Results of Proficiency Test
Dissolved Gas Analysis
November 2019

Organised by: Institute for Interlaboratory Studies
Spijkenisse, the Netherlands

Author: A. Lewinska, MSc.
Correctors: ing. A.S. Noordman-de Neef & ing. R.J. Starink

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1 INTRODUCTION

Since 2007 the Institute for Interlaboratory Studies organizes a proficiency test for the analyses on Dissolved Gas Analysis (DGA) in Transformer Oil every year. During the annual proficiency testing program 2019/2020, it was decided to continue the round robin for the analyses on Dissolved Gas Analysis (DGA) in Transformer Oil.

In this interlaboratory study on DGA in Transformer Oil, 55 laboratories from 33 different countries did register for participation. See appendix 3 for the number of participants per country. In this report the results of the 2019 interlaboratory study on Dissolved Gas Analysis (DGA) in Transformer Oil are presented and discussed. This report is also electronically available through the iis website www.iisnl.com.

2 SET UP

The Institute for Interlaboratory Studies (iis) in Spijkenisse, the Netherlands, was the organizer of this proficiency test (PT). In total one batch of 59 certified syringes was prepared with lot code RN375. The syringes were prepared in two different volumes: 50mL and 100mL. The syringes (True North) were provided by Morgan Schaffer Ltd. (Quebec, Canada). Each syringe was uniquely numbered and labelled #19244. It was decided to send to each participating laboratory one syringe (50 or 100 mL) without the Morgan Schaffer certificate. Participants were requested to report rounded and unrounded test results. The unrounded test results were preferably used for statistical evaluation.

2.1 ACCREDITATION

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, is accredited in agreement with ISO/IEC17043:2010 (R007), since January 2000, by the Dutch Accreditation Council (Raad voor Accreditatie). This PT falls under the accredited scope. 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.
Morgan Schaffer Ltd is ISO/IEC17025 and ISO/IEC17034 accredited by ANSI-ASQ.

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 Organization, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5). This protocol can be downloaded from 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

In this proficiency test one type of Transformer Oil was used for the preparation of the gas tight syringes of 50mL or 100mL. These syringes were subsequently tested by Morgan Schaffer Ltd. (Quebec, Canada) in accordance with ASTM D3612.
In total one batch of 59 syringes (25x50mL and 34x100mL) was prepared with lot code RN375. Each syringe was labelled #19244. Morgan Schaffer Ltd. guaranteed that the batch to be homogenous according to their ISO/IEC17034 accreditation. The reported values are given in table 4 (see paragraph 5).
To each of the participating laboratories a syringe of 50mL or a syringe of 100mL (depending on the registration) was sent on October 23, 2019. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

Morgan Schaffer declares that bulk storage prior to shipping has a shelf life of at least 6 months. This was assumed to be sufficient for the period of the proficiency test.

2.6 ANALYSES

The participants were requested to determine on sample #19244: Hydrogen (H_2), Oxygen (O_2), Nitrogen (N_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), Ethane (C_2H_6), Ethene (C_2H_4), Ethyne (C_2H_2), Propane (C_3H_8) and Propene (C_3H_6). Also, some analytical details were requested.

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 appropriate reference test methods 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 reanalysis). Additional or corrected test results are used for data analysis and the original test results are placed under ‘Remarks’ in the test 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 organisation 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.

According to ISO5725 the original test results per determination were submitted to Dixon’s, Grubbs' and/or Rosner’s outlier tests. 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 these 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 analysis 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. The Kernel Density Graph 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 was projected over the Kernel Density Graph for reference.

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, e.g. ASTM reproducibilities, 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. In some cases, a reproducibility based on former iis proficiency tests could be used.

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 result tables of 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:

	$\lvert z \rvert$	< 1	good
1 <	$\lvert z \rvert$	< 2	satisfactory
2 <	$\lvert z \rvert$	< 3	questionable
3 <	$\lvert z \rvert$		unsatisfactory

4 EVALUATION

In this proficiency test some problems were encountered with the dispatch of the samples. It appeared that two laboratories were closed and two laboratories reported that equipment was out of order. Four participants reported after the final reporting date and ten participants did not report any test results at all. Not all participants were able to report all requested components.
Finally, 45 participants reported 428 numerical test results. Observed were 44 outlying test results, which is 10.3% of the numerical test results.
In proficiency studies, outlier percentages of 3% - 7.5% are quite normal.

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

4.1 EVALUATION PER COMPONENT

In this section the reported test results are discussed per component. The test methods, which were used by the various laboratories, were taken into account for explaining the observed differences when possible and applicable. These methods are also in the tables together with the original data. The abbreviations, used in these tables, are explained in appendix 4.

Test values of laboratories 511, 614, 913, 6053 and 6255 are excluded due to many other related statistical outliers.

Hydrogen (H_2): The determination of this component was problematic. Seven statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of IEC60567:11.

Oxygen (O_2): The determination of this component was problematic. Four statistical outliers were observed and two other test results were excluded.
The calculated reproducibility after rejection of the suspect data is not in agreement with the requirements of IEC60567:11.

Nitrogen (N_2): The determination of this component was problematic. Five statistical outliers were observed and two other test results were excluded.
The calculated reproducibility after rejection of the suspect data is not in agreement with the requirements of IEC60567:11.

Carbon Monoxide (CO): The determination of this component was problematic. Four statistical outliers were observed and one other test result was excluded.
The calculated reproducibility after rejection of the suspect data is not in agreement with the requirements of IEC60567:11.

Carbon Dioxide (CO_2): The determination of this component was very problematic. Six statistical outliers were observed and two other test results were excluded. The calculated reproducibility after rejection of the suspect data is not at all in agreement with the requirements of IEC60567:11.

Methane (CH_4): The determination of this component was not problematic. Five statistical outliers were observed. However, the calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of IEC60567:11.

Ethane (C_2H_6): The determination of this component was problematic. Two statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the requirements of IEC60567:11.

Ethene (C_2H_4): The determination of this component was problematic. Two statistical outliers were observed and three other test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the requirements of IEC60567:11.

Ethyne (C_2H_2): The determination of this component was problematic. Five statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of IEC60567:11.

Propane (C_3H_8): The determination of this component was very problematic. No statistical outliers were observed but one test result was excluded. As the calculated reproducibility is no at all in agreement with the requirements of IEC60567:11. It was decided not to calculate z-scores.

Propene (C_3H_6): The determination of this component was problematic. Four statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of IEC60567:11.

4.2 PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES

A comparison has been made between the reproducibility as declared by the relevant reference test method and the reproducibility as found for the group of participating laboratories. The number of significant test results, the average result, the calculated reproducibility (2.8 * standard deviation) and the target reproducibilities derived from reference test method (in casu IEC60567 test method) are compared in next table.

Component	unit	n	average	2.8 * sd	R(lit)
Hydrogen (H_2)	µL/L	38	104	36	21
Oxygen (O_2)	µL/L	38	15934	6001	3198
Nitrogen (N_2)	µL/L	36	55968	17824	11254
Carbon Monoxide (CO)	µL/L	40	102	31	20
Carbon Dioxide (CO_2)	µL/L	36	146	76	29
Methane (CH_4)	µL/L	40	100	22	20
Ethane (C_2H_6)	µL/L	40	104	34	21
Ethene (C_2H_4)	µL/L	40	101	25	20
Ethyne (C_2H_2)	µL/L	40	105	35	21
Propane (C_3H_8)	µL/L	13	115	83	(23)
Propene (C_3H_6)	µL/L	9	113	35	23

Table 1: reproducibilities of components on sample #19244

Without further statistical calculations it can be concluded from the overview given in table 1 that for most determinations it is difficult to get a compliance of the performance of the group of participating laboratories with the relevant standard IEC60567:11.

The problematic components have been discussed in paragraph 4.1.

4.3 COMPARISON OF THE PROFICIENCY TEST OF NOVEMBER 2019 WITH PREVIOUS PTS

	November 2019	November 2018	November 2017	November 2016	November 2015
Number of reporting laboratories	45	53	61	53	45
Number of test results reported	428	496	580	487	401
Number of statistical outliers	44	25	21	57	29
Percentage of statistical outliers	10.3%	5.0%	3.6%	11.7%	7.2%

Table 2: 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, expressed as relative standard deviation (RSD) of the PTs, see below table.

Component	November 2019	November 2018	November 2017	November 2016	November 2015	IEC605671
Hydrogen (H_2)	13%	10%	15%	10%	21%	7%
Oxygen (O_2)	13%	8%	12%	13%	19%	7%
Nitrogen (N_2)	11%	12%	19%	13%	16%	7%
Carbon Monoxide (CO)	11%	10%	16%	12%	11%	7%
Carbon Dioxide CO_2)	18%	9%	15%	16%	12%	7%
Methane (CH_4)	8%	8%	12%	10%	13%	7%
Ethane (C_2H_6)	12%	9%	11%	12%	17%	7%

Component	November 2019	November 2018	November 2017	November 2016	November 2015	IEC605671
Ethene (C_2H_4)	9%	8%	12%	12%	12%	7%
Ethyne (C_2H_2)	12%	9%	11%	12%	11%	7%
Propane (C_3H_8)	n.e.	n.e.	11%	9%	n.e.	n.e.
Propene (C_3H_6)	11%	12%	n.e.	n.e.	26%	n.e.

