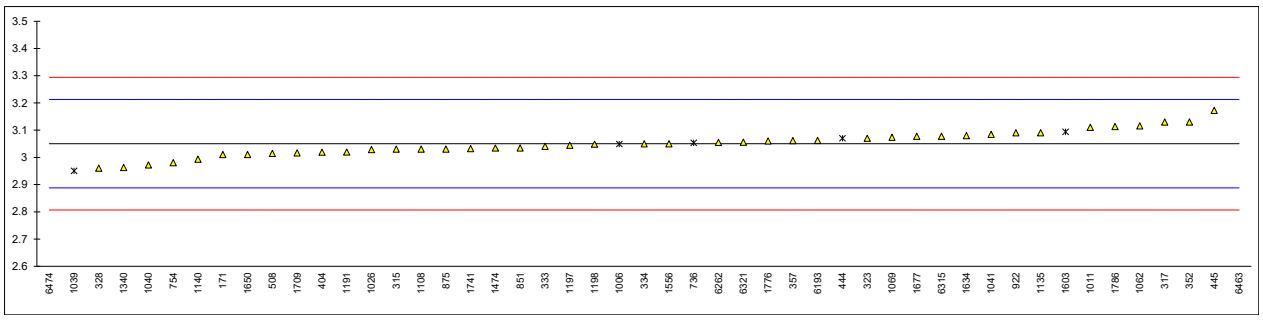

7
6.8
6.6
6.4
6.2
6
5.8
5.6
1006 1786 1140 6433 171 6463 1069 922 1039 1603 6262 1340 328 1198 1011 445 1677 851 404 1709 1650 754 1191 1108 6315 1062 1556 315 6321 1634 1776 6193 1197 352 333 1041 1741 6474 334 1026 1040 444 508 323 317 357 1474 1135 875 6411 736

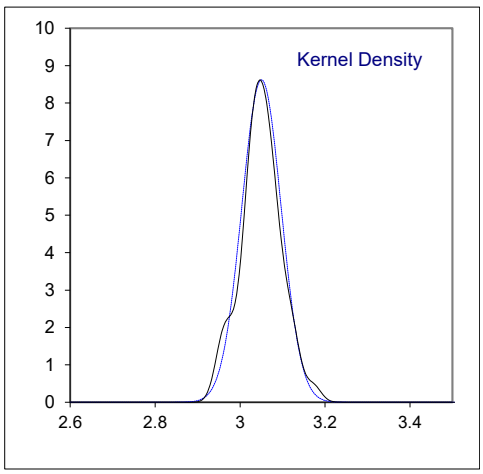

Kernel Density
3.5
3
2.5
2
1.5
1
0.5
0
5.5
6
6.5
7

Determination of 1-Butene on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	3.01		-0.50	
315	D2163	3.03		-0.25	
317	D2163	3.13		0.98	
323	D2163	3.07		0.24	
328	D2163	2.96		-1.11	
333	D2163	3.04		-0.13	
334	D2163	3.05		0.00	
352	EN27941	3.13		0.98	
357	D2163	3.061		0.13	
404	EN27941	3.019		-0.39	
444	ISO7941	3.07	ex	0.24	test result excluded, see §4.1
445	D2163	3.172		1.50	
508	D2163	3.01445		-0.44	
736	GOST10676	3.053	ex	0.03	test result excluded, see §4.1
754	D2163	2.98		-0.87	
851	D2163	3.034672		-0.19	
869		-----		-----	
875	D2163	3.0305		-0.24	
922	D2163	3.09		0.49	
1006	D2163	3.049	ex,C	-0.02	test result excluded, see §4.1 / first reported 3.012
1011		3.11		0.73	
1026	ISO7941	3.02874		-0.27	
1039	EN27941	2.95	ex	-1.24	test result excluded, see §4.1
1040	DIN51619	2.972		-0.97	
1041	DIN51619	3.084	C	0.41	first reported 3.081
1062	D2163	3.1159		0.81	
1065		-----		-----	
1069	D4423	3.074		0.29	
1108	D2163	3.03		-0.25	
1135	D2163	3.09	C	0.49	first reported 2.88
1140	ISO7941	2.993		-0.71	
1191	IP473	3.019420		-0.38	
1197	D2163	3.0445		-0.07	
1198	D2163	3.0482		-0.03	
1340	EN27941	2.963		-1.08	
1357		-----		-----	
1474	D2163	3.034		-0.20	
1556	EN27941	3.050		0.00	
1603	In house	3.0938	ex	0.54	test result excluded, see §4.1
1634	ISO7941	3.08		0.37	
1650	D2163	3.01		-0.50	
1677	D2163	3.077		0.33	
1709	D2163	3.016		-0.42	
1720		-----		-----	
1741	EN27941	3.032		-0.23	
1776	EN27941	3.06		0.12	
1786	D2163	3.112811		0.77	
6193	EN15984	3.062		0.14	
6262	D2163	3.0545		0.05	
6315	DIN51619	3.077		0.33	
6321	D2163	3.055		0.06	
6411		-----		-----	
6433	D2163	Not Detected		-----	
6463	D2163	4.144079	R(0.01)	13.47	
6474	D2163	2.309	R(0.01)	-9.13	

	normality	OK
	n	42
	outliers	2 +5ex
	mean (n)	3.0503
	st.dev. (n)	0.04624
	R(calc.)	0.1295
	st.dev.(D2163:14R19)	0.08117
	R(D2163:14R19)	0.2273
Compare:		
	EN27941:93(liq)	1.0257

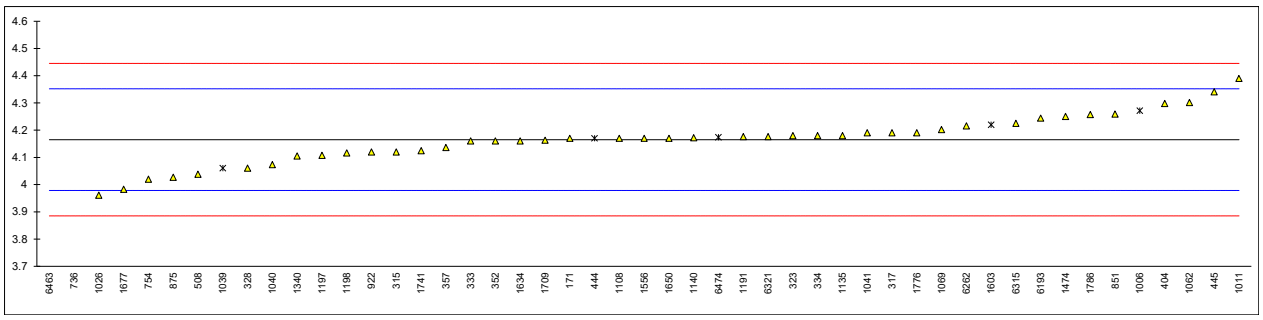

3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
6474 1039 328 1340 1040 754 1140 171 1650 508 1709 404 1191 1026 315 1108 875 1741 1474 851 333 1197 1198 1006 334 1556 736 6262 6321 1776 357 6193 444 323 1069 1677 6315 1634 1041 922 1135 1603 1011 1786 1062 317 352 445 6463

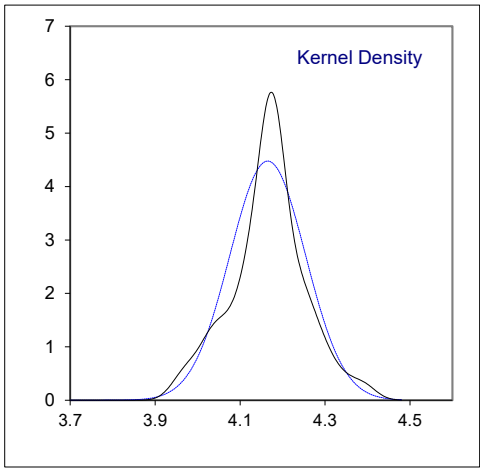

Kernel Density
10
9
8
7
6
5
4
3
2
1
0
2.6
2.8
3
3.2
3.4

Determination of iso-Butene on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	4.17		0.05	
315	D2163	4.12		-0.48	
317	D2163	4.19		0.27	
323	D2163	4.18		0.16	
328	D2163	4.06		-1.12	
333	D2163	4.16		-0.05	
334	D2163	4.18		0.16	
352	EN27941	4.16		-0.05	
357	D2163	4.136		-0.31	
404	EN27941	4.298		1.42	
444	ISO7941	4.17	ex	0.05	test result excluded, see §4.1
445	D2163	4.341		1.88	
508	D2163	4.03781		-1.36	
736	GOST10676	3.176	R(0.01)	-10.59	
754	D2163	4.02		-1.55	
851	D2163	4.259030		1.01	
869		-----		-----	
875	D2163	4.0268		-1.48	
922	D2163	4.12	C	-0.48	first reported 4.11
1006	D2163	4.271	ex,C	1.14	test result excluded, see §4.1 / first reported 4.181
1011		4.39		2.41	
1026	ISO7941	3.96081		-2.19	
1039	EN27941	4.06	ex	-1.12	test result excluded, see §4.1
1040	DIN51619	4.073		-0.98	
1041	DIN51619	4.190	C	0.27	first reported 4.186
1062	D2163	4.3010		1.46	
1065		-----		-----	
1069	D4423	4.202		0.40	
1108	D2163	4.17		0.05	
1135	D2163	4.18	C	0.16	first reported 3.97
1140	ISO7941	4.172		0.08	
1191	IP473	4.175777		0.12	
1197	D2163	4.1073		-0.62	
1198	D2163	4.1159		-0.53	
1340	EN27941	4.105		-0.64	
1357		-----		-----	
1474	D2163	4.250		0.91	
1556	EN27941	4.170		0.05	
1603	In house	4.2197	ex	0.59	test result excluded, see §4.1
1634	ISO7941	4.16		-0.05	
1650	D2163	4.17		0.05	
1677	D2163	3.983		-1.95	
1709	D2163	4.163		-0.02	
1720		-----		-----	
1741	EN27941	4.124		-0.44	
1776	EN27941	4.19		0.27	
1786	D2163	4.256838		0.98	
6193	EN15984	4.244		0.85	
6262	D2163	4.2159		0.55	
6315	DIN51619	4.225		0.64	
6321	D2163	4.176		0.12	
6411		-----		-----	
6433	D2163	Not Detected		-----	
6463	D2163	2.924330	R(0.01)	-13.29	
6474	D2163	4.174	ex	0.10	test result excluded, see §4.1

	normality	OK
	n	42
	outliers	2 +5ex
	mean (n)	4.1650
	st.dev. (n)	0.08912
	R(calc.)	0.2495
	st.dev.(D2163:14R19)	0.09339
	R(D2163:14R19)	0.2615
Compare:		
	EN27941:93(liq)	1.0257

