



Institute for
Interlaboratory Studies

Results of Proficiency Test Styrene October 2023

Organized by: Institute for Interlaboratory Studies
Spijkenisse, the Netherlands

Author: ing. G.A. Oosterlaken-Buijs
Correctors: Mrs. E.R. Montenij-Bos & ing. R.J. Starink
Approved by: ing. R.J. Starink

Report: iis23C07

November 2023

CONTENTS

1 INTRODUCTION 3

2 SET UP 3

2.1 ACCREDITATION 3

2.2 PROTOCOL 3

2.3 CONFIDENTIALITY STATEMENT 3

2.4 SAMPLES 4

2.5 STABILITY OF THE SAMPLES 4

2.6 ANALYZES 5

3 RESULTS 5

3.1 STATISTICS 5

3.2 GRAPHICS 6

3.3 Z-SCORES 7

4 EVALUATION 7

4.1 EVALUATION PER TEST 8

4.2 PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES 9

4.3 COMPARISON OF THE PROFICIENCY TEST OF OCTOBER 2023 WITH PREVIOUS PTS 10

Appendices:

1. Data, statistical and graphic results 12

2. Other reported test results 27

3. Number of participants per country 29

4. Abbreviations and literature 30

1 INTRODUCTION

Since 1999 the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for the analysis of Styrene in accordance with the latest version of ASTM D2827 every year. During the annual proficiency testing program of 2023 it was decided to continue the round robin for the analysis of Styrene.

In this interlaboratory study 35 laboratories in 18 countries registered for participation, see appendix 3 for the number of participants per country. In this report the results of the Styrene 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). Sample analyzes for fit-for-use and homogeneity testing were subcontracted to a laboratory that has performed the tests in accordance with for ISO/IEC17043 relevant requirements of ISO/IEC17025.

It was decided to send one sample Styrene in a 0.5 L glass bottle labelled #23180.

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

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

A batch of approximately 35 liters of Styrene was obtained from a local supplier. After homogenization 55 amber glass bottles of 0.5 L were filled and labelled #23180. The homogeneity of the subsamples was checked by determination of Density at 20 °C in accordance with ASTM D4052 on 8 stratified randomly selected subsamples.

	Density at 20 °C in kg/L
sample #23180-1	0.90619
sample #23180-2	0.90618
sample #23180-3	0.90619
sample #23180-4	0.90619
sample #23180-5	0.90620
sample #23180-6	0.90619
sample #23180-7	0.90619
sample #23180-8	0.90619

Table 1: homogeneity test results of subsamples #23180

From the above test results the repeatability was calculated and compared with 0.3 times the reproducibility of the reference test method in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Density at 20 °C in kg/L
r (observed)	0.00001
reference test method	ISO12185:96
0.3 x R (reference test method)	0.00015

Table 2: evaluation of the repeatability of subsamples #23180

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

To each of the participating laboratories one 0.5 L bottle of Styrene labelled #23180 was sent on September 06, 2023. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

The stability of Styrene packed in amber glass bottles was checked. The material was found sufficiently stable for the period of the proficiency test.

2.6 ANALYZES

The participants were requested to determine: Aldehydes as Benzaldehyde, Appearance, Organic Chlorides, Color Pt/Co, Density at 20 °C, Inhibitor as TBC, Peroxides as H₂O₂, Polymer, Total Sulfur, Water, Purity by GC, Benzene, Toluene, Ethylbenzene, sum of m- and p-Xylenes, iso-Propylbenzene (Cumene), o-Xylene, n-Propylbenzene, sum of m- and p-Ethyltoluenes, alpha-Methylstyrene, 1,2-Diethylbenzene, sum of alpha-Methylstyrene and 1,2-Diethylbenzene, Phenylacetylene, 3/4-Methylstyrenes, sum of Phenylacetylene and 3/4-Methylstyrenes, Benzaldehyde and Non-aromatics.

It was also requested to report some analytical details on the determination of Aldehydes as Benzaldehyde.

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 appendices 1 and 2 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 appendices 1 and 2. Test results that came in after the deadline were not taken into account in this screening for suspect data and thus these participants were not requested for checks.