Table 3: comparison of the uncertainties on the various components

The overall performance of the 2019 PT is in line with previous PTs but not in agreement with the strict target value of IEC605671.

5. DISCUSSION

The consensus values as determined in this PT are compared with the average values from the homogeneity testing by Morgan Schaffer 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 by Morgan Schaffer after the preparation of the syringes.

Component	Morgan Schaffer in µL/L	iis19L14 in µL/L	Differences in µL/L	Calculated z-scores
Hydrogen (H_2)	102	104	-2	-0.27
Oxygen (O_2)	16200	15934	266	0.23
Nitrogen (N_2)	57100	55968	1132	0.28
Carbon Monoxide (CO)	101	102	-1	-0.14
Carbon Dioxide (CO_2)	137	146	-9	-0.86
Methane (CH_4)	101	100	1	0.14
Ethane (C_2H_6)	103	104	-1	-0.14
Ethene (C_2H_4)	101	101	0	0.00
Ethyne (C_2H_2)	102	105	-3	-0.40
Propane (C_3H_8)	104	n.e.	n.e.	n.e.
Propene (C_3H_6)	101	113	-12	-1.49

Table 4: comparison of consensus values with values determined by Morgan Schaffer

No statistical differences were observed between the test results of the 50mL syringes and the 100mL syringes. Both the averages and the variabilities for each of the components were in line with each other for both type of syringes. Regarding the extraction method used a vast majority of the participants (75%) used “Head Space”.

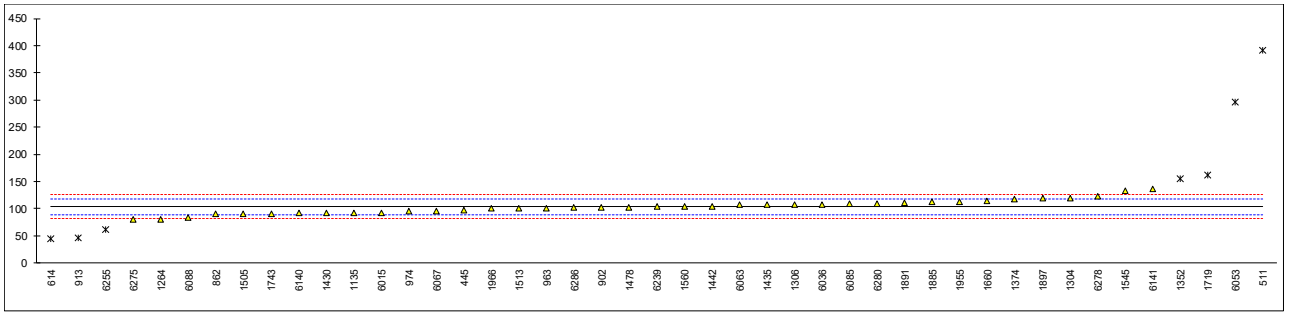
Please note that for next proficiency tests on Dissolved Gas Analyzes we cannot purchase 100mL syringes any more.

APPENDIX 1

Determination of Hydrogen (H_2) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	97.6		-0.82	
511	D3612	391.2	R(0.01)	38.84	
614	D3612	45	R(0.05)	-7.92	
862	IEC60567	89.9		-1.86	
902	D3612	101.6		-0.28	
912		-----		-----	
913	D3612	45.41	R(0.05)	-7.87	
963	D3612	101.4		-0.30	
974	D3612	95		-1.17	
975		-----		-----	
1135	IEC60567	92		-1.57	
1137		-----		-----	
1264	D3612	80.44		-3.14	
1304	In house	119.18		2.10	
1306	D3612	107.69845		0.55	
1352		155	R(0.05)	6.94	
1374	D3612	118		1.94	
1430	IEC60567	92		-1.57	
1435	IEC60567	107.5999		0.53	
1442	IEC60567	104.7		0.14	
1444		-----		-----	
1478	IEC60567	102.52		-0.15	
1505	D3612	90.3		-1.80	
1513	IEC60567	100.47		-0.43	
1545	D3612	132.2		3.86	
1560	IEC60567	104		0.05	
1660	IEC60567	114.7		1.49	
1719	D3612	162	R(0.05)	7.88	
1743	IEC60567	90.4		-1.79	
1885	D3612	113		1.26	
1891	IEC60567	111.6		1.07	
1897	IEC60567	118.8		2.05	
1955	IEC60567	113.2		1.29	
1966	IEC60567	100.28		-0.46	
6015	D3612	92.00		-1.57	
6036	IEC60567	108		0.59	
6053	IEC60567	296	C,R(0.01)	25.98	first reported 526
6063	IEC60567	107.42		0.51	
6067	IEC60567	95.42		-1.11	
6085	D3612	109		0.72	
6088	IEC60567	84		-2.65	
6140	D3612	91.3		-1.67	
6141	D3612	137.17		4.53	
6239	D3612	103.8		0.02	
6255	IEC60567	60.7	C,R(0.05)	-5.80	first reported 46.54
6264		-----		-----	
6275	IEC60567	79.5		-3.26	
6278	D3612	122		2.48	
6280	IEC60567	109		0.72	
6286	IEC60567	101.52		-0.29	

normality	OK
n	38
outliers	7
mean (n)	103.65
st.dev. (n)	13.013
R(calc.)	36.44
st.dev.(IEC60567:11)	7.404
R(IEC60567:11)	20.73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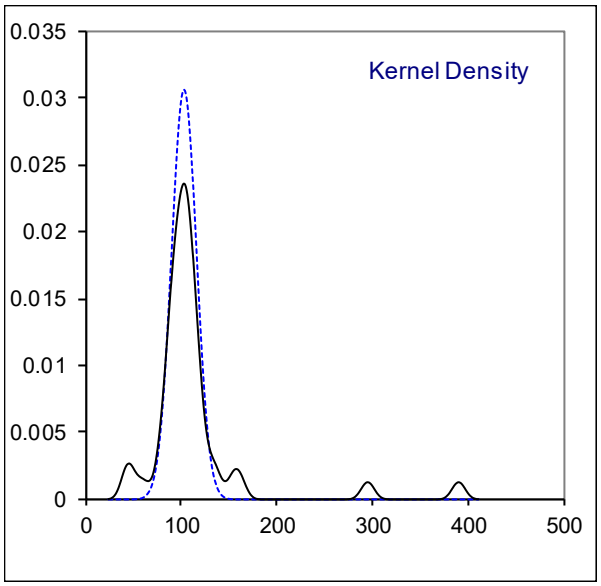
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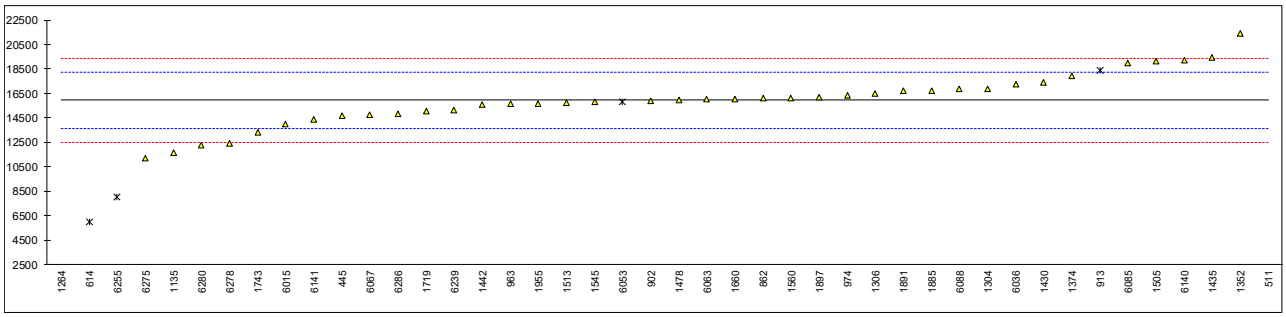
0.03
0.025
0.02
0.015
0.01
0.005
0
0
100
200
300
400
500