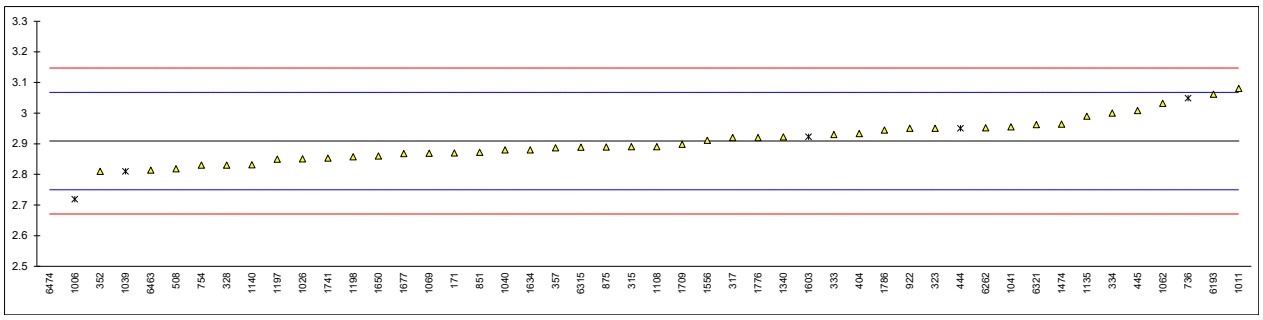

4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
6463 736 1026 1677 754 875 508 1039 328 1040 1340 1197 1198 922 315 1741 357 333 352 1634 1709 171 444 1108 1556 1650 1140 6474 1191 6321 323 334 1135 1041 317 1776 1069 6262 1603 6315 6193 1474 1786 851 1006 404 1062 445 1011

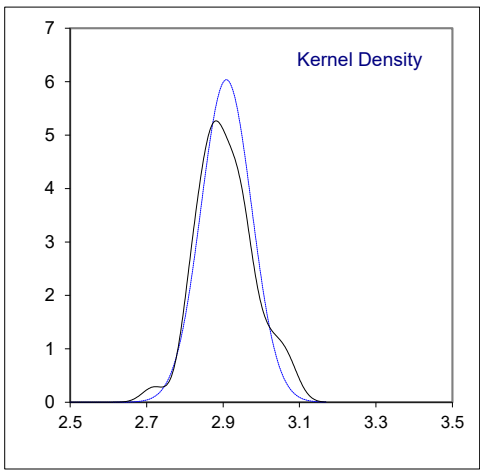

Kernel Density
7
6
5
4
3
2
1
0
3.7
3.9
4.1
4.3
4.5

Determination of trans-2-Butene on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	2.87		-0.49	
315	D2163	2.89		-0.24	
317	D2163	2.92		0.14	
323	D2163	2.95		0.52	
328	D2163	2.83		-0.99	
333	D2163	2.93		0.27	
334	D2163	3.00		1.15	
352	EN27941	2.81		-1.24	
357	D2163	2.887		-0.27	
404	EN27941	2.933		0.30	
444	ISO7941	2.95	ex	0.52	test result excluded, see §4.1
445	D2163	3.008		1.25	
508	D2163	2.81834		-1.14	
736	GOST10676	3.049	ex	1.76	test result excluded, see §4.1
754	D2163	2.83		-0.99	
851	D2163	2.871986		-0.46	
869		-----		-----	
875	D2163	2.8893		-0.25	
922	D2163	2.95	C	0.52	first reported 2.96
1006	D2163	2.719	ex,C	-2.39	test result excluded, see §4.1 / first reported 2.716
1011		3.08		2.15	
1026	ISO7941	2.85047		-0.73	
1039	EN27941	2.81	ex	-1.24	test result excluded, see §4.1
1040	DIN51619	2.880		-0.36	
1041	DIN51619	2.955	C	0.58	first reported 2.953
1062	D2163	3.0320		1.55	
1065		-----		-----	
1069	D4423	2.869		-0.50	
1108	D2163	2.89		-0.24	
1135	D2163	2.99	C	1.02	first reported 2.36
1140	ISO7941	2.831		-0.98	
1191		-----		-----	
1197	D2163	2.8496		-0.75	
1198	D2163	2.8573		-0.65	
1340	EN27941	2.922		0.17	
1357		-----		-----	
1474	D2163	2.964		0.69	
1556	EN27941	2.911		0.03	
1603	In house	2.9225	ex	0.17	test result excluded, see §4.1
1634	ISO7941	2.88		-0.36	
1650	D2163	2.86		-0.61	
1677	D2163	2.868		-0.51	
1709	D2163	2.898		-0.14	
1720		-----		-----	
1741	EN27941	2.853		-0.70	
1776	EN27941	2.92		0.14	
1786	D2163	2.944753		0.45	
6193	EN15984	3.062		1.93	
6262	D2163	2.9521		0.54	
6315	DIN51619	2.8885		-0.26	
6321	D2163	2.962		0.67	
6411		-----		-----	
6433	D2163	Not Detected		-----	
6463	D2163	2.813814		-1.20	
6474	D2163	2.227	R(0.01)	-8.58	

	normality	OK
	n	42
	outliers	1 +5ex
	mean (n)	2.9088
	st.dev. (n)	0.06609
	R(calc.)	0.1851
	st.dev.(D2163:14R19)	0.07946
	R(D2163:14R19)	0.2225
Compare:		
	EN27941:93(liq)	1.0257

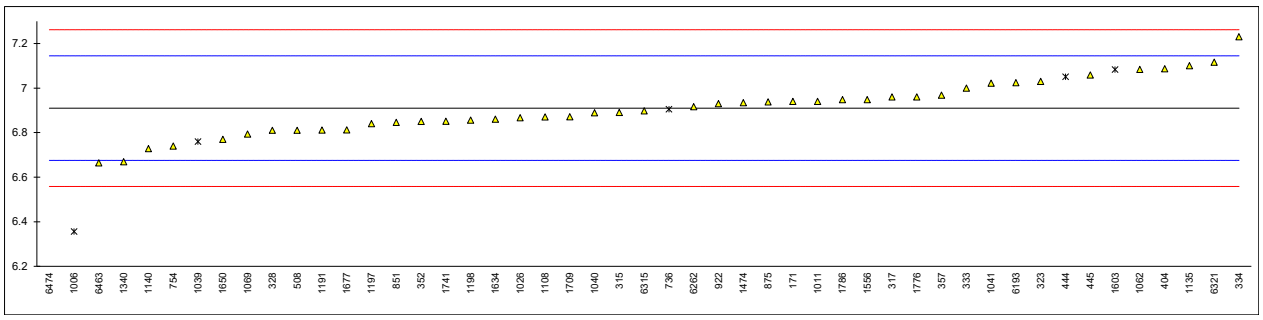

3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
6474 1006 352 1039 6463 508 754 328 1140 1197 1026 1741 1198 1650 1677 1069 171 851 1040 1634 357 6315 875 315 1108 1709 1556 317 1776 1340 1603 333 404 1786 922 323 444 6262 1041 6321 1474 1135 334 445 1062 736 6193 1011


Kernel Density
7
6
5
4
3
2
1
0
2.5
2.7
2.9
3.1
3.3
3.5

Determination of cis-2-Butene on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	6.94		0.26	
315	D2163	6.89		-0.17	
317	D2163	6.96		0.43	
323	D2163	7.03		1.02	
328	D2163	6.81		-0.85	
333	D2163	7.00		0.77	
334	D2163	7.23		2.73	
352	EN27941	6.85		-0.51	
357	D2163	6.968		0.49	
404	EN27941	7.086		1.50	
444	ISO7941	7.05	ex	1.19	test result excluded, see §4.1
445	D2163	7.058		1.26	
508	D2163	6.81026		-0.85	
736	GOST10676	6.905	ex	-0.04	test result excluded, see §4.1
754	D2163	6.74		-1.45	
851	D2163	6.845362		-0.55	
869		-----		-----	
875	D2163	6.9378		0.24	
922	D2163	6.93		0.17	
1006	D2163	6.356	C,R(0.01)	-4.72	first reported 6.271
1011		6.94		0.26	
1026	ISO7941	6.86678		-0.37	
1039	EN27941	6.76	ex	-1.28	test result excluded, see §4.1
1040	DIN51619	6.889		-0.18	
1041	DIN51619	7.022	C	0.96	first reported 7.016
1062	D2163	7.0837		1.48	
1065		-----		-----	
1069	D4423	6.794		-0.99	
1108	D2163	6.87		-0.34	
1135	D2163	7.10	C	1.62	first reported 5.28
1140	ISO7941	6.728		-1.55	
1191	IP473	6.811548		-0.84	
1197	D2163	6.8402		-0.59	
1198	D2163	6.8564		-0.46	
1340	EN27941	6.669		-2.05	
1357		-----		-----	
1474	D2163	6.934		0.21	
1556	EN27941	6.948		0.32	
1603	In house	7.0828	ex	1.47	test result excluded, see §4.1
1634	ISO7941	6.86		-0.43	
1650	D2163	6.77		-1.19	
1677	D2163	6.812		-0.84	
1709	D2163	6.871		-0.33	
1720		-----		-----	
1741	EN27941	6.851		-0.50	
1776	EN27941	6.96		0.43	
1786	D2163	6.947778		0.32	
6193	EN15984	7.024		0.97	
6262	D2163	6.9163		0.05	
6315	DIN51619	6.8975		-0.11	
6321	D2163	7.116		1.76	
6411		-----		-----	
6433	D2163	Not Detected		-----	
6463	D2163	6.664142		-2.10	
6474	D2163	5.248	R(0.01)	-14.17	

	normality	OK
	n	43
	outliers	2 +4ex
	mean (n)	6.9099
	st.dev. (n)	0.12024
	R(calc.)	0.3367
	st.dev.(D2163:14R19)	0.11728
	R(D2163:14R19)	0.3284
Compare:		
	EN27941:93(liq)	1.0257