3.1 STATISTICS

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

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

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

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

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

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

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

3.2 GRAPHICS

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

Furthermore, Kernel Density Graphs were made. This is a method for producing a smooth density approximation to a set of data that avoids some problems associated with histograms. Also, a normal Gauss curve (dotted line) was projected over the Kernel Density

Graph (smooth line) for reference. The Gauss curve is calculated from the consensus value and the corresponding standard deviation.

3.3 Z-SCORES

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

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

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

The z-scores were calculated according to:

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

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

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

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

4 EVALUATION

Some problems were encountered with the dispatch of the samples. Therefore, the reporting time on the data entry portal was extended with another week. Four participant reported test results after the extended reporting date and two other participants did not report any test results. Not all participants were able to report all tests requested.

In total 33 participants reported 352 numerical test results. Observed were 9 outlying test results, which is 2.6%. In proficiency studies 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 TEST

In this section the reported test results are discussed per test. The test methods which were used by the various laboratories were taken into account for explaining the observed differences when possible and applicable. These test methods are also in the tables together with the original data in appendix 1. The abbreviations, used in these tables, are explained in appendix 4.

In the iis PT reports ASTM test methods are referred to with a number (e.g. D1209) and an added designation for the year that the test method was adopted or revised (e.g. D1209:05). When a method has been reapproved an "R" will be added and the year of approval (e.g. D1209:05R19).

Aldehydes as Benzaldehyde: The group of participants had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the requirements of ASTM D7704:16 and also not in agreement with the very strict requirements of ASTM D2119:19.

Appearance: All reporting participants agreed about the appearance of the sample as Pass (Clear & Bright).

Organic Chlorides: All reporting participants agreed on a value near or below the limit of detection. Therefore, no z-scores are calculated.

Color Pt/Co: The group of participants met the target requirements. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the requirements of ASTM D5386:16 and ASTM D1209:05R19.

Density at 20 °C: The group of participants met the target requirements. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the requirements of ISO12185:96.

Inhibitor as TBC: The group of participants had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the requirements of ASTM D4590:22.

Peroxides as H₂O₂: The group of participants had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the requirements of ASTM D2340:23.

Polymer: Almost all reporting participants agreed on a value near or below the limit of detection. Therefore, no z-scores are calculated.

Total Sulfur: All reporting participants agreed on a value near or below the application range. Therefore, no z-scores are calculated.

Water: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ASTM E1064:23.

Purity by GC: The group of participants met the target requirements. Three statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of ASTM D5135:21.

Ethylbenzene: The group of participants met the target requirements. Three statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of ASTM D5135:21.

alpha-Methylstyrene: The group of participants met the target requirements. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the requirements of ASTM D5135:21.

1,2-Diethylbenzene: Only six test results were reported of which two were numerical. Therefore, no z-scores are calculated.

sum of alpha-Methylstyrene and 1,2-Diethylbenzene: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ASTM D5135:21.

Benzaldehyde: The group of participants had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the requirements of ASTM D5135:21.

Non-aromatics: The group of participants had difficulty to meet the target requirements. No statistical outliers were observed. The calculated reproducibility is not in agreement with the requirements of ASTM D5135:21.

The participants agreed on a concentration near or below the limit of detection for all other components mentioned in paragraph 2.6. Therefore, no z-scores are calculated for these components. The reported test results are given in appendix 2.

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 ($2.8 \cdot$ standard deviation) and the target reproducibility derived from reference methods are presented in the next table.

Parameter	unit	n	average	2.8 * sd	R(lit)
Aldehydes as Benzaldehyde	mg/kg	25	85	118	106
Appearance		31	Pass (Cl & Br)	n.a.	n.a.
Organic Chlorides	mg/kg	19	<1	n.e.	n.e.
Color Pt/Co		31	8.8	4.1	6.0
Density at 20 °C	kg/L	29	0.9063	0.0002	0.0005
Inhibitor as TBC	mg/kg	33	6.9	3.3	2.9
Peroxides as H ₂ O ₂	mg/kg	27	25.6	32.4	13
Polymer	mg/kg	30	≤1	n.e.	n.e.
Total Sulfur	mg/kg	28	<1	n.e.	n.e.
Water	mg/kg	33	129	33	44
Purity by GC	%M/M	30	99.964	0.015	0.034
Ethylbenzene	mg/kg	30	115.8	16.5	25.6
alpha-Methylstyrene	mg/kg	29	107.5	18.0	32.4
sum of alpha-Methylstyrene and 1,2-Diethylbenzene	mg/kg	5	105.4	26.1	32.3
Benzaldehyde	mg/kg	19	44.6	37.4	16.7
Non-aromatics	mg/kg	17	59.7	118.9	69.7

Table 3: reproducibilities of tests on sample #23180

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.