Determination of Oxygen (O_2) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	14662.1		-1.11	
511	D3612	80899.5	R(0.01)	56.87	
614	D3612	5961	R(0.05)	-8.73	
862	IEC60567	16082.7		0.13	
902	D3612	15900		-0.03	
912		-----		-----	
913	D3612	18360.11	ex	2.12	see §4.1
963	D3612	15640.5		-0.26	
974	D3612	16364		0.38	
975		-----		-----	
1135	IEC60567	11689		-3.72	
1137		-----		-----	
1264	D3612	952.71	R(0.01)	-13.12	
1304	In house	16902.43		0.85	
1306	D3612	16505.6		0.50	
1352		21400		4.78	
1374	D3612	17901		1.72	
1430	IEC60567	17416		1.30	
1435	IEC60567	19462.7		3.09	
1442	IEC60567	15613		-0.28	
1444		-----		-----	
1478	IEC60567	15969.53		0.03	
1505	D3612	19170.7	C	2.83	first reported 20668.1
1513	IEC60567	15754		-0.16	
1545	D3612	15776.1		-0.14	
1560	IEC60567	16112		0.16	
1660	IEC60567	16070		0.12	
1719	D3612	15061		-0.76	
1743	IEC60567	13350		-2.26	
1885	D3612	16705		0.67	
1891	IEC60567	16690		0.66	
1897	IEC60567	16173		0.21	
1955	IEC60567	15667.977		-0.23	
1966		-----		-----	
6015	D3612	14034.00		-1.66	
6036	IEC60567	17278		1.18	
6053	IEC60567	15825	ex	-0.10	see §4.1
6063	IEC60567	16039.52		0.09	
6067	IEC60567	14785.57		-1.01	
6085	D3612	19013		2.70	
6088	IEC60567	16883		0.83	
6140	D3612	19235.6		2.89	
6141	D3612	14397.43		-1.35	
6239	D3612	15166.9		-0.67	
6255	IEC60567	7999.7	C,R(0.05)	-6.95	first reported 6882.87
6264		-----		-----	
6275	IEC60567	11204.0		-4.14	
6278	D3612	12378		-3.11	
6280	IEC60567	12235		-3.24	
6286	IEC60567	14820.40		-0.98	

normality	OK
n	38
outliers	4+2ex
mean (n)	15934.44
st.dev. (n)	2143.059
R(calc.)	6000.57
st.dev.(IEC60567:11)	1142.310
R(IEC60567:11)	3198.47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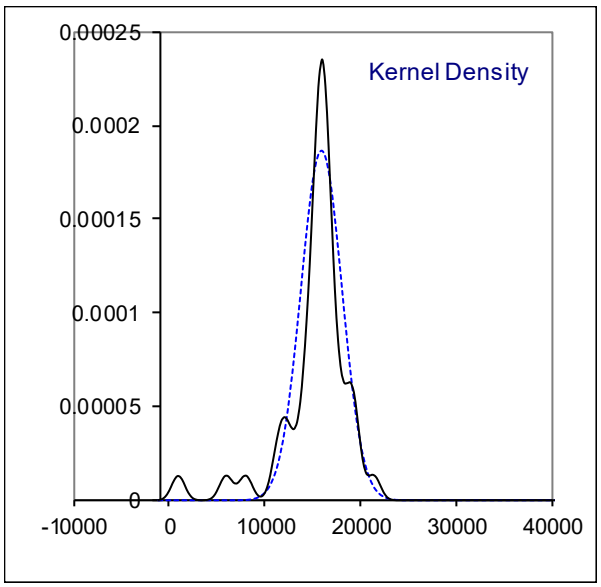
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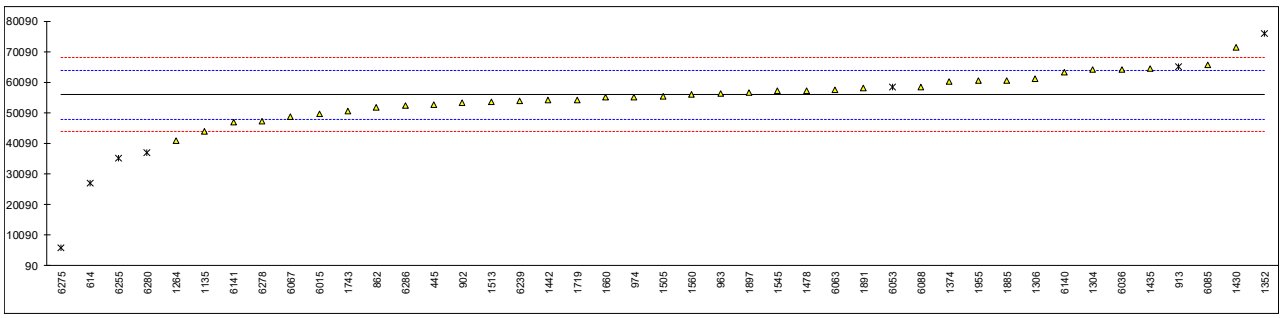
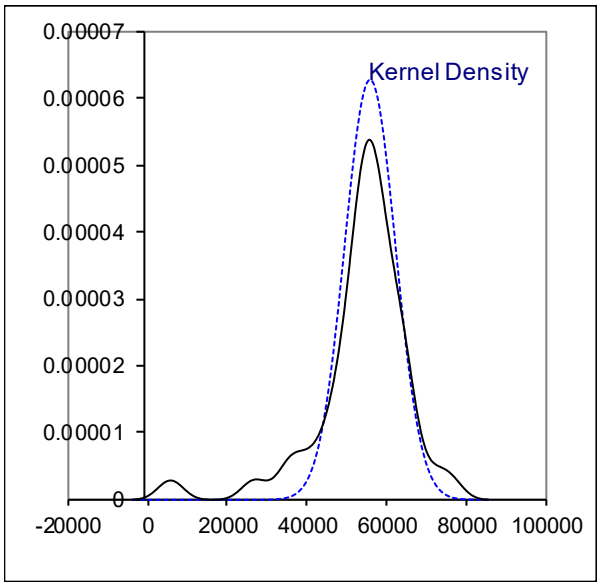
30000
40000

Determination of Nitrogen (N_2) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	52861.2		-0.77	
511		-----		-----	
614	D3612	26970	R(0.01)	-7.21	
862	IEC60567	51951.0		-1.00	
902	D3612	53294		-0.67	
912		-----		-----	
913	D3612	65079.01	ex	2.27	see §4.1
963	D3612	56374.0		0.10	
974	D3612	55120		-0.21	
975		-----		-----	
1135	IEC60567	43946		-2.99	
1137		-----		-----	
1264	D3612	40973.4		-3.73	
1304	In house	64111.84		2.03	
1306	D3612	61128.5		1.28	
1352		76033	R(0.01)	4.99	
1374	D3612	60425		1.11	
1430	IEC60567	71568		3.88	
1435	IEC60567	64631.9		2.16	
1442	IEC60567	54191		-0.44	
1444		-----		-----	
1478	IEC60567	57390.05		0.35	
1505	D3612	55319.9		-0.16	
1513	IEC60567	53741		-0.55	
1545	D3612	57360.8		0.35	
1560	IEC60567	55913		-0.01	
1660	IEC60567	55081		-0.22	
1719	D3612	54255		-0.43	
1743	IEC60567	50550		-1.35	
1885	D3612	60697		1.18	
1891	IEC60567	58103		0.53	
1897	IEC60567	56816		0.21	
1955	IEC60567	60657.743		1.17	
1966		-----		-----	
6015	D3612	49686.00		-1.56	
6036	IEC60567	64156		2.04	
6053	IEC60567	58347	ex	0.59	see §4.1
6063	IEC60567	57608.74		0.41	
6067	IEC60567	48854.43		-1.77	
6085	D3612	65751		2.43	
6088	IEC60567	58512		0.63	
6140	D3612	63242.0		1.81	
6141	D3612	46854.53		-2.27	
6239	D3612	53913.0		-0.51	
6255	IEC60567	35107.1	C,R(0.01)	-5.19	first reported 30215.73
6264		-----		-----	
6275	IEC60567	5961.5	R(0.01)	-12.44	
6278	D3612	47355		-2.14	
6280	IEC60567	37171	R(0.01)	-4.68	
6286	IEC60567	52465.77		-0.87	

normality	OK
n	36
outliers	5+2ex
mean (n)	55968.30
st.dev. (n)	6365.673
R(calc.)	17823.88
st.dev.(IEC60567:11)	4019.332
R(IEC60567:11)	11254.13