7.2
7
6.8
6.6
6.4
6.2
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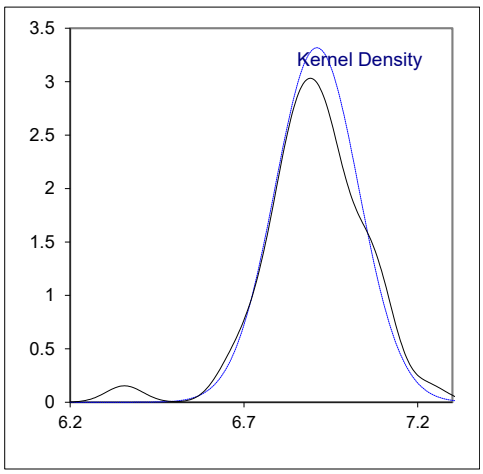
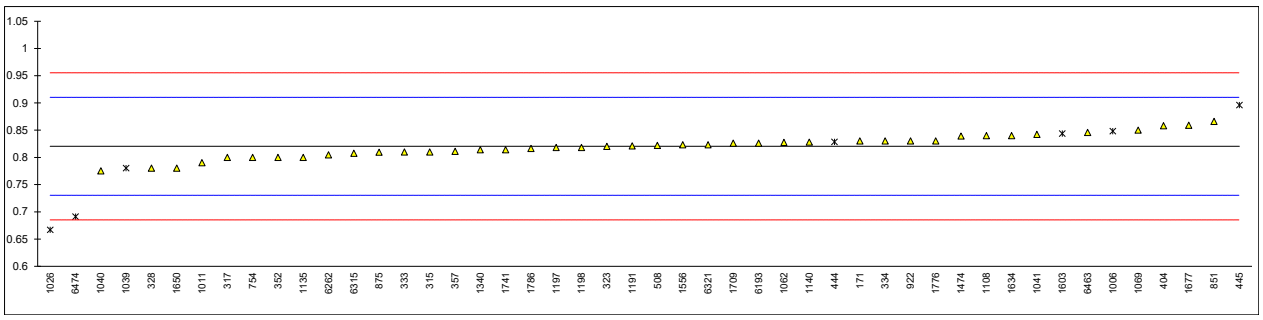
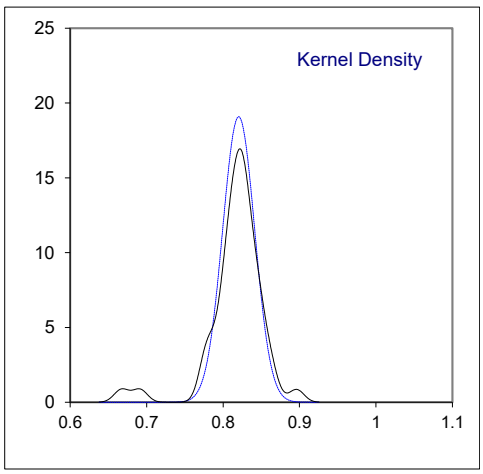

Kernel Density
3.5
3
2.5
2
1.5
1
0.5
0
6.2
6.7
7.2

Determination of 1,3-Butadiene on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.83		0.22	
315	D2163	0.81		-0.23	
317	D2163	0.80		-0.45	
323	D2163	0.82		-0.01	
328	D2163	0.78		-0.90	
333	D2163	0.81		-0.23	
334	D2163	0.83		0.22	
352	EN27941	0.8		-0.45	
357	D2163	0.811		-0.21	
404	EN27941	0.858		0.84	
444	ISO7941	0.8285	ex,C	0.18	test result excluded, see §4.1 / first reported 0
445	D2163	0.896	R(0.05)	1.68	
508	D2163	0.82184		0.03	
736		-----		-----	
754	D2163	0.80		-0.45	
851	D2163	0.865978		1.02	
869		-----		-----	
875	D2163	0.8095		-0.24	
922	D2163	0.83		0.22	
1006	D2163	0.848	ex,C	0.62	test result excluded, see §4.1 / first reported 0.850
1011		0.79		-0.67	
1026	ISO7941	0.66701	R(0.01)	-3.41	
1039	EN27941	0.78	ex	-0.90	test result excluded, see §4.1
1040	DIN51619	0.775		-1.01	
1041	DIN51619	0.842	C	0.48	first reported 0.937
1062	D2163	0.8273		0.16	
1065		-----		-----	
1069	D4423	0.850		0.66	
1108	D2163	0.84		0.44	
1135	D2163	0.80	C	-0.45	first reported 0.79
1140	ISO7941	0.828		0.17	
1191	IP473	0.821028		0.02	
1197	D2163	0.8180		-0.05	
1198	D2163	0.8181		-0.05	
1340	EN27941	0.814		-0.14	
1357		-----		-----	
1474	D2163	0.839		0.42	
1556	EN27941	0.823		0.06	
1603	In house	0.8438	ex	0.52	test result excluded, see §4.1
1634	ISO7941	0.84		0.44	
1650	D2163	0.78		-0.90	
1677	D2163	0.859		0.86	
1709	D2163	0.826		0.13	
1720		-----		-----	
1741	EN27941	0.814		-0.14	
1776	EN27941	0.83		0.22	
1786	D2163	0.816133		-0.09	
6193	EN15984	0.826		0.13	
6262	D2163	0.8044		-0.35	
6315	DIN51619	0.8075		-0.29	
6321	D2163	0.823		0.06	
6411		-----		-----	
6433	D2163	Not Detected		-----	
6463	D2163	0.845479		0.56	
6474	D2163	0.691	R(0.01)	-2.88	

	normality	OK
	n	41
	outliers	3 +4ex
	mean (n)	0.8203
	st.dev. (n)	0.02091
	R(calc.)	0.0586
	st.dev.(D2163:14R19)	0.04495
	R(D2163:14R19)	0.1259
Compare:		
	EN27941:93(liq)	1.0639


1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
1026 6474 1040 1039 328 1650 1011 317 754 362 1135 6262 6315 875 333 315 357 1340 1741 1786 1197 1198 323 1191 508 1556 6321 1709 6193 1062 1140 444 171 334 922 1776 1474 1108 1634 1041 1603 6463 1006 1069 404 1677 851 445


Kernel Density
25
20
15
10
5
0
0.6
0.7
0.8
0.9
1
1.1

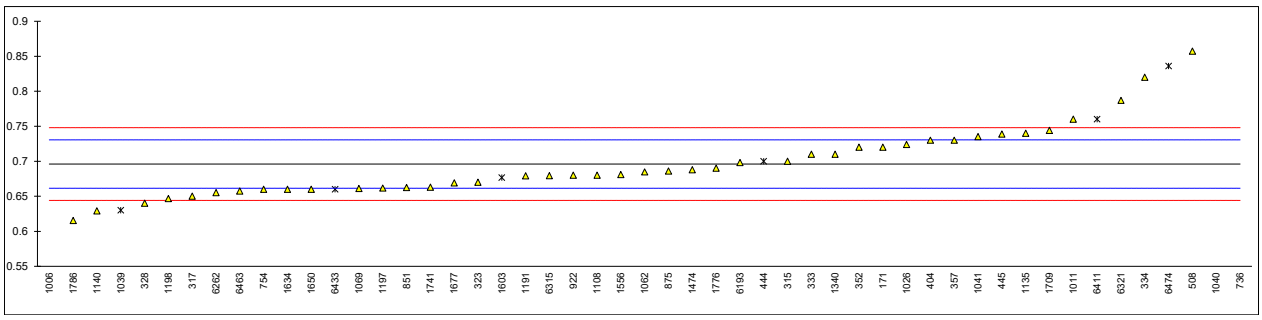
Determination of n-Pentane on sample #22095; results in %mol/mol

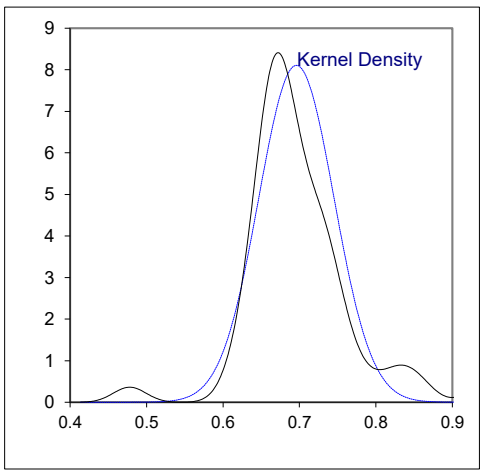
lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.0		-----	
315	D2163	<0.01		-----	
317	D2163	<0.01		-----	
323	D2163	< 0.01		-----	
328	D2163	<0.01		-----	
333	D2163	<0.01		-----	
334	D2163	<0.01		-----	
352		-----		-----	
357	D2163	0.011		-----	
404	EN27941	0.0		-----	
444	ISO7941	0.0013	C	-----	first reported 0.67
445	D2163	<0.01		-----	
508	D2163	0.00000		-----	
736		-----		-----	
754	D2163	<0.01		-----	
851	D2163	0.00		-----	
869		-----		-----	
875	D2163	0.0033		-----	
922	D2163	<0.01		-----	
1006	D2163	0		-----	
1011		<0.1		-----	
1026	ISO7941	0		-----	
1039		-----		-----	
1040	DIN51619	0.003		-----	
1041	DIN51619	0.000	C	-----	first reported <0.01
1062	D2163	0.0000		-----	
1065		-----		-----	
1069	D4423	0.000		-----	
1108	D2163	0.00		-----	
1135	D2163	<0.01		-----	
1140	ISO7941	0.000		-----	
1191	IP473	0		-----	
1197		-----		-----	
1198		-----		-----	
1340		-----		-----	
1357		-----		-----	
1474	D2163	0.000		-----	
1556	EN27941	0		-----	
1603	In house	0.0013		-----	
1634	ISO7941	0		-----	
1650	D2163	0		-----	
1677	D2163	< 0.001		-----	
1709	D2163	<0.01		-----	
1720		-----		-----	
1741		-----		-----	
1776	EN27941	0.00		-----	
1786		-----		-----	
6193		-----		-----	
6262	D2163	<0,01		-----	
6315	DIN51619	0.001		-----	
6321	D2163	<0.001		-----	
6411	D2163	<0.01		-----	
6433	D2163	<0.01		-----	
6463		-----		-----	
6474	D2163	0.006		-----	
	n	41			
	mean (n)	<0.1			