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

	October 2023	October 2022	October 2021	October 2020	October 2019
Number of reporting laboratories	33	26	28	37	29
Number of test results	352	334	345	498	468
Number of statistical outliers	9	6	16	9	10
Percentage of statistical outliers	2.6%	1.8%	4.6%	1.8%	2.1%

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.

Parameter	October 2023	October 2022	October 2021	October 2020	October 2019
Aldehydes as Benzaldehyde	-	-	++	++	++
Organic Chloride	n.e.	n.e.	++	+	+/-
Color Pt/Co	+	+	+/-	+	+
Density at 20 °C	++	++	++	++	++
Inhibitor as TBC	-	+	+	+	+
Peroxides as H ₂ O ₂	--	--	-	-	-
Polymer	n.e.	+	++	+	++
Total Sulfur	n.e.	n.e.	+/-	n.e.	-
Water	+	+/-	-	+	-
Purity by GC	++	-	+	+	-
Benzene	n.e.	+	+	n.e.	+
Toluene	n.e.	+	+	n.e.	+
Ethylbenzene	+	+	+/-	+/-	+
sum of m- and p-Xylenes	n.e.	n.e.	n.e.	+	+/-
iso-Propylbenzene (Cumene)	n.e.	n.e.	n.e.	n.e.	--
o-Xylene	n.e.	n.e.	n.e.	n.e.	+
n-Propylbenzene	n.e.	n.e.	n.e.	n.e.	--
sum of m- and p-Ethyltoluenes	n.e.	n.e.	n.e.	n.e.	-
alpha-Methylstyrene	+	+	-	+/-	+
1,2-Diethylbenzene	n.e.	n.e.	n.e.	n.e.	n.e.
sum of alpha-Methylstyrene and 1,2-Diethylbenzene	+	n.e.	n.e.	-	n.e.
Phenylacetylene	n.e.	n.e.	n.e.	n.e.	-
3/4-Methylstyrenes	n.e.	n.e.	--	n.e.	n.e.
sum of Phenylacetylene and 3/4-Methylstyrenes	n.e.	n.e.	+	n.e.	n.e.
Benzaldehyde	--	+/-	+	-	-
Non-aromatics	--	--	-	-	-

Table 5: comparison of the determinations to the reference test methods

The following performance categories were used:

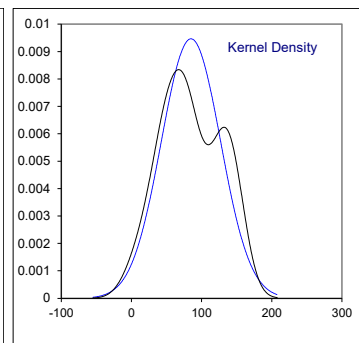
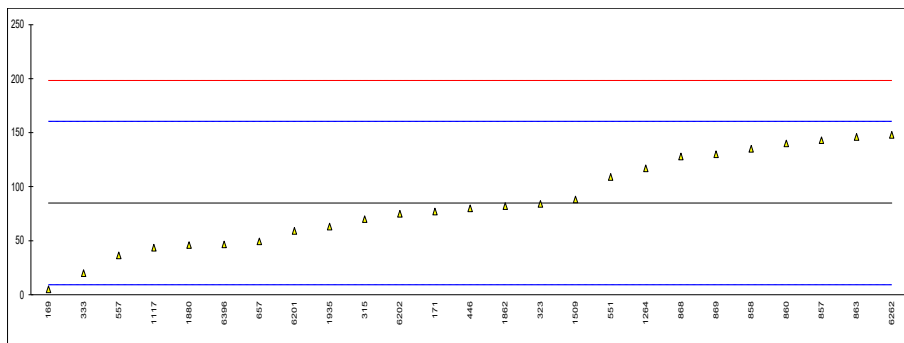
- ++ : group performed much better than the reference test method
- + : group performed better than the reference test method
- +/- : group performance equals the reference test method
- : group performed worse than the reference test method
- : group performed much worse than the reference test method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