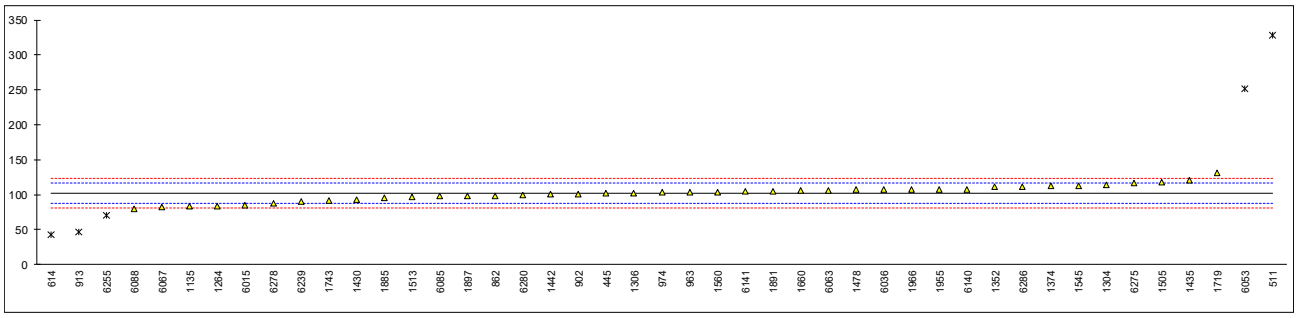

80090
70090
60090
50090
40090
30090
20090
10090
90
6275 614 6255 6280 1264 1135 6141 6278 6067 6015 1743 862 6286 445 902 1513 6239 1442 1719 1660 974 1505 1560 963 1897 1545 1478 6063 1891 6053 6088 1374 1955 1885 1306 6140 1304 6036 1435 913 6085 1430 1352

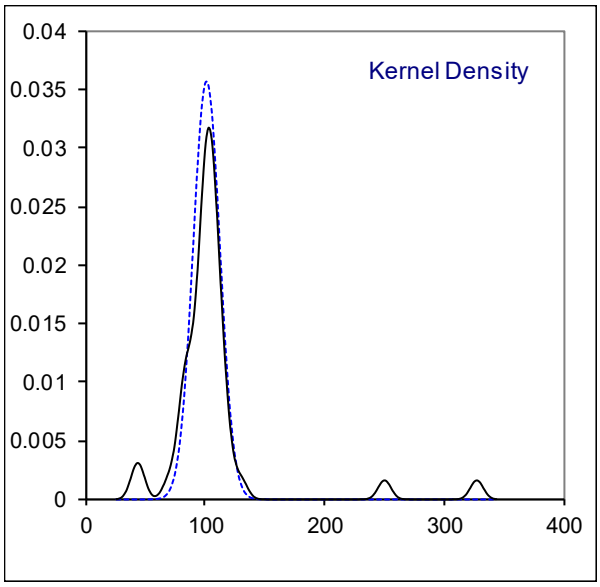

Kernel Density
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0
-20000 0 20000 40000 60000 80000 100000

Determination of Carbon Monoxide (CO) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	101.60		-0.07	
511	D3612	328.2	R(0.01)	31.23	
614	D3612	43	R(0.01)	-8.16	
862	IEC60567	98.6		-0.48	
902	D3612	100.55		-0.21	
912		-----		-----	
913	D3612	46.18	R(0.01)	-7.73	
963	D3612	103.9		0.25	
974	D3612	103		0.12	
975		-----		-----	
1135	IEC60567	83		-2.64	
1137		-----		-----	
1264	D3612	83.855		-2.52	
1304	In house	113.47		1.57	
1306	D3612	102.20583		0.01	
1352		111		1.23	
1374	D3612	113		1.51	
1430	IEC60567	93		-1.26	
1435	IEC60567	120.74426		2.58	
1442	IEC60567	100.2		-0.26	
1444		-----		-----	
1478	IEC60567	106.74		0.64	
1505	D3612	117.8		2.17	
1513	IEC60567	97.29		-0.66	
1545	D3612	113.0		1.51	
1560	IEC60567	104		0.26	
1660	IEC60567	106.1		0.55	
1719	D3612	131		3.99	
1743	IEC60567	91.1		-1.52	
1885	D3612	96		-0.84	
1891	IEC60567	104.9		0.39	
1897	IEC60567	98.2		-0.54	
1955	IEC60567	107.6		0.76	
1966	IEC60567	107.15		0.70	
6015	D3612	85.50		-2.29	
6036	IEC60567	107		0.68	
6053	IEC60567	251	C,R(0.01)	20.57	first reported 547
6063	IEC60567	106.60		0.62	
6067	IEC60567	82.60		-2.69	
6085	D3612	98		-0.57	
6088	IEC60567	80		-3.05	
6140	D3612	107.9		0.80	
6141	D3612	104.244		0.30	
6239	D3612	90.0		-1.67	
6255	IEC60567	70.9	ex,C	-4.31	first reported 47.39, see §4.1
6264		-----		-----	
6275	IEC60567	116.0		1.92	
6278	D3612	87		-2.09	
6280	IEC60567	99		-0.43	
6286	IEC60567	111.30		1.27	

normality	OK
n	40
outliers	4+1ex
mean (n)	102.10
st.dev. (n)	11.192
R(calc.)	31.34
st.dev.(IEC60567:11)	7.239
R(IEC60567:11)	20.27

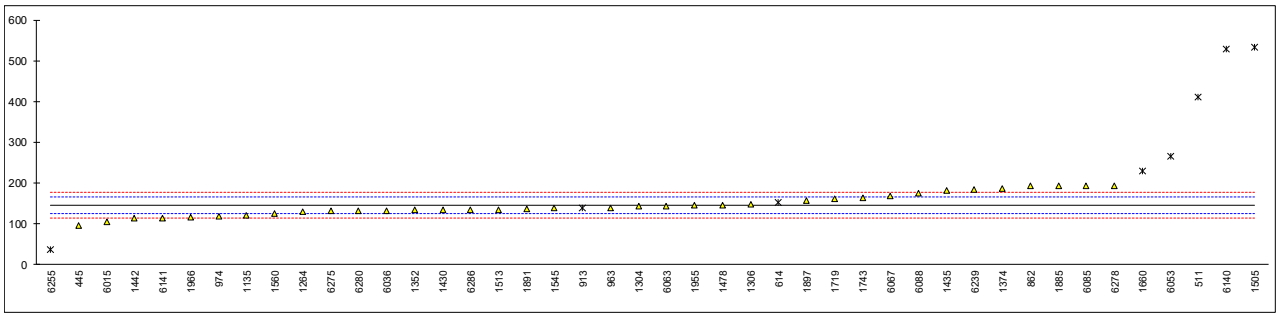

350
300
250
200
150
100
50
0
614
913
6255
6088
6087
1135
1264
6015
6278
6239
1743
1430
1885
1513
6085
1897
862
6280
1442
902
445
1306
974
963
1560
6141
1891
1660
6063
1478
6036
1966
1955
6140
1352
6286
1374
1545
1304
6275
1505
1435
1719
6053
511

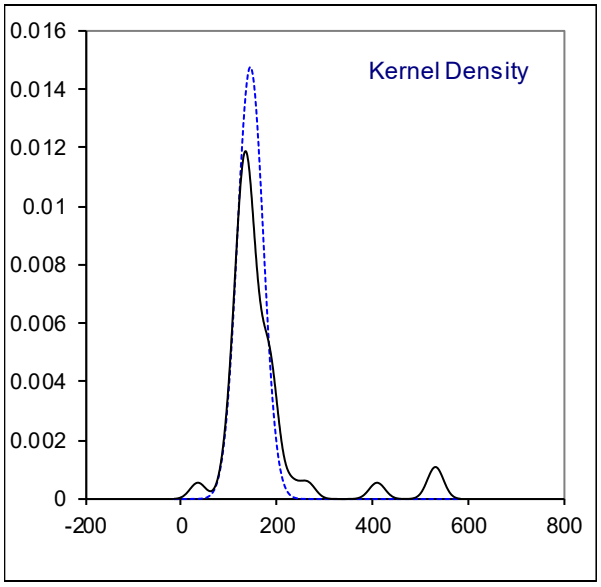

Kernel Density
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
100
200
300
400

Determination of Carbon Dioxide (CO_2) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	95.9		-4.81	
511	D3612	409.8	R(0.01)	25.27	
614	D3612	152	ex	0.56	see §4.1
862	IEC60567	192.0		4.40	
902		-----		-----	
912		-----		-----	
913	D3612	138.17	ex	-0.76	see §4.1
963	D3612	138.5		-0.73	
974	D3612	118		-2.70	
975		-----		-----	
1135	IEC60567	121		-2.41	
1137		-----		-----	
1264	D3612	130.6		-1.49	
1304	In house	142.34		-0.36	
1306	D3612	147.2922		0.11	
1352		134		-1.16	
1374	D3612	186		3.82	
1430	IEC60567	134		-1.16	
1435	IEC60567	182.41508		3.48	
1442	IEC60567	114.2		-3.06	
1444		-----		-----	
1478	IEC60567	146.03		-0.01	
1505	D3612	533.9	C,R(0.01)	37.17	first reported 281.7
1513	IEC60567	135		-1.07	
1545	D3612	138.1		-0.77	
1560	IEC60567	126		-1.93	
1660	IEC60567	229.6	R(0.01)	8.00	
1719	D3612	162		1.52	
1743	IEC60567	163		1.62	
1885	D3612	192		4.40	
1891	IEC60567	135.9		-0.98	
1897	IEC60567	157.2		1.06	
1955	IEC60567	145.981		-0.01	
1966	IEC60567	115.55		-2.93	
6015	D3612	105.50		-3.89	
6036	IEC60567	133		-1.26	
6053	IEC60567	265	C,R(0.05)	11.39	first reported 521
6063	IEC60567	144.17		-0.19	
6067	IEC60567	168.88		2.18	
6085	D3612	192		4.40	
6088	IEC60567	175		2.77	
6140	D3612	528.3	C,R(0.01)	36.63	first reported 241.5
6141	D3612	114.546		-3.03	
6239	D3612	183.4		3.57	
6255	IEC60567	37.2	C,R(0.05)	-10.44	first reported 23.16
6264		-----		-----	
6275	IEC60567	131.0		-1.45	
6278	D3612	194		4.59	
6280	IEC60567	132		-1.35	
6286	IEC60567	134.01		-1.16	

normality	OK
n	36
outliers	6+2ex
mean (n)	146.13
st.dev. (n)	27.001
R(calc.)	75.60
st.dev.(IEC60567:11)	10.434
R(IEC60567:11)	29.21