Determination of iso-Pentane on sample #22095; results in %mol/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2163	0.72		1.39	
315	D2163	0.70		0.23	
317	D2163	0.65		-2.66	
323	D2163	0.67		-1.51	
328	D2163	0.64		-3.24	
333	D2163	0.71		0.81	
334	D2163	0.82		7.17	
352	EN27941	0.72		1.39	
357	D2163	0.730	C	1.96	first reported 0.913
404	EN27941	0.730		1.96	
444	ISO7941	0.70	ex	0.23	test result excluded, see §4.1
445	D2163	0.739		2.49	
508	D2163	0.85722		9.32	
736	GOST10676	1.063	R(0.01)	21.23	
754	D2163	0.66		-2.08	
851	D2163	0.662464		-1.94	
869		-----		-----	
875	D2163	0.6860		-0.58	
922	D2163	0.68	C	-0.93	first reported 0.69
1006	D2163	0.478	C,R(0.01)	-12.61	first reported 0.496
1011		0.76		3.70	
1026	ISO7941	0.72387		1.61	
1039	EN27941	0.63	ex	-3.82	test result excluded, see §4.1
1040	DIN51619	0.940	R(0.01)	14.11	
1041	DIN51619	0.735	C	2.25	first reported 0.734
1062	D2163	0.6847		-0.66	
1065		-----		-----	
1069	D4423	0.661		-2.03	
1108	D2163	0.68		-0.93	
1135	D2163	0.74	C	2.54	first reported 0.33
1140	ISO7941	0.629		-3.88	
1191	IP473	0.679255		-0.97	
1197	D2163	0.6616		-1.99	
1198	D2163	0.6467		-2.85	
1340	EN27941	0.710		0.81	
1357		-----		-----	
1474	D2163	0.688		-0.46	
1556	EN27941	0.681		-0.87	
1603	In house	0.6767	ex	-1.12	test result excluded, see §4.1
1634	ISO7941	0.66		-2.08	
1650	D2163	0.66		-2.08	
1677	D2163	0.669		-1.56	
1709	D2163	0.744		2.77	
1720		-----		-----	
1741	EN27941	0.663		-1.91	
1776	EN27941	0.69		-0.35	
1786	D2163	0.615392		-4.66	
6193	EN15984	0.698		0.11	
6262	D2163	0.6551		-2.37	
6315	DIN51619	0.6795		-0.96	
6321	D2163	0.787		5.26	
6411	D2163	0.76	ex	3.70	test result excluded, see §4.1
6433	D2163	0.66	ex	-2.08	test result excluded, see §4.1
6463	D2163	0.657363		-2.24	
6474	D2163	0.836	ex	8.10	test result excluded, see §4.1

normality	not OK
n	42
outliers	3 +6ex
mean (n)	0.6960
st.dev. (n)	0.04923
R(calc.)	0.1378
st.dev.(D2163:14R19)	0.01729
R(D2163:14R19)	0.0484
Compare:	
EN27941:93(liq)	0.7976

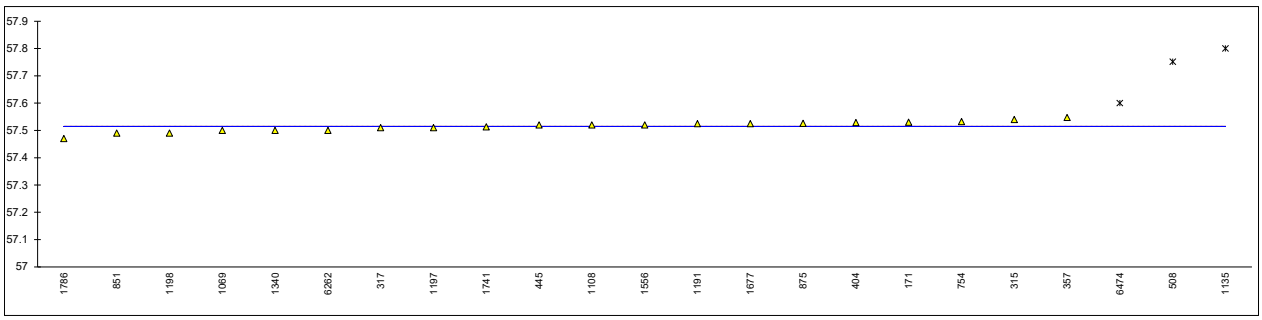

0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
1006 1786 1140 1039 328 1198 317 6262 6463 754 1634 1650 6433 1069 1197 851 1741 1677 323 1603 1191 6315 922 1108 1586 1062 875 1474 1776 6193 444 315 333 1340 352 171 1026 404 357 1041 445 1135 1709 1011 6411 6321 334 6474 508 1040 736

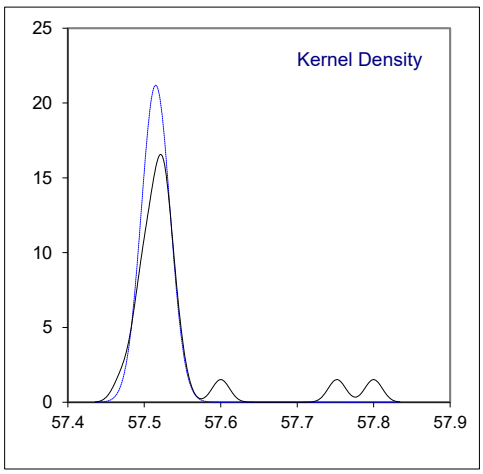

Kernel Density
9
8
7
6
5
4
3
2
1
0
0.4
0.5
0.6
0.7
0.8
0.9

Determination of Molar Mass on sample #22095; results in g/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2598	57.53		-----	
315	ISO8973	57.54		-----	
317	INH-001	57.51		-----	
323		-----		-----	
328		-----		-----	
333		-----		-----	
334		-----		-----	
352		-----		-----	
357	ISO8973	57.547	C	-----	first reported 57.64
404	ISO8973	57.5288		-----	
444		-----		-----	
445	D2163	57.520		-----	
508	D2598	57.752	R(0.01)	-----	
736		-----		-----	
754	D2421	57.532		-----	
851	D2598	57.49		-----	
869		-----		-----	
875	D2421	57.526		-----	
922		-----		-----	
1006		-----		-----	
1011		-----		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1041		-----		-----	
1062		-----		-----	
1065		-----		-----	
1069	ISO8973	57.5		-----	
1108	ISO8973	57.52		-----	
1135	D2598	57.8	C,E,R(0.01)	-----	first reported 57.3 / iis calculated 57.6
1140		-----		-----	
1191	IP473	57.5244	E	-----	calculation difference, iis calc. 55.9
1197	D2598	57.51		-----	
1198	D2421	57.49		-----	
1340		57.50		-----	
1357		-----		-----	
1474		-----		-----	
1556	ISO8973	57.52		-----	
1603		-----		-----	
1634		-----		-----	
1650		-----		-----	
1677	D2598	57.5245		-----	
1709		-----		-----	
1720		-----		-----	
1741	ISO8973	57.513		-----	
1776		-----		-----	
1786	D2421	57.47		-----	
6193		-----		-----	
6262	D2163	57.50		-----	
6315		-----		-----	
6321		-----		-----	
6411		-----		-----	
6433		-----		-----	
6463		-----		-----	
6474	D2598	57.6	ex	-----	test result excluded, see §4.1
					iis calc. based on ALL reported composition results: *)
	normality	OK			OK
	n	20			39
	outliers	2 +1ex			4 +7ex
	mean (n)	57.515			57.523
	st.dev. (n)	0.0188			0.0217
	R(calc.)	0.053			0.061

*) Calculated by iis 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

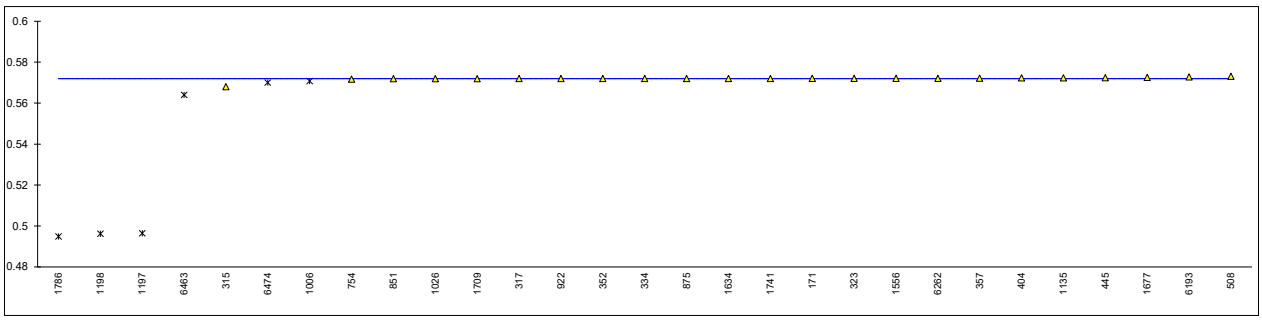

57.9
57.8
57.7
57.6
57.5
57.4
57.3
57.2
57.1
57
1786
851
1198
1069
1340
6262
317
1197
1741
445
1108
1556
1191
1677
875
404
171
754
315
357
6474
508
1135