APPENDIX 1

Determination of Aldehydes as Benzaldehyde on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	molarity NaOH solution	remarks
150		----		----	---	
169	D2119	5		-2.11	0.02 N NaOH	
171	D2119	77		-0.21	---	
273		----		----	---	
315	D2119	70		-0.39	0.05 N NaOH	
323	D2119	84		-0.02	---	
333	D2119	20	C	-1.71	---	reported 0.002 mg/kg
347		----		----	---	
446	D2119	80		-0.13	0.05 N NaOH	
551	D2119	109		0.64	0.05 N NaOH	
557	D2119	36.406815		-1.28	0.01 N NaOH	
657	D2119	49.41		-0.94	0.05 N NaOH	
857	D2119	143		1.54	0.05 N NaOH	
858	D2119	135		1.32	0.05 N NaOH	
860	D2119	140		1.46	0.05 N NaOH	
863	D2119	146		1.62	0.05 N NaOH	
868	D2119	128		1.14	0.05 N NaOH	
869	D2119	130		1.19	0.05 N NaOH	
913		----		----	---	
1117	D7704	43.51		-1.09	0.02 N KOH in MEOH	
1189		----		----	---	
1264	D2119	117		0.85	0.01 N NaOH	
1509	D2119	88.18		0.09	0.05 N NaOH	
1515		----		----	---	
1823		----		----	---	
1862	D2119	82		-0.08	0.05 N NaOH	
1880	D7704	46		-1.03	0.02 N KOH in Methanol	
1935	D2119	63		-0.58	0.05 N NaOH	
6198		----		----	---	
6201	D2119	59	C	-0.68	---	first reported 0.0059
6202	D2119	75		-0.26	0.05 N NaOH	
6262	D2119	148	C	1.67	0.02 N NaOH	first reported 0.013
6396	D2119	46.59		-1.01	0.02 N NaOH	
7014		----		----	---	
9008		----		----	---	

normality OK
n 25
outliers 0
mean (n) 84.844
st.dev. (n) 42.1393
R(calc.) 117.990
st.dev.(D7704:16) 37.8571
R(D7704:16) 106
compare
R(D2119:19) 34



Determination of Appearance on sample #23180;

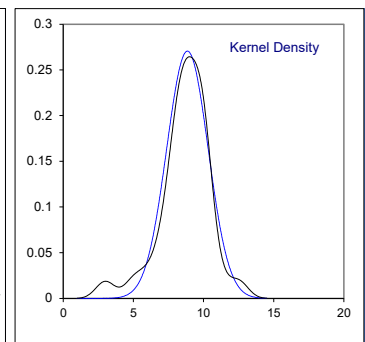
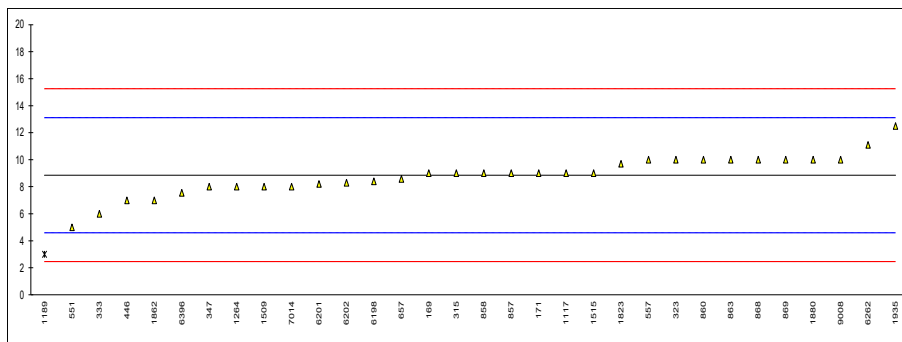
lab	method	value	mark	z(targ)	remarks
150	Visual	clear, bright, free from solid matter and water		----	
169	Visual	CBFSM		----	
171	E2680	Pass		----	
273		----		----	
315	E2680	pass		----	
323	E2680	PASS		----	
333		----		----	
347	E2680	Pass		----	
446	D4176	PASS		----	
551	E2680	Pass		----	
557	Visual	Clear and bright			
657	E2680	Pass		----	
857	E2680	Pass		----	
858	E2680	Pass		----	
860	E2680	Pass		----	
863	E2680	Pass		----	
868	E2680	Pass		----	
869	Visual	Clear and bright			
913		----		----	
1117	D4176	pass		----	
1189	Visual	Br & Cl		----	
1264	Visual	Pass		----	
1509	E2680	Clear & FFMS			
1515	E2680	PASS		----	
1823	D4176	Clear&FFSM&No Free Water			
1862	Visual	Cl&Br		----	
1880	Visual	Pass		----	
1935	Visual	B&C		----	
6198		----		----	
6201	Visual	Clear		----	
6202	Visual	CLEAR & BRIGHT			
6262	Visual	pass		----	
6396		Clear & Bright			
7014		Clear		----	
9008	Visual	Clear		----	
	n	31			
	mean (n)	Pass (Clear & Bright)			