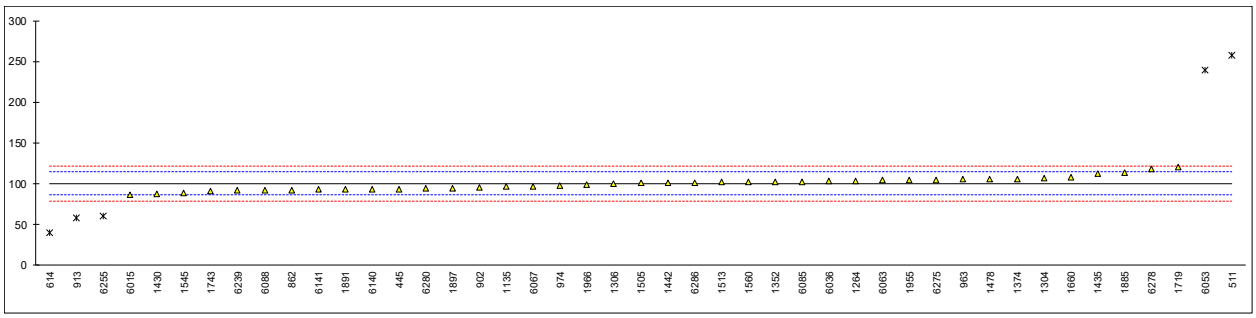

600
500
400
300
200
100
0
6255 445 6015 1442 6141 1966 974 1135 1560 1264 6275 6280 6036 1352 1430 6286 1513 1891 1545 913 963 1304 6063 1955 1478 1306 614 1897 1719 1743 6067 6088 1435 6239 1374 862 1885 6085 6278 1660 6053 511 6140 1505

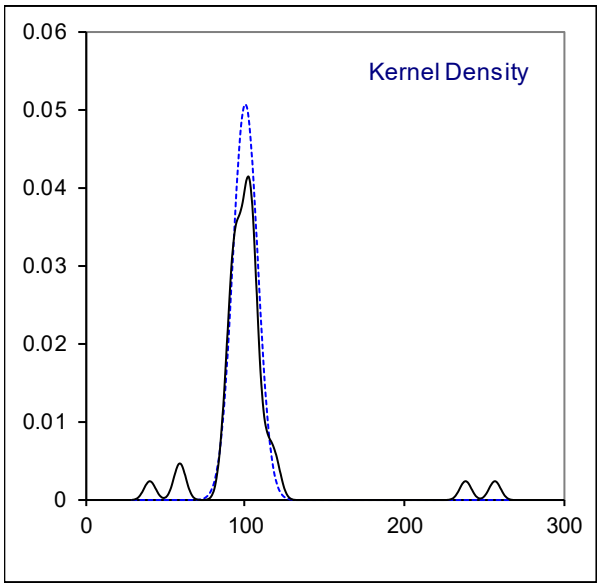

Kernel Density
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
-200
0
200
400
600
800

Determination of Methane (CH_4) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	93.68		-0.91	
511	D3612	257.5	R(0.01)	21.99	
614	D3612	40	R(0.01)	-8.41	
862	IEC60567	92.2		-1.11	
902	D3612	95.86		-0.60	
912		-----		-----	
913	D3612	58.05	R(0.01)	-5.89	
963	D3612	105.3		0.72	
974	D3612	98		-0.30	
975		-----		-----	
1135	IEC60567	96		-0.58	
1137		-----		-----	
1264	D3612	103.75		0.50	
1304	In house	106.91		0.94	
1306	D3612	100.47675		0.04	
1352		102		0.26	
1374	D3612	106		0.81	
1430	IEC60567	88		-1.70	
1435	IEC60567	112.73969		1.76	
1442	IEC60567	100.7		0.07	
1444		-----		-----	
1478	IEC60567	105.92		0.80	
1505	D3612	100.6		0.06	
1513	IEC60567	101.81		0.23	
1545	D3612	88.3		-1.66	
1560	IEC60567	102		0.26	
1660	IEC60567	107.9		1.08	
1719	D3612	120		2.77	
1743	IEC60567	90.6		-1.34	
1885	D3612	114		1.93	
1891	IEC60567	93.6		-0.92	
1897	IEC60567	94.6		-0.78	
1955	IEC60567	105.0		0.67	
1966	IEC60567	99.22		-0.13	
6015	D3612	86.50		-1.91	
6036	IEC60567	103		0.40	
6053	IEC60567	239	C,R(0.01)	19.40	first reported 541
6063	IEC60567	104.09		0.55	
6067	IEC60567	97.08		-0.43	
6085	D3612	102		0.26	
6088	IEC60567	92		-1.14	
6140	D3612	93.6		-0.92	
6141	D3612	93.259		-0.97	
6239	D3612	91.9		-1.16	
6255	IEC60567	59.8	C,R(0.01)	-5.64	first reported 44.03
6264		-----		-----	
6275	IEC60567	105.0		0.67	
6278	D3612	118	C	2.49	first reported 149
6280	IEC60567	93.8		-0.89	
6286	IEC60567	101.42		0.17	

normality	OK
n	40
outliers	5
mean (n)	100.17
st.dev. (n)	7.880
R(calc.)	22.06
st.dev.(IEC60567:11)	7.155
R(IEC60567:11)	20.03

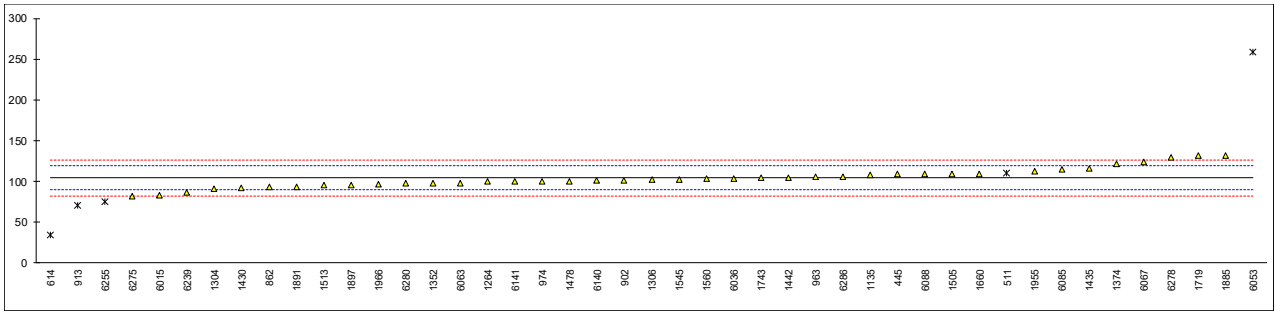

300
250
200
150
100
50
0
614
913
6255
6015
1430
1545
1743
6239
6088
862
6141
1891
6140
445
6280
1897
902
1135
6067
974
1966
1306
1505
1442
6286
1513
1560
1352
6085
6036
1264
6063
1955
6275
963
1478
1374
1304
1660
1435
1885
6278
1719
6053
511