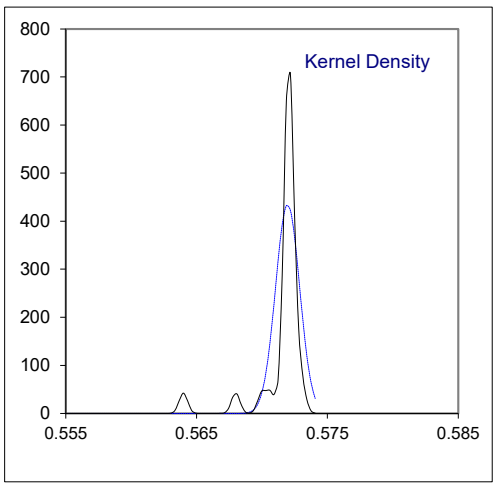

Kernel Density
25
20
15
10
5
0
57.4
57.5
57.6
57.7
57.8
57.9

Determination of Relative Density at 60/60 °F on sample #22095; unitless results

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171	D2598	0.5721		-----	
315	D2598	0.568		-----	
317	D2598	0.572	C	-----	first reported 0.568
323	D2598	0.5721		-----	
328		-----		-----	
333		-----		-----	
334	D2598	0.572		-----	
352	ISO8973	0.5720		-----	
357	D2598	0.5722	C	-----	first reported 0.5725
404	ISO8973	0.5723		-----	
444		-----		-----	
445	ISO8973	0.5724		-----	
508	D2598	0.5731		-----	
736		-----		-----	
754	D2598	0.5717		-----	
851	D2598	0.5719		-----	
869		-----		-----	
875	D2598	0.572		-----	
922	D2598	0.5720		-----	
1006	D2598	0.5707	ex,C	-----	test result excluded, see §4.1 / first reported 0.5711
1011		-----		-----	
1026	ISO8973	0.5719		-----	
1039		-----		-----	
1040		-----		-----	
1041		-----		-----	
1062		-----		-----	
1065		-----		-----	
1069		-----		-----	
1108		-----		-----	
1135	D2598	0.5723	C	-----	first reported 0.5684
1140		-----		-----	
1191		-----		-----	
1197	D2598	0.4964	E,R(0.01)	-----	calculation difference, iis calc. 0.5718
1198	D2598	0.4962	E,R(0.01)	-----	calculation difference, iis calc. 0.5718
1340		-----		-----	
1357		-----		-----	
1474		-----		-----	
1556	ISO8973	0.5721		-----	
1603		-----		-----	
1634	ISO8973	0.572		-----	
1650		-----		-----	
1677	ISO8973	0.57251		-----	
1709	D2598	0.5719		-----	
1720		-----		-----	
1741	ISO8973	0.5720		-----	
1776		-----		-----	
1786	D2598	0.4948	E,R(0.01)	-----	calculation difference, iis calc. 0.5719
6193	ISO8973	0.57273	C	-----	first reported 572.73
6262	D2598	0.5721	C	-----	first reported 0.5434
6315		-----		-----	
6321		-----		-----	
6411		-----		-----	
6433		-----		-----	
6463	D2598	0.564	E,R(0.01)	-----	calculation difference, iis calc. 0.572
6474	D2598	0.570	ex	-----	test result excluded, see §4.1
					iis calc. based on ALL reported composition results: *)
	normality	not OK			OK
	n	23			42
	outliers	4 +2ex			1 +7ex
	mean (n)	0.57197			0.5720
	st.dev. (n)	0.000918			0.00019
	R(calc.)	0.00257			0.0005

*) Calculated by iis 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 D2163:14R19
N.B. Effect of different factors from ASTM D2598:21 and ISO8973:97/IP432:00 on the calculation is very small


0.6
0.58
0.56
0.54
0.52
0.5
0.48
1786
1198
1197
6463
315
6474
1006
754
851
1026
1709
317
922
362
334
875
1634
1741
171
323
1556
6262
357
404
1135
445
1677
6193
508


Kernel Density
800
700
600
500
400
300
200
100
0
0.555
0.565
0.575
0.585

Determination of Abs. Vapor Pressure at 100 °F on sample #22095; results in psi

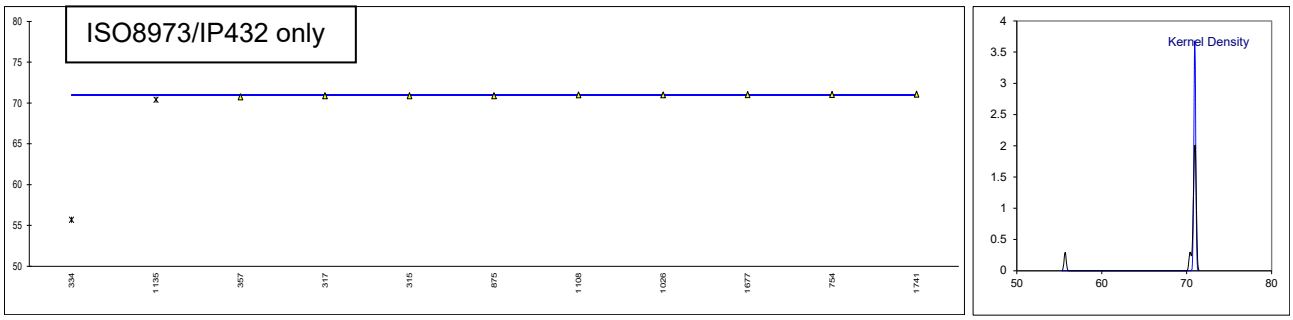
lab	method	ISO8973	mark	z(targ)	D2598	mark	z(targ)	remarks
150		-----		-----	-----		-----	
171	D2598	-----		-----	70.35		-----	
315	ISO8973	70.9		-----	-----		-----	
317	ISO8973	70.9		-----	-----		-----	
323		-----		-----	-----		-----	
328		-----		-----	-----		-----	
333		-----		-----	-----		-----	
334	ISO8973	55.7	E,G(0.01)	-----	-----		-----	calculation difference, iis calculated 70.7
352		-----		-----	-----		-----	
357	ISO8973	70.75	C	-----	-----		-----	first reported 70.02
404		-----		-----	-----		-----	
444		-----		-----	-----		-----	
445		-----		-----	-----		-----	
508	D2598	-----		-----	55.0	E,G(0.01)	-----	calculation difference, iis calculated 70.2
736		-----		-----	-----		-----	
754	ISO8973	71.063		-----	-----		-----	
851	D2598	-----		-----	70.6		-----	
869		-----		-----	-----		-----	
875	ISO8973	70.9		-----	-----		-----	
922	D2598	-----		-----	70.62	C	-----	first reported 70.69
1006	D2598	-----		-----	71.2	ex,C	-----	test result excluded, see §4.1 / fr. 71.6
1011		-----		-----	-----		-----	
1026	ISO8973	71.009		-----	-----		-----	
1039		-----		-----	-----		-----	
1040		-----		-----	-----		-----	
1041		-----		-----	-----		-----	
1062		-----		-----	-----		-----	
1065		-----		-----	-----		-----	
1069		-----		-----	-----		-----	
1108	ISO8973	71.0		-----	-----		-----	
1135	ISO8973	70.4	C,G(0.05)	-----	-----		-----	first reported 76.8
1140		-----		-----	-----		-----	
1191		-----		-----	-----		-----	
1197	D2598	-----		-----	382.7	E,ex	-----	calculation difference, iis calculated 71.1
1198	D2598	-----		-----	383.6	E,ex	-----	calculation difference, iis calculated 71.3
1340		-----		-----	-----		-----	
1357		-----		-----	-----		-----	
1474		-----		-----	-----		-----	
1556		-----		-----	-----		-----	
1603		-----		-----	-----		-----	
1634		-----		-----	-----		-----	
1650		-----		-----	-----		-----	
1677	ISO8973	71.045		-----	-----		-----	
1709		-----		-----	-----		-----	
1720		-----		-----	-----		-----	
1741	ISO8973	71.087		-----	-----		-----	
1776		-----		-----	-----		-----	
1786	D2598	-----		-----	384.1	E,ex	-----	calculation difference, iis calculated 71.4
6193		-----		-----	-----		-----	
6262	D2598	-----		-----	70.0532		-----	
6315		-----		-----	-----		-----	
6321		-----		-----	-----		-----	
6411		-----		-----	-----		-----	
6433		-----		-----	-----		-----	
6463	D2598	-----		-----	70.5		-----	
6474	D2598	-----		-----	70.7	ex	-----	test result excluded, see §4.1

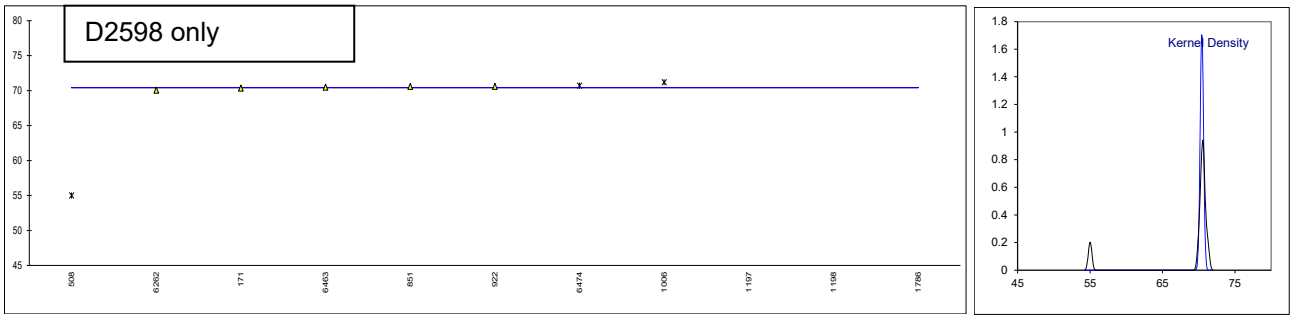
Labs 1197, 1198 and 1786 test result excluded from statistical evaluation as the same test results were reported for both Absolute and Relative Vapor Pressure

	ISO8973/IP432	D2598
normality	OK	suspect
n	9	5
outliers	2	1 +5ex
mean (n)	70.9615	70.4246
st.dev. (n)	0.10773	0.23352
R(calc.)	0.3016	0.6539

	iis calc. based on ALL *) reported composition results	iis calc. based on ALL **) reported composition results
normality	suspect	suspect
n	40	40
outliers	3 +7ex	3 +7ex
mean (n)	70.9805	70.3474
st.dev. (n)	0.20671	0.17843
R(calc.)	0.5788	0.4996