Determination of Organic Chlorides on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D7359	<0.10		----	
169		----		----	
171	D5808	0.3		----	
273		----		----	
315	D5808	<0.7		----	
323	D5808	<0.2		----	
333		----		----	
347	D4929	<1		----	
446		----		----	
551		----		----	
557		----		----	
657	D5808	0.22		----	
857	D5808	<1		----	
858		----		----	
860	D5808	<1		----	
863		----		----	
868	D5808	<0.2		----	
869		----		----	
913		----		----	
1117		----		----	
1189	UOP779	<1		----	
1264	D5808	<1.0		----	
1509	D5808	<0.1		----	
1515		----		----	
1823		----		----	
1862	D5808	<1		----	
1880	D5808	0.1		----	
1935	UOP779	0.06		----	
6198		----		----	
6201	D5808	0.10		----	
6202		----		----	
6262	UOP779	0.05		----	
6396	D7536	0.00		----	
7014		----		----	
9008	D7359	<0.1		----	
	n	19			
	mean (n)	<1			

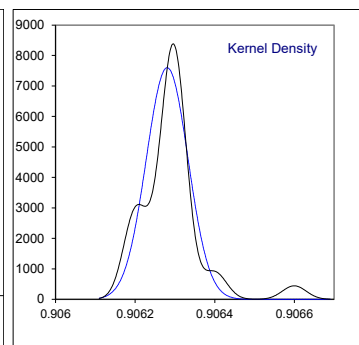
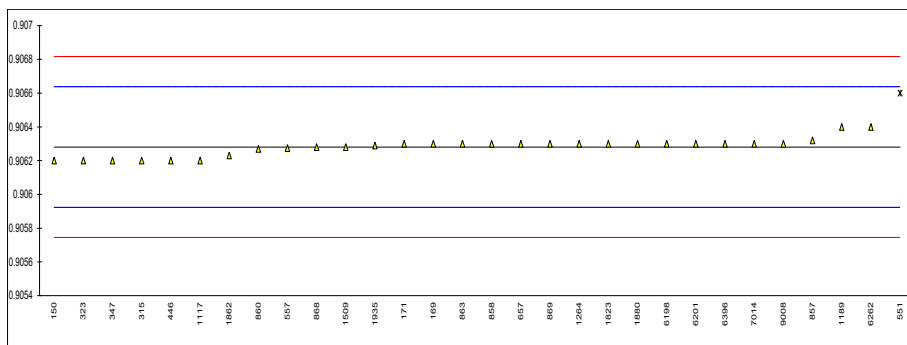
Determination of Color Pt/Co on sample #23180;