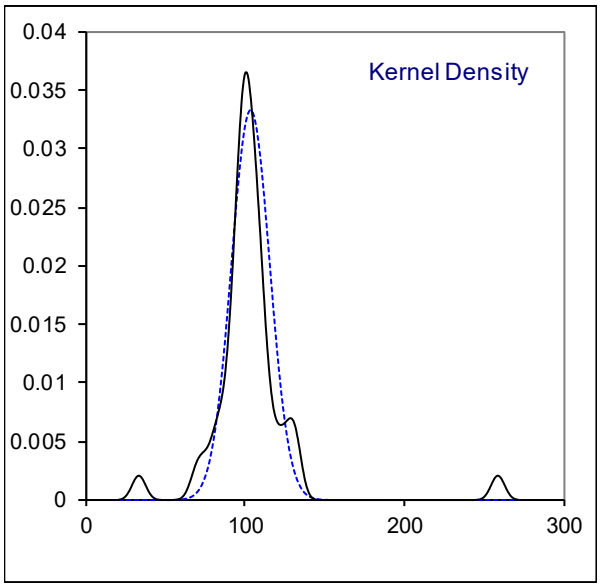

Kernel Density
0.06
0.05
0.04
0.03
0.02
0.01
0
0
100
200
300

Determination of Ethane (C_2H_6) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	109.00		0.68	
511	D3612	109.6	ex	0.76	see §4.1
614	D3612	34	R(0.01)	-9.55	
862	IEC60567	92.6		-1.56	
902	D3612	101.56		-0.34	
912		-----		-----	
913	D3612	70.10	ex	-4.63	see §4.1
963	D3612	105.2		0.16	
974	D3612	100		-0.55	
975		-----		-----	
1135	IEC60567	108.3		0.58	
1137		-----		-----	
1264	D3612	99.5		-0.62	
1304	In house	90.55		-1.84	
1306	D3612	101.82278		-0.30	
1352		98		-0.82	
1374	D3612	122		2.45	
1430	IEC60567	92		-1.64	
1435	IEC60567	116.37110		1.68	
1442	IEC60567	104.6		0.08	
1444		-----		-----	
1478	IEC60567	100.36		-0.50	
1505	D3612	109.4		0.73	
1513	IEC60567	95.61		-1.15	
1545	D3612	102.5		-0.21	
1560	IEC60567	103		-0.14	
1660	IEC60567	109.4		0.73	
1719	D3612	132	C	3.81	first reported 125
1743	IEC60567	104		-0.01	
1885	D3612	132		3.81	
1891	IEC60567	93.2		-1.48	
1897	IEC60567	95.9		-1.11	
1955	IEC60567	112.4		1.14	
1966	IEC60567	97.1		-0.95	
6015	D3612	83.50		-2.80	
6036	IEC60567	103		-0.14	
6053	IEC60567	259	C,R(0.01)	21.12	first reported 549
6063	IEC60567	98.20		-0.80	
6067	IEC60567	124.12		2.74	
6085	D3612	115		1.49	
6088	IEC60567	109		0.68	
6140	D3612	100.7		-0.46	
6141	D3612	99.85		-0.57	
6239	D3612	86.1		-2.45	
6255	IEC60567	75.1	ex,C	-3.95	first reported 69.01, see §4.1
6264		-----		-----	
6275	IEC60567	81.5		-3.07	
6278	D3612	129	C	3.40	first reported 154
6280	IEC60567	97.4		-0.91	
6286	IEC60567	106.06		0.27	

normality	OK
n	40
outliers	2+3ex
mean (n)	104.05
st.dev. (n)	11.990
R(calc.)	33.57
st.dev.(IEC60567:11)	7.337
R(IEC60567:11)	20.54

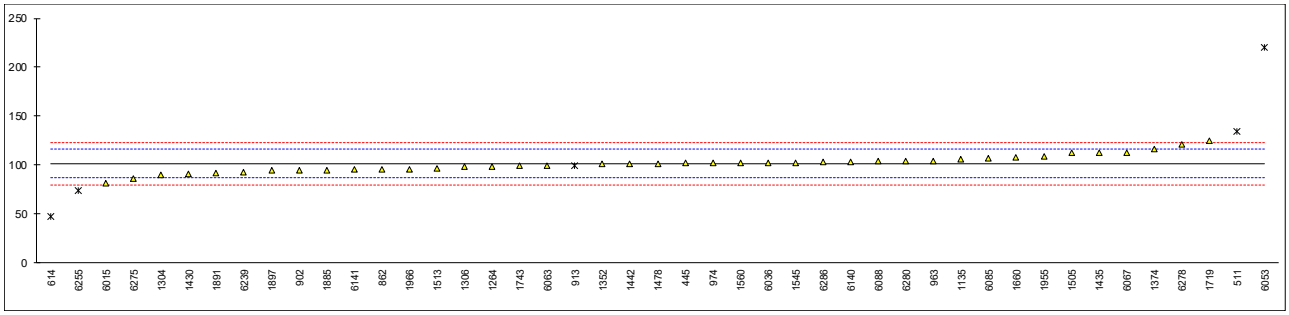

300
250
200
150
100
50
0
614
913
6255
6275
6015
6239
1304
1430
862
1891
1513
1897
1966
6280
1352
6063
1264
6141
974
1478
6140
902
1306
1545
1560
6036
1743
1442
963
6286
1135
445
6088
1505
1660
511
1955
6085
1435
1374
6067
6278
1719
1885
6053

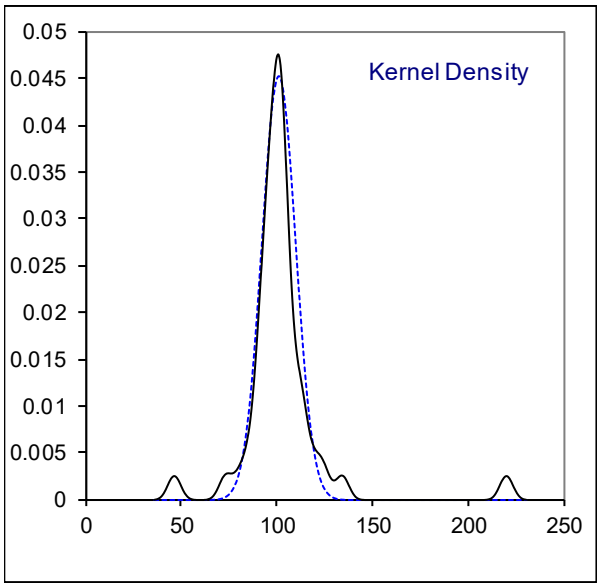

Kernel Density
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
100
200
300

Determination of Ethene / Ethylene (C_2H_4) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	101.83		0.05	
511	D3612	134.5	ex	4.56	see §4.1
614	D3612	47	R(0.01)	-7.51	
862	IEC60567	95.7		-0.79	
902	D3612	94.41		-0.97	
912		-----		-----	
913	D3612	99.47	ex	-0.27	see §4.1
963	D3612	104.3		0.40	
974	D3612	102		0.08	
975		-----		-----	
1135	IEC60567	105.6		0.57	
1137		-----		-----	
1264	D3612	98.55		-0.40	
1304	In house	89.45		-1.65	
1306	D3612	98.44118		-0.41	
1352		101		-0.06	
1374	D3612	116		2.01	
1430	IEC60567	91		-1.44	
1435	IEC60567	112.85561		1.58	
1442	IEC60567	101.0		-0.06	
1444		-----		-----	
1478	IEC60567	101.09		-0.05	
1505	D3612	112.4		1.51	
1513	IEC60567	96.71		-0.65	
1545	D3612	102.5		0.15	
1560	IEC60567	102		0.08	
1660	IEC60567	107.4		0.82	
1719	D3612	125	C	3.25	first reported 123
1743	IEC60567	99.3		-0.29	
1885	D3612	95	C	-0.89	first reported 128
1891	IEC60567	92.1		-1.29	
1897	IEC60567	94.4		-0.97	
1955	IEC60567	108.8		1.02	
1966	IEC60567	96.05		-0.74	
6015	D3612	81.50		-2.75	
6036	IEC60567	102		0.08	
6053	IEC60567	220	C,R(0.01)	16.35	first reported 548
6063	IEC60567	99.38		-0.28	
6067	IEC60567	112.98		1.59	
6085	D3612	107		0.77	
6088	IEC60567	104		0.35	
6140	D3612	103.6		0.30	
6141	D3612	95.483		-0.82	
6239	D3612	92.3		-1.26	
6255	IEC60567	73.8	ex,C	-3.81	first reported 62.08, see §4.1
6264		-----		-----	
6275	IEC60567	86.5		-2.06	
6278	D3612	121		2.70	
6280	IEC60567	104		0.35	
6286	IEC60567	102.70		0.17	

normality	OK
n	40
outliers	2+3ex
mean (n)	101.43
st.dev. (n)	8.818
R(calc.)	24.69
st.dev.(IEC60567:11)	7.251
R(IEC60567:11)	20.30

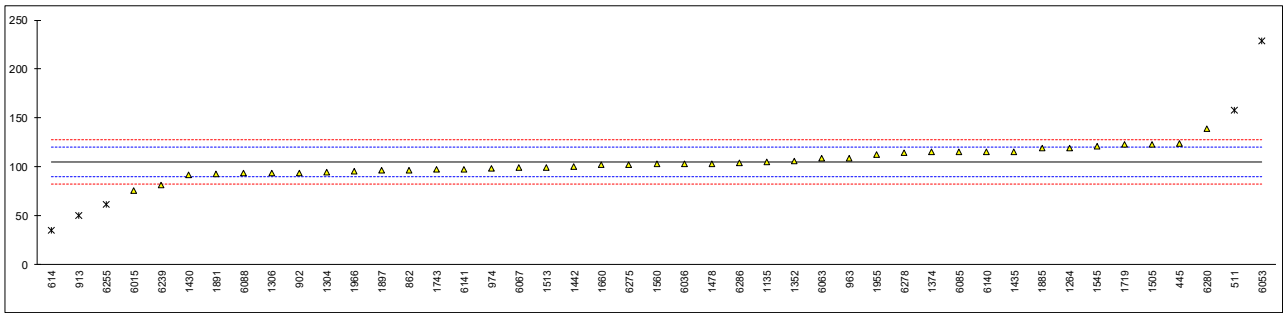

250
200
150
100
50
0
614
6255
6015
6275
1304
1430
1891
6239
1897
902
1885
6141
862
1966
1513
1306
1264
1743
6063
913
1352
1442
1478
445
974
1560
6036
1545
6286
6140
6088
6280
963
1135
6085
1660
1955
1505
1435
6067
1374
6278
1719
511
6053