*) Calculated by iis based on Vapor Pressure factors at 100 °F (37.8 °C) as given in table A.1 of ISO8973:97/IP432:00
**) Calculated by iis based 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 psia - (101.325 kPa * 0.145038) = 44.76 = 45 psig





Determination of Rel. Vapor Pressure at 100 °F on sample #22095; results in psi

lab	method	ISO8973	mark	z(targ)	D2598	mark	z(targ)	remarks
150		-----		-----	-----		-----	
171		-----		-----	-----		-----	
315	ISO8973	56.1		-----	-----		-----	
317	ISO8973	56.3		-----	-----		-----	
323	D2598	-----		-----	55.65		-----	
328		-----		-----	-----		-----	
333		-----		-----	-----		-----	
334	ISO8973	41.0	E,G(0.01)	-----	-----		-----	calculation difference, iis calc. 56.0
352		-----		-----	-----		-----	
357	ISO8973	56.05	C	-----	-----		-----	first reported 55.33
404		-----		-----	-----		-----	
444		-----		-----	-----		-----	
445	ISO8973	56		-----	-----		-----	
508		-----		-----	-----		-----	
736		-----		-----	-----		-----	
754	ISO8973	56.367		-----	-----		-----	
851	D2598	-----		-----	55.9		-----	
869		-----		-----	-----		-----	
875	ISO8973	56.2		-----	-----		-----	
922	D2598	-----		-----	55.92	C	-----	first reported 55.99
1006	D2598	-----		-----	56.6	ex,C	-----	test result excluded, see §4.1 / fr. 57.0
1011		-----		-----	-----		-----	
1026	ISO8973	56.313		-----	-----		-----	
1039		-----		-----	-----		-----	
1040		-----		-----	-----		-----	
1041		-----		-----	-----		-----	
1062		-----		-----	-----		-----	
1065		-----		-----	-----		-----	
1069		-----		-----	-----		-----	
1108	ISO8973	56.3		-----	-----		-----	
1135	ISO8973	55.8	C	-----	-----		-----	first reported 62.1
1140		-----		-----	-----		-----	
1191		-----		-----	-----		-----	
1197	D2598	-----		-----	382.7	E,ex	-----	calculation difference, iis calc. 56.4
1198	D2598	-----		-----	383.6	E,ex	-----	calculation difference, iis calc. 56.6
1340		-----		-----	-----		-----	
1357		-----		-----	-----		-----	
1474		-----		-----	-----		-----	
1556		-----		-----	-----		-----	
1603		-----		-----	-----		-----	
1634		-----		-----	-----		-----	
1650		-----		-----	-----		-----	
1677	ISO8973	56.349		-----	-----		-----	
1709	D2598	-----		-----	55.76		-----	
1720		-----		-----	-----		-----	
1741	ISO8973	56.391		-----	-----		-----	
1776		-----		-----	-----		-----	
1786	D2598	-----		-----	384.1	E,ex	-----	calculation difference, iis calc. 56.7
6193		-----		-----	-----		-----	
6262	D2598	-----		-----	71.12	E,C,G(0.01)	-----	calculation difference, iis calc. 56.42
6315		-----		-----	-----		-----	
6321		-----		-----	-----		-----	
6411		-----		-----	-----		-----	
6433		-----		-----	-----		-----	
6463	D2598	-----		-----	55.8		-----	
6474	D2598	-----		-----	56	ex	-----	test result excluded, see §4.1

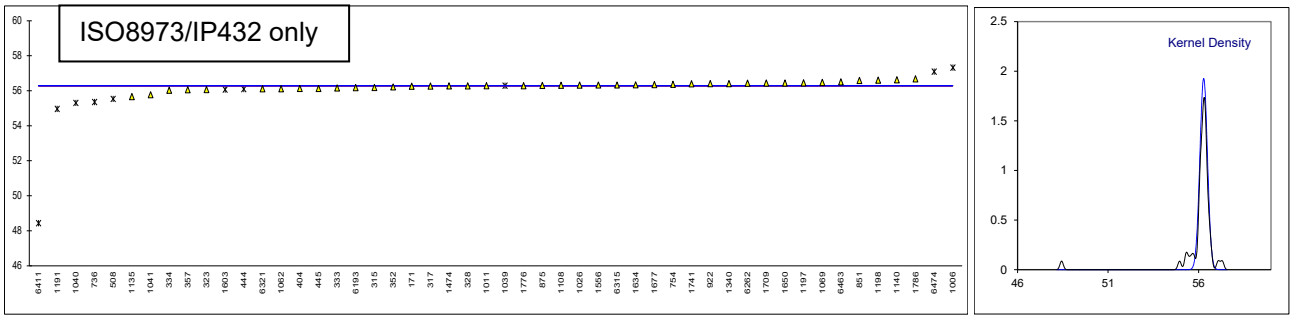
Labs 1197, 1198 and 1786 test result excluded from statistical evaluation as the same test results were reported for both Absolute and Relative Vapor Pressure

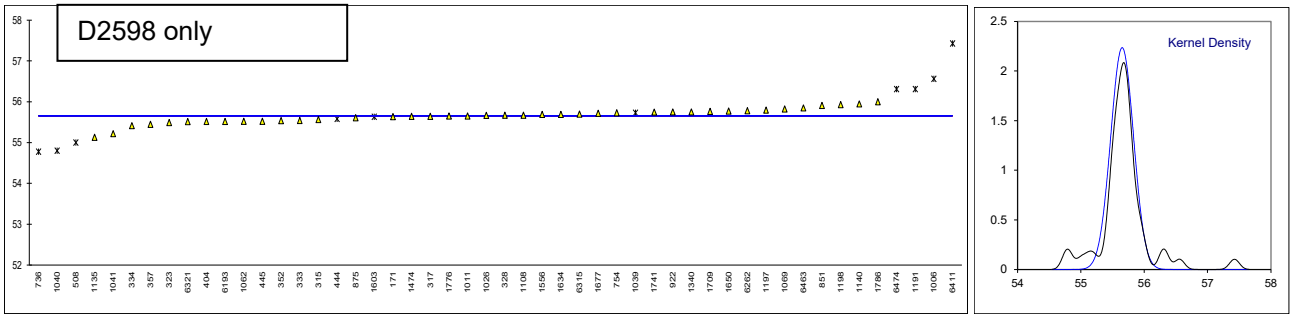
Lab 6262 first reported 70.011

	ISO8973/IP432	D2598
normality	OK	OK
n	11	5
outliers	1	1 +5ex
mean (n)	56.1973	55.8060
st.dev. (n)	0.18755	0.10991
R(calc.)	0.5251	0.3077

	iis calc. based on ALL *) reported composition results	iis calc. based on ALL **) reported composition results
normality	suspect	suspect
n	40	40
outliers	3 +7ex	3 +7ex
mean (n)	56.2845	55.6514
st.dev. (n)	0.20671	0.17843
R(calc.)	0.5788	0.4996

*) Calculated by iis based on Vapor Pressure factors at 100 °F (37.8 °C) as given in table A.1 of ISO8973:97/IP432:00
**) Calculated by iis based 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 psia - (101.325 kPa * 0.145038) = 44.76 = 45 psig.



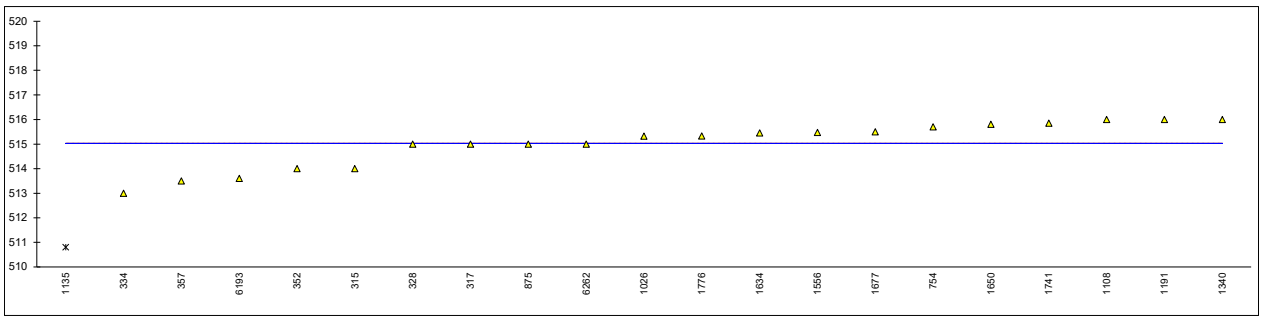


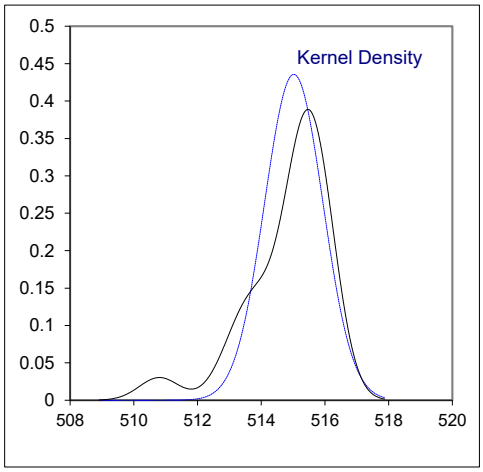
Determination of Abs. Vapor Pressure at 40 °C on sample #22095; results in kPa