lab	method	value	mark	z(targ)	remarks
150		----		----	
169	D5386	9		0.07	
171	D5386	9		0.07	
273		----		----	
315	D5386	9		0.07	
323	D5386	10		0.54	
333	D5386	6		-1.34	
347	D5386	8		-0.40	
446	D5386	7		-0.87	
551	D5386	5		-1.81	
557	D5386	10	C	0.54	first reported 1
657	D5386	8.58		-0.13	
857	D5386	9		0.07	
858	D5386	9		0.07	
860	D5386	10		0.54	
863	D5386	10		0.54	
868	D1209	10		0.54	
869	D1209	10		0.54	
913		----		----	
1117	D5386	9		0.07	
1189		3.0	R(0.05)	-2.74	
1264	D1209	8		-0.40	
1509	D1209	8		-0.40	
1515	D1209	9		0.07	
1823	D5386	9.7		0.40	
1862	D1209	7		-0.87	
1880	D5386	10		0.54	
1935	D1209	12.5		1.71	
6198	D5386	8.4		-0.21	
6201	D5386	8.2		-0.30	
6202	D1209	8.3		-0.26	
6262	D5386	11.1		1.06	
6396	D5386	7.55		-0.61	
7014	D1209	8.0		-0.40	
9008	D5386	10		0.54	
normality		suspect			
n		31			
outliers		1			
mean (n)		8.85			
st.dev. (n)		1.474			
R(calc.)		4.13			
st.dev.(D5386:16)		2.131			
R(D5386:16)		5.97			
compare					
R(D1209:05R19)		7			



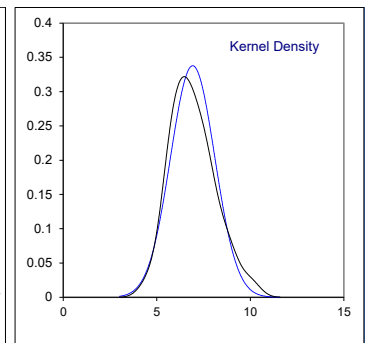
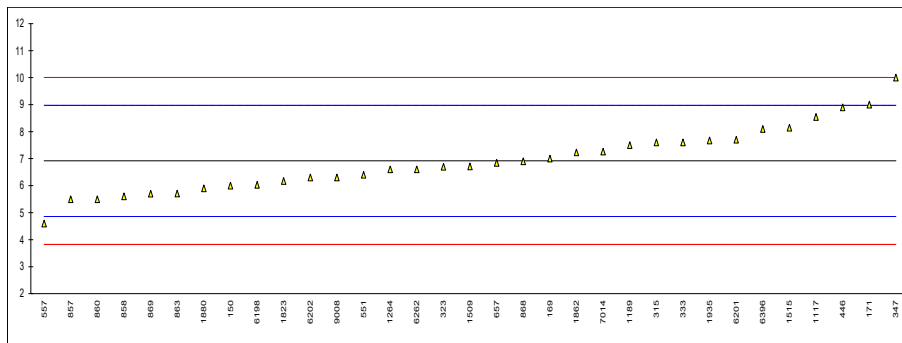
Determination of Density at 20 °C on sample #23180; results in kg/L

lab	method	value	mark	z(targ)	remarks
150	D4052	0.9062		-0.45	
169	D4052	0.9063	C	0.11	first reported 0.9019
171	D4052	0.9063		0.11	
273		-----		-----	
315	D4052	0.9062		-0.45	
323	D4052	0.9062		-0.45	
333		-----		-----	
347	D4052	0.9062		-0.45	
446	D4052	0.9062		-0.45	
551	D4052	0.9066	R(0.01)	1.79	
557	D4052	0.906275		-0.03	
657	D4052	0.9063		0.11	
857	D4052	0.90632		0.22	
858	D4052	0.9063		0.11	
860	D4052	0.90627		-0.06	
863	D4052	0.9063		0.11	
868	D4052	0.90628		0.00	
869	D4052	0.9063		0.11	
913		-----		-----	
1117	D4052	0.9062		-0.45	
1189		0.9064		0.67	
1264	D4052	0.9063		0.11	
1509	D4052	0.90628		0.00	
1515		-----		-----	
1823	D4052	0.9063		0.11	
1862	ISO12185	0.90623		-0.28	
1880	D4052	0.9063		0.11	
1935	D4052	0.90629		0.05	
6198	D4052	0.9063		0.11	
6201	ISO12185	0.9063		0.11	
6202		-----		-----	
6262	D4052	0.9064		0.67	
6396	D4052	0.9063		0.11	
7014	D4052	0.90630		0.11	
9008	D4052	0.9063		0.11	
	normality	OK			
	n	29			
	outliers	1			
	mean (n)	0.90628			
	st.dev. (n)	0.000052			
	R(calc.)	0.00015			
	st.dev.(ISO12185:96)	0.000179			
	R(ISO12185:96)	0.0005			