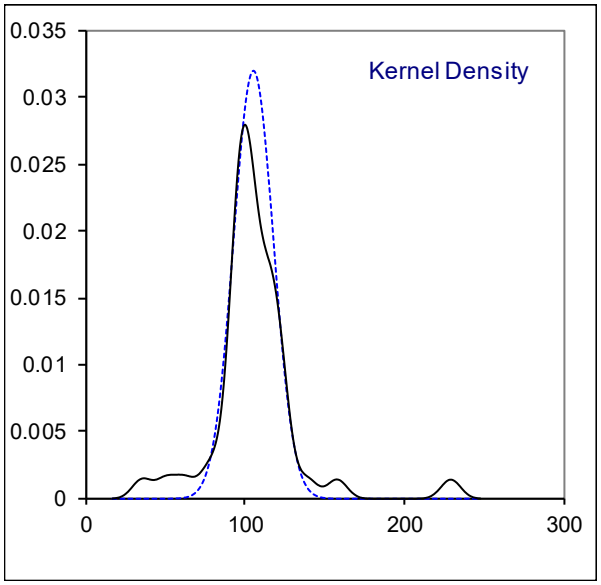

Kernel Density
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250

Determination of Ethyne / Acetylene (C_2H_2) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	123.56		2.46	
511	D3612	157.7	R(0.05)	7.01	
614	D3612	35	R(0.05)	-9.34	
862	IEC60567	96.9		-1.09	
902	D3612	93.93		-1.48	
912		-----		-----	
913	D3612	49.87	R(0.05)	-7.36	
963	D3612	109.0		0.52	
974	D3612	98		-0.94	
975		-----		-----	
1135	IEC60567	105.1		0.00	
1137		-----		-----	
1264	D3612	119.234		1.89	
1304	In house	94.61		-1.39	
1306	D3612	93.55989		-1.53	
1352		106		0.12	
1374	D3612	115		1.32	
1430	IEC60567	92		-1.74	
1435	IEC60567	115.19437		1.35	
1442	IEC60567	100.1		-0.66	
1444		-----		-----	
1478	IEC60567	103.36		-0.23	
1505	D3612	123.3		2.43	
1513	IEC60567	99.73		-0.71	
1545	D3612	121.3		2.16	
1560	IEC60567	103		-0.28	
1660	IEC60567	102.5		-0.34	
1719	D3612	123		2.39	
1743	IEC60567	97.6		-1.00	
1885	D3612	119		1.86	
1891	IEC60567	93.0		-1.61	
1897	IEC60567	96.5		-1.14	
1955	IEC60567	113.0		1.06	
1966	IEC60567	95.8		-1.24	
6015	D3612	76.00		-3.87	
6036	IEC60567	103		-0.28	
6053	IEC60567	229	C,R(0.01)	16.51	first reported 533
6063	IEC60567	108.69		0.48	
6067	IEC60567	99.63		-0.73	
6085	D3612	115		1.32	
6088	IEC60567	93.5		-1.54	
6140	D3612	115.0		1.32	
6141	D3612	97.836		-0.96	
6239	D3612	81.6		-3.13	
6255	IEC60567	61.9	C,R(0.01)	-5.75	first reported 54.28
6264		-----		-----	
6275	IEC60567	102.5		-0.34	
6278	D3612	114		1.19	
6280	IEC60567	139		4.52	
6286	IEC60567	103.83		-0.17	

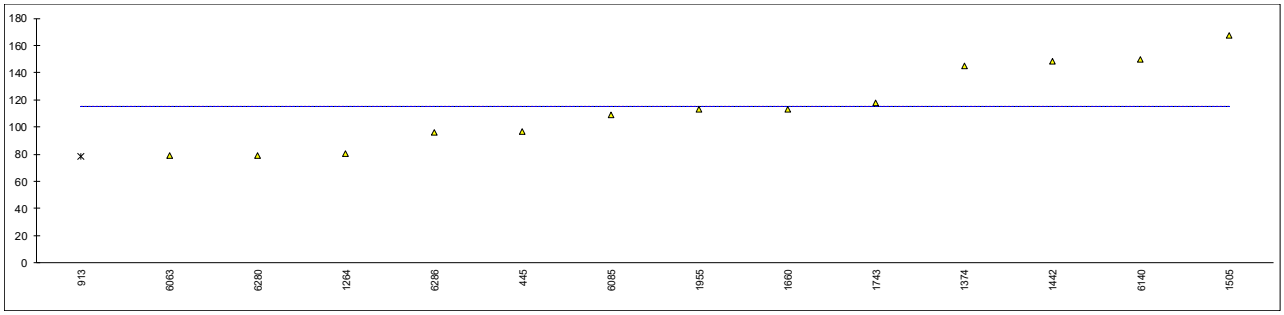
normality	OK
n	40
outliers	5
mean (n)	105.07
st.dev. (n)	12.487
R(calc.)	34.96
st.dev.(IEC60567:11)	7.505
R(IEC60567:11)	21.01

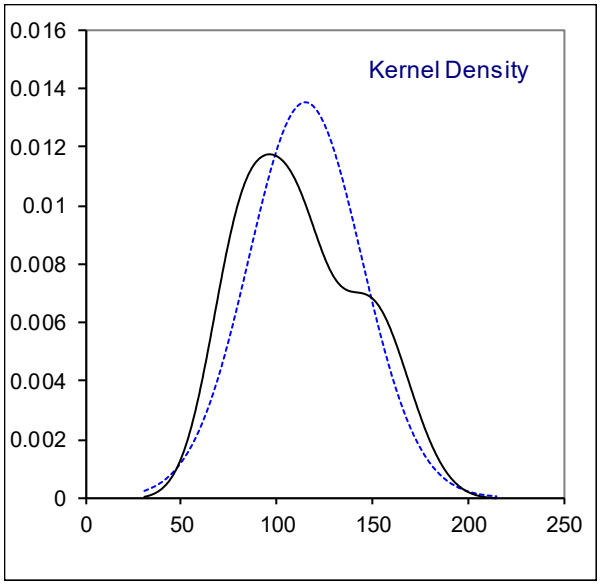

250
200
150
100
50
0
614
913
6255
6015
6239
1430
1891
6088
1306
902
1304
1966
1897
862
1743
6141
974
6067
1513
1442
1660
6275
1560
6036
1478
6286
1135
1352
6063
963
1955
6278
1374
6085
6140
1435
1885
1264
1545
1719
1505
445
6280
511
6053


Kernel Density
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
100
200
300

Determination of Propane (C_3H_8) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	97.00		-----	
511		-----		-----	
614		-----		-----	
862		-----		-----	
902		-----		-----	
912		-----		-----	
913	D3612	78.50	ex	-----	see §4.1
963		-----		-----	
974		-----		-----	
975		-----		-----	
1135		-----		-----	
1137		-----		-----	
1264	D3612	80.64		-----	
1304		-----		-----	
1306		-----		-----	
1352		-----		-----	
1374	D3612	145		-----	
1430		-----		-----	
1435		-----		-----	
1442	IEC60567	148.5		-----	
1444		-----		-----	
1478		-----		-----	
1505	D3612	167.1		-----	
1513		-----		-----	
1545		-----		-----	
1560		-----		-----	
1660	IEC60567	113.0		-----	
1719		-----		-----	
1743	IEC60567	118		-----	
1885		-----		-----	
1891		-----		-----	
1897		-----		-----	
1955	IEC60567	112.7		-----	
1966		-----		-----	
6015		-----		-----	
6036		-----		-----	
6053		-----		-----	
6063	IEC60567	78.72		-----	
6067		-----		-----	
6085	D3612	109		-----	
6088		-----		-----	
6140	D3612	149.6		-----	
6141		-----		-----	
6239		-----		-----	
6255		-----		-----	
6264		-----		-----	
6275		-----		-----	
6278		-----		-----	
6280	IEC60567	79.2		-----	
6286	IEC60567	95.90		-----	
	normality	OK			
	n	13			
	outliers	0+1ex			
	mean (n)	114.95			
	st.dev. (n)	29.517			
	R(calc.)	82.65			
	st.dev.(IEC60567:11)	(8.211)			
	R(IEC60567:11)	(22.99)			