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315	ISO8973	514		-----	
317	ISO8973	515		-----	
323		-----		-----	
328	ISO8973	515		-----	
333		-----		-----	
334	ISO8973	513		-----	
352	ISO8973	514		-----	
357	ISO8973	513.5	C	-----	first reported 508.1
404		-----		-----	
444		-----		-----	
445		-----		-----	
508		-----		-----	
736		-----		-----	
754	ISO8973	515.701		-----	
851		-----		-----	
869		-----		-----	
875	ISO8973	515		-----	
922		-----		-----	
1006		-----		-----	
1011		-----		-----	
1026	ISO8973	515.32		-----	
1039		-----		-----	
1040		-----		-----	
1041		-----		-----	
1062		-----		-----	
1065		-----		-----	
1069		-----		-----	
1108	ISO8973	516	E	-----	calculation difference, iis calc. 515
1135	ISO8973	510.8	C,R(0.01)	-----	first reported 436.6
1140		-----		-----	
1191	ISO8973	516	E	-----	calculation difference, iis calc. 505
1197		-----		-----	
1198		-----		-----	
1340	ISO8973	516.0		-----	
1357		-----		-----	
1474		-----		-----	
1556	ISO8973	515.47		-----	
1603		-----		-----	
1634	ISO8973	515.45		-----	
1650	ISO8973	515.8		-----	
1677	ISO8973	515.5		-----	
1709		-----		-----	
1720		-----		-----	
1741	ISO8973	515.849		-----	
1776	ISO8973	515.325		-----	
1786		-----		-----	
6193	ISO8973	513.6	E	-----	calculation difference, iis calc. 514.4
6262	ISO8973	515	E	-----	calculation difference, iis calc. 516
6315		-----		-----	
6321		-----		-----	
6411		-----		-----	
6433		-----		-----	
6463		-----		-----	
6474		-----		-----	

			iis calc. based on ALL reported composition results: *)
	normality	OK	suspect
	n	20	40
	outliers	1	3 +7ex
	mean (n)	515.0258	515.1786
	st.dev. (n)	0.91566	1.46675
	R(calc.)	2.5639	4.1069

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


520
519
518
517
516
515
514
513
512
511
510
1135
334
357
6193
352
315
328
317
875
6262
1026
1776
1634
1566
1677
754
1650
1741
1108
1191
1340

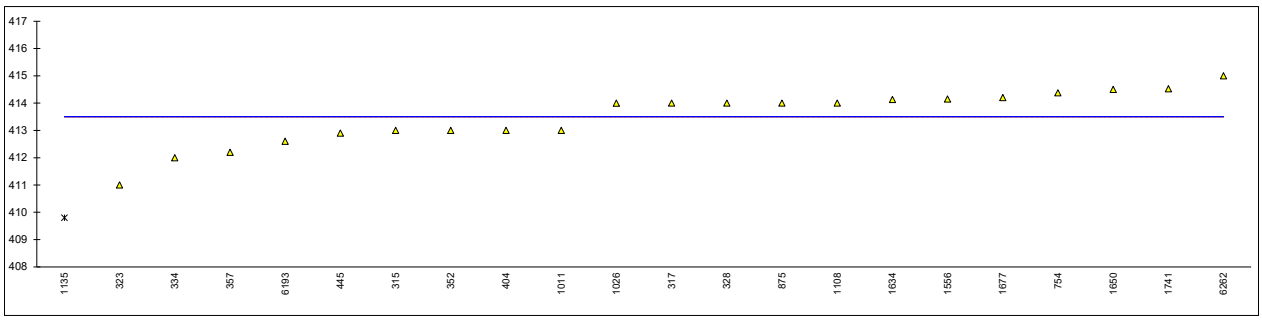

Kernel Density
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
508
510
512
514
516
518
520

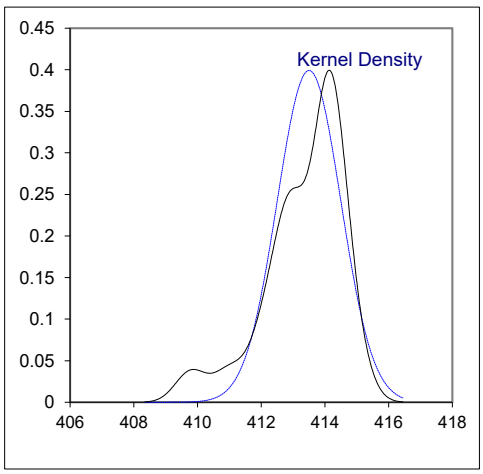
Determination of Rel. Vapor Pressure at 40 °C on sample #22095; results in kPa

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315	ISO8973	413		-----	
317	ISO8973	414		-----	
323	ISO8973	411	E	-----	calculation difference, iis calc. 412
328	ISO8973	414		-----	
333		-----		-----	
334	ISO8973	412		-----	
352	ISO8973	413		-----	
357	ISO8973	412.2	C	-----	first reported 406.8
404	ISO8973	413		-----	
444		-----		-----	
445	ISO8973	412.9		-----	
508		-----		-----	
736		-----		-----	
754	ISO8973	414.376		-----	
851		-----		-----	
869		-----		-----	
875	ISO8973	414		-----	
922		-----		-----	
1006		-----		-----	
1011	ISO8973	413		-----	
1026	ISO8973	413.995		-----	
1039		-----		-----	
1040		-----		-----	
1041		-----		-----	
1062		-----		-----	
1065		-----		-----	
1069		-----		-----	
1108	ISO8973	414		-----	
1135	ISO8973	409.8	C,R(0.05)	-----	first reported 536.6
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1340		-----		-----	
1357		-----		-----	
1474		-----		-----	
1556	ISO8973	414.15		-----	
1603		-----		-----	
1634	ISO8973	414.13		-----	
1650	ISO8973	414.5		-----	
1677	ISO8973	414.2		-----	
1709		-----		-----	
1720		-----		-----	
1741	ISO8973	414.52		-----	
1776		-----		-----	
1786		-----		-----	
6193	ISO8973	412.6		-----	
6262	ISO8973	415		-----	
6315		-----		-----	
6321		-----		-----	
6411		-----		-----	
6433		-----		-----	
6463		-----		-----	
6474		-----		-----	

			iis calc. based on ALL reported composition results: *)
	normality	OK	suspect
	n	21	40
	outliers	1	3 +7ex
	mean (n)	413.5034	413.8537
	st.dev. (n)	0.99930	1.46676
	R(calc.)	2.7980	4.1069

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


417
416
415
414
413
412
411
410
409
408
1135
323
334
357
6193
445
315
352
404
1011
1026
317
328
875
1108
1634
1566
1677
754
1650
1741
6262


Kernel Density
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
406
408
410
412
414
416
418

Determination of Motor Octane Number, MON on sample #22095;

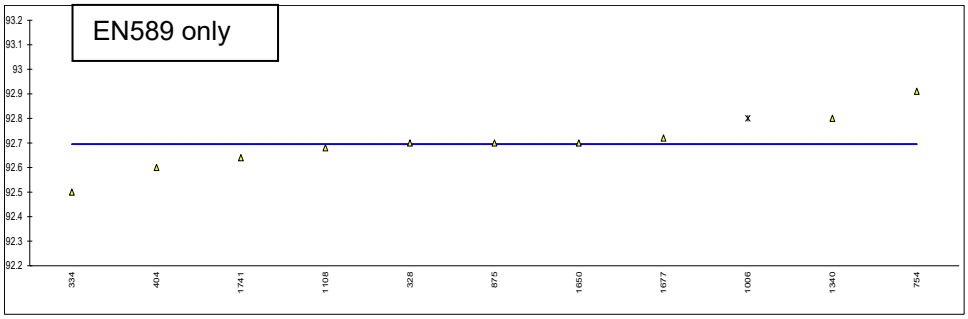
lab	method	EN589	mark	z(targ)	D2598	mark	z(targ)	remarks
150		-----		-----	-----		-----	
171	D2598	-----		-----	88.58	E,C	-----	fr. 94.409 / calc. difference *), iis calc. 94.51
315		-----		-----	-----		-----	
317		-----		-----	-----		-----	
323		-----		-----	-----		-----	
328	EN589	92.7		-----	-----		-----	
333		-----		-----	-----		-----	
334	EN589	92.5		-----	-----		-----	
352		-----		-----	-----		-----	
357		-----		-----	-----		-----	
404	EN589	92.6		-----	-----		-----	
444		-----		-----	-----		-----	
445	EN589	-----		-----	-----		-----	
508	D2598	-----		-----	88.21	E	-----	calc. difference *), iis calc. 94.54
736		-----		-----	-----		-----	
754	EN589	92.91		-----	-----		-----	
851	D2598	-----		-----	94.5	DG(0.01)	-----	
869		-----		-----	-----		-----	
875	EN589	92.7		-----	-----		-----	
922		-----		-----	-----		-----	
1006	EN589	92.8	ex	-----	-----		-----	test result excluded, see §4.1
1011		-----		-----	-----		-----	
1026		-----		-----	-----		-----	
1039		-----		-----	-----		-----	
1040		-----		-----	-----		-----	
1041		-----		-----	-----		-----	
1062		-----		-----	-----		-----	
1065		-----		-----	-----		-----	
1069		-----		-----	-----		-----	
1108	EN589	92.68		-----	-----		-----	
1135	D2598	-----		-----	94	C,DG(0.01)	-----	first reported 94.4
1140		-----		-----	-----		-----	
1191		-----		-----	-----		-----	
1197	D2598	-----		-----	88.7	E	-----	calc. difference *), iis calc. 94.5
1198	D2598	-----		-----	88.6	E	-----	calc. difference *), iis calc. 94.5
1340	EN589	92.8		-----	-----		-----	
1357		-----		-----	-----		-----	
1474		-----		-----	-----		-----	
1556		-----		-----	-----		-----	
1603		-----		-----	-----		-----	
1634		-----		-----	-----		-----	
1650	EN589	92.7		-----	-----		-----	
1677	EN589	92.72		-----	-----		-----	
1709		-----		-----	-----		-----	
1720		-----		-----	-----		-----	
1741	EN589	92.64		-----	-----		-----	
1776		-----		-----	-----		-----	
1786	D2598	-----		-----	88.4	E	-----	calc. difference *), iis calc. 94.5
6193		-----		-----	-----		-----	
6262	D2598	-----		-----	88.48	E,C	-----	fr. 87.92 / calc. difference *), iis calc. 94.48
6315		-----		-----	-----		-----	
6321		-----		-----	-----		-----	
6411		-----		-----	-----		-----	
6433		-----		-----	-----		-----	
6463		-----		-----	-----		-----	
6474	D2598	-----		-----	89.59	E,ex	-----	test result ex., see §4.1 / calc. diff. *), iis calc. 94.91

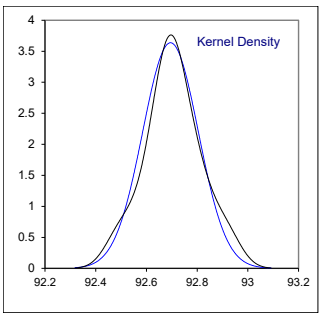
*) participant has calculated without factors iso-Butene, trans-2-Butene and 1,3-Butadiene (see comments next page)

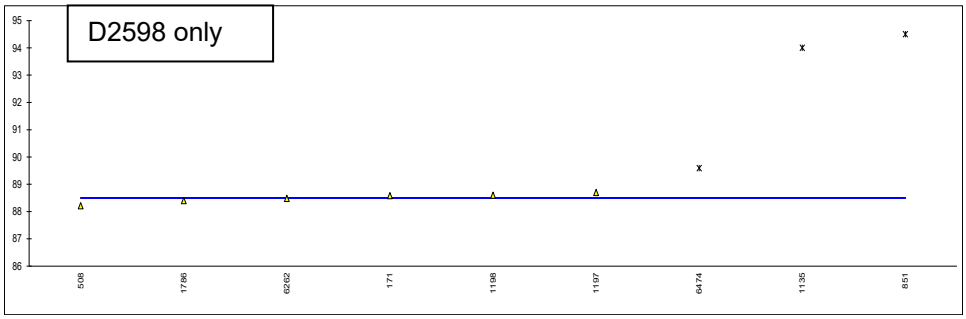
	EN589	D2598
normality	suspect	OK
n	10	6
outliers	0 +1ex	2 +1ex
mean (n)	92.695	88.495
st.dev. (n)	0.1097	0.1736
R(calc.)	0.307	0.486

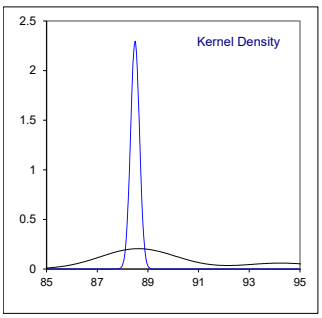
	iis calc. based on ALL *) reported composition results	iis calc. based on ALL **) reported composition results
normality	OK	OK
n	42	42
outliers	1 +7ex	1 +7ex
mean (n)	92.619	94.487
st.dev. (n)	0.0699	0.0420
R(calc.)	0.196	0.118

*) Calculated by iis based on MON factors given in table B.1 of EN589:08+A1:12. 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.
**) Calculated by iis 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.







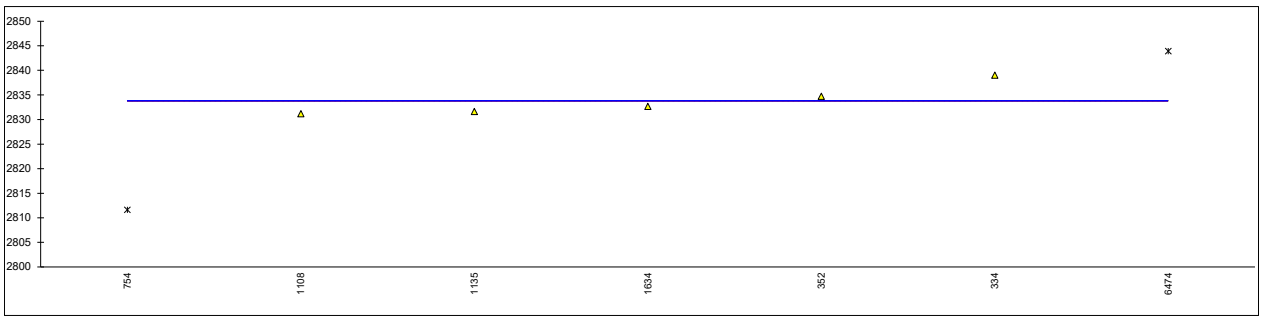


Determination of Ideal Gross Heating Value at 14.696 psia/60 °F on sample #22095; results in kJ/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315		-----		-----	
317		-----		-----	
323		-----		-----	
328		-----		-----	
333		-----		-----	
334	D3588	2839.0	E	-----	calculation difference, iis calculated 2831.6
352	D3588	2834.717		-----	
357		-----		-----	
404		-----		-----	
444		-----		-----	
445		-----		-----	
508		-----		-----	
736		-----		-----	
754	D3588	2811.6	E,G(0.05)	-----	calculation difference **), iis calculated 2831.9
851		-----		-----	
869		-----		-----	
875		-----		-----	
922		-----		-----	
1006		-----		-----	
1011		-----		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1041		-----		-----	
1062		-----		-----	
1065		-----		-----	
1069		-----		-----	
1108	D3588	2831.16		-----	
1135	D3588	2831.6		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1340		-----		-----	
1357		-----		-----	
1474		-----		-----	
1556		-----		-----	
1603		-----		-----	
1634	D3588	2832.66		-----	
1650		-----		-----	
1677		-----		-----	
1709		-----		-----	
1720		-----		-----	
1741		-----		-----	
1776		-----		-----	
1786		-----		-----	
6193		-----		-----	
6262		-----	W	-----	test result withdrawn, reported 2809.72
6315		-----		-----	
6321		-----		-----	
6411		-----		-----	
6433		-----		-----	
6463		-----		-----	
6474	D3588	2843.9	E,ex	-----	test result excluded, see §4.1 / calc. diff., iis calc. 2836.5
					iis calc. based on ALL reported composition results: *)
	normality	unknown			OK
	n	5			39
	outliers	1 +1ex			4 +7ex
	mean (n)	2833.827			2831.136
	st.dev. (n)	3.2010			1.0824
	R(calc.)	8.963			3.031

*) 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.

**) participant has calculated without the factor 1,3-Butadiene

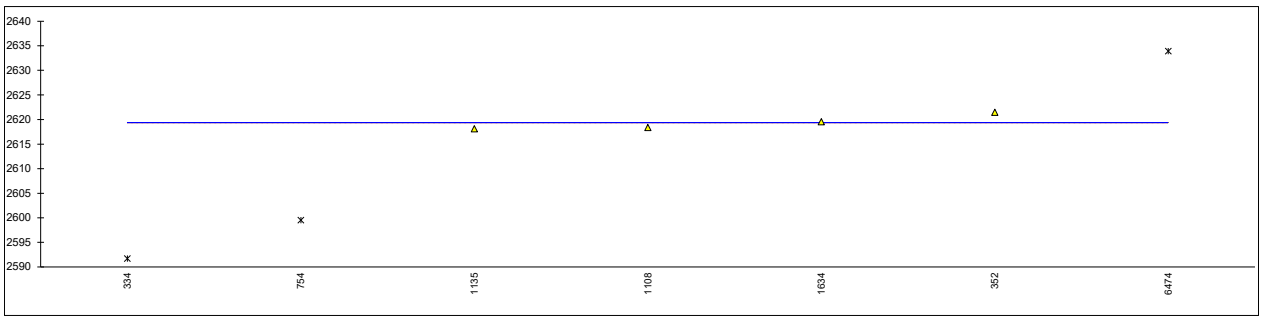

2850
2845
2840
2835
2830
2825
2820
2815
2810
2805
2800
754
1108
1135
1634
352
334
6474

Determination of Ideal Net Heating Value at 14.696 psia/60 °F on sample #22095; results in kJ/mol

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
315		-----		-----	
317		-----		-----	
323		-----		-----	
328		-----		-----	
333		-----		-----	
334	D3588	2591.7	E,DG(0.01)	-----	calculation difference, iis calculated 2618.9
352	D3588	2621.464		-----	
357		-----		-----	
404		-----		-----	
444		-----		-----	
445		-----		-----	
508		-----		-----	
736		-----		-----	
754	D3588	2599.5	E,DG(0.01)	-----	calculation difference **), iis calculated 2618.9
851		-----		-----	
869		-----		-----	
875		-----		-----	
922		-----		-----	
1006		-----		-----	
1011		-----		-----	
1026		-----		-----	
1039		-----		-----	
1040		-----		-----	
1041		-----		-----	
1062		-----		-----	
1065		-----		-----	
1069		-----		-----	
1108	D3588	2618.37		-----	
1135	D3588	2618.1		-----	
1140		-----		-----	
1191		-----		-----	
1197		-----		-----	
1198		-----		-----	
1340		-----		-----	
1357		-----		-----	
1474		-----		-----	
1556		-----		-----	
1603		-----		-----	
1634	D3588	2619.51		-----	
1650		-----		-----	
1677		-----		-----	
1709		-----		-----	
1720		-----		-----	
1741		-----		-----	
1776		-----		-----	
1786		-----		-----	
6193		-----		-----	
6262		-----	W	-----	test result withdrawn, reported 2598.12
6315		-----		-----	
6321		-----		-----	
6411		-----		-----	
6433		-----		-----	
6463		-----		-----	
6474	D3588	2633.9	E,ex	-----	test result excluded, see §4.1 / calc. diff., iis calc. 2622.2
					iis calc. based on ALL reported composition results: *)
	normality	unknown			OK
	n	4			39
	outliers	2 +1ex			4 +7ex
	mean (n)	2619.361			2618.374
	st.dev. (n)	1.5294			0.9779
	R(calc.)	4.282			2.738

*) 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.

**) participant has calculated without the factor 1,3-Butadiene


2640
2635
2630
2625
2620
2615
2610
2605
2600
2595
2590
334
754
1135
1108
1634
352
6474

APPENDIX 2

Number of participants per country

2 labs in ALGERIA
4 labs in BELGIUM
1 lab in BOSNIA and HERZEGOVINA
1 lab in BRAZIL
1 lab in CHINA, People's Republic
1 lab in DENMARK
1 lab in ESTONIA
3 labs in FINLAND
3 labs in FRANCE
4 labs in GERMANY
1 lab in GREECE
1 lab in HONG KONG
1 lab in ISRAEL
1 lab in KAZAKHSTAN
1 lab in MACEDONIA
3 labs in MALAYSIA
1 lab in MEXICO
4 labs in NETHERLANDS
1 lab in OMAN
1 lab in PAKISTAN
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 SUDAN
2 labs in SWEDEN
2 labs in TAIWAN
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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