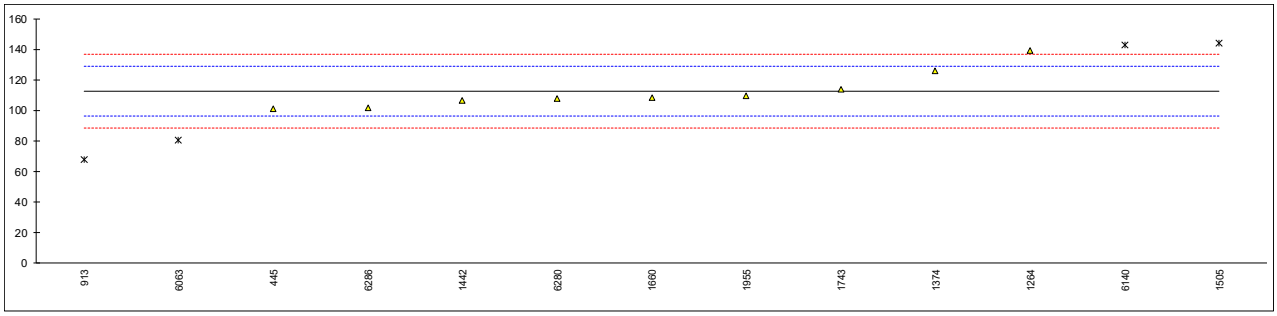

180
160
140
120
100
80
60
40
20
0
913
6063
6280
1264
6286
445
6085
1955
1660
1743
1374
1442
6140
1505

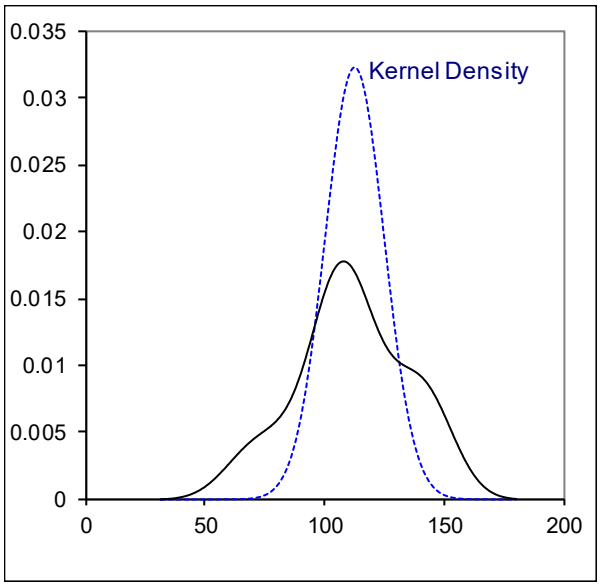

Kernel Density
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
50
100
150
200
250

Determination of Propene (C_3H_6) on sample #19244; results in µL/L

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237		-----		-----	
331		-----		-----	
360		-----		-----	
398		-----		-----	
445	IEC60567	101.08		-1.43	
511		-----		-----	
614		-----		-----	
862		-----		-----	
902		-----		-----	
912		-----		-----	
913	D3612	67.74	D(0.01)	-5.58	
963		-----		-----	
974		-----		-----	
975		-----		-----	
1135		-----		-----	
1137		-----		-----	
1264	D3612	138.91		3.27	
1304		-----		-----	
1306		-----		-----	
1352		-----		-----	
1374	D3612	126		1.67	
1430		-----		-----	
1435		-----		-----	
1442	IEC60567	106.3		-0.78	
1444		-----		-----	
1478		-----		-----	
1505	D3612	143.8	C,D(0.01)	3.88	first reported 157.7
1513		-----		-----	
1545		-----		-----	
1560		-----		-----	
1660	IEC60567	108.3		-0.53	
1719		-----		-----	
1743	IEC60567	114		0.17	
1885		-----		-----	
1891		-----		-----	
1897		-----		-----	
1955	IEC60567	109.4		-0.40	
1966		-----		-----	
6015		-----		-----	
6036		-----		-----	
6053		-----		-----	
6063	IEC60567	80.43	D(0.01)	-4.00	
6067		-----		-----	
6085		-----		-----	
6088		-----		-----	
6140	D3612	142.7	D(0.01)	3.74	
6141		-----		-----	
6239		-----		-----	
6255		-----		-----	
6264		-----		-----	
6275		-----		-----	
6278		-----		-----	
6280	IEC60567	108		-0.57	
6286	IEC60567	101.37		-1.40	

normality	not OK
n	9
outliers	4
mean (n)	112.60
st.dev. (n)	12.360
R(calc.)	34.61
st.dev.(IEC60567:11)	8.043
R(IEC60567:11)	22.52


160
140
120
100
80
60
40
20
0
913
6063
445
6286
1442
6280
1660
1955
1743
1374
1264
6140
1505


Kernel Density
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200

APPENDIX 2

Analytical details

lab	Extraction method	Type of syringe (mL)
179	---	---
237	---	---
331	---	---
360	---	---
398	---	---
445	Head Space	50 mL
511	---	---
614	ToGas	100 mL
862	Oscillation	100 mL
902	Head Space	100 mL
912	---	---
913	---	---
963	Head Space	50 mL
974	Head Space	100 mL
975	---	---
1135	Head Space	50 mL
1137	---	---
1264	Head Space	100 mL
1304	Head Space	50 mL
1306	Head Space	50 mL
1352	Toepler	100 mL
1374	Head Space	50 mL
1430	Head Space	50 mL
1435	Head Space	50 mL
1442	Head Space	50 mL
1444	---	---
1478	Toepler	100 mL
1505	Head Space	50 mL
1513	Toepler	100 mL
1545	---	---
1560	Head Space	50 mL
1660	Head Space	50 mL
1719	Stripper Column	100 mL
1743	Head Space	100 mL
1885	Toepler	100 mL
1891	Head Space	50 mL
1897	Head Space	50 mL
1955	Head Space	100 mL
1966	---	---
6015	Head Space	50 mL
6036	Head Space	50 mL
6053	Head Space	100 mL
6063	Toepler	100 mL
6067	Head Space	100 mL
6085	Head Space	50 mL
6088	Head Space	100 mL
6140	Head Space	50 mL
6141	Head Space	100 mL
6239	Head Space	50 mL
6255	Head Space	100 mL
6264	---	---
6275	Stripper Column	50 mL
6278	Toepler	100 mL
6280	Head Space	100 mL
6286	Head Space	100 mL

APPENDIX 3

Number of participants per country

6 labs in	AUSTRALIA
2 labs in	BELGIUM
1 lab in	BOSNIA and HERZEGOVINA
2 labs in	BULGARIA
1 lab in	CHINA, People's Republic
2 labs in	FRANCE
1 lab in	GEORGIA
2 labs in	GERMANY
2 labs in	GREECE
2 labs in	INDIA
1 lab in	INDONESIA
1 lab in	ISRAEL
2 labs in	ITALY
1 lab in	KUWAIT
2 labs in	MALAYSIA
1 lab in	NEW ZEALAND
1 lab in	NIGERIA
1 lab in	PERU
1 lab in	PHILIPPINES
1 lab in	POLAND
1 lab in	PORTUGAL
2 labs in	QATAR
3 labs in	SAUDI ARABIA
2 labs in	SINGAPORE
2 labs in	SLOVENIA
1 lab in	SOUTH AFRICA
1 lab in	SOUTH KOREA
2 labs in	SPAIN
1 lab in	SWITZERLAND
2 labs in	TURKEY
3 labs in	UNITED ARAB EMIRATES
1 lab in	UNITED KINGDOM
1 lab in	UNITED STATES OF AMERICA

APPENDIX 4

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	= possibly an error in calculations
W	= test result withdrawn on request of participant
ex	= test result excluded from statistical evaluation
fr.	= first reported
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
SDS	= Safety Data Sheet

Literature

1 iis Interlaboratory Studies, Protocol for the Organisation, Statistics and Evaluation, June 2018
2 ASTM E178:02
3 ASTM E1301:95(2003)
4 ISO13528:05
5 ISO5725:86
6 ISO5725, parts 1-6, 1994
7 M. Thompson and R. Wood, J. AOAC Int, 76, 926, (1993)
8 W.J. Youden and E.H. Steiner, Statistical Manual of the AOAC, (1975)
9 IP 367/84
10 DIN 38402 T41/42
11 P.L. Davies, Fr. Z. Anal. Chem, 331, 513, (1988)
12 J.N. Miller, Analyst, 118, 455, (1993)
13 Analytical Methods Committee, Technical Brief, No 4, January 2001
14 P.J. Lowthian and M. Thompson, The Royal Society of Chemistry, Analyst, 127, 1359-1364 (2002)
15 Bernard Rosner, Percentage Points for a Generalized ESD Many-Outlier Procedure, Technometrics, 25(2), 165-172, (1983).