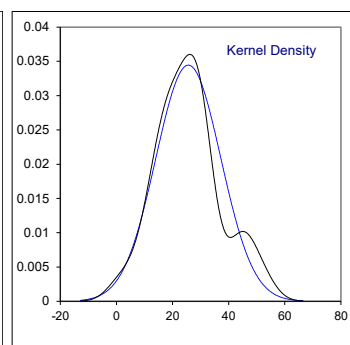
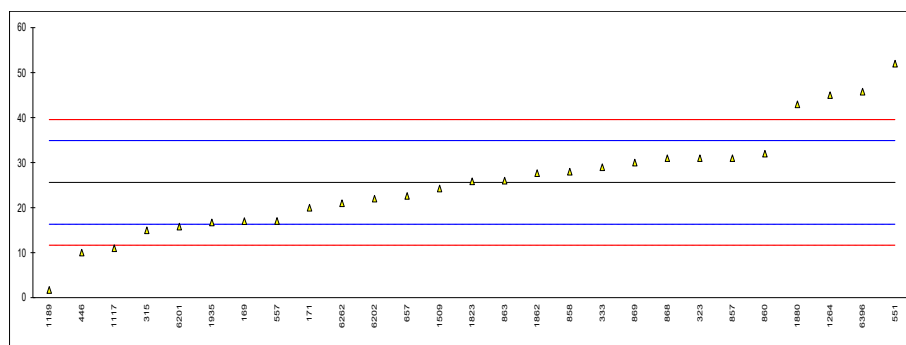
Determination of Inhibitor as TBC on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D4590	6		-0.89	
169	D4590	7		0.08	
171	D4590	9		2.02	
273		----		----	
315	D4590	7.6		0.66	
323	D4590	6.7		-0.21	
333	D4590	7.6		0.66	
347	D4590	10		2.99	
446	D4590	8.9		1.92	
551	D4590	6.4		-0.50	
557	D4590	4.6		-2.25	
657	D4590	6.8420		-0.07	
857	D4590	5.5		-1.38	
858	D4590	5.6		-1.28	
860	D4590	5.5		-1.38	
863	D4590	5.71		-1.17	
868	D4590	6.9		-0.02	
869	D4590	5.7		-1.18	
913		----		----	
1117	D4590	8.54		1.57	
1189		7.5		0.56	
1264	D4590	6.6		-0.31	
1509	D4590	6.716		-0.20	
1515	D4590	8.14950		1.19	
1823	D4590	6.175		-0.72	
1862	D4590	7.23		0.30	
1880	D4590	5.9		-0.99	
1935	D4590	7.673		0.73	
6198	D4590	6.03		-0.86	
6201	D4590	7.7		0.76	
6202	D4590	6.3		-0.60	
6262	D4590	6.6		-0.31	
6396	D4590	8.10		1.15	
7014	D4590	7.26		0.33	
9008	D4590	6.3		-0.60	
	normality	OK			
	n	33			
	outliers	0			
	mean (n)	6.919			
	st.dev. (n)	1.1806			
	R(calc.)	3.306			
	st.dev.(D4590:22)	1.0299			
	R(D4590:22)	2.884			



Determination of Peroxides as H₂O₂ on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150		----		----	
169	D2340	17		-1.85	
171	D2340	20		-1.21	
273		----		----	
315	D2340	15		-2.28	
323	D2340	31	C	1.16	first reported 61
333	D2340	29		0.73	
347		----		----	
446	D2340	10		-3.36	
551	D2340	52		5.68	
557	D2340	17.0424538		-1.85	
657	D2340	22.61		-0.65	
857	D2340	31		1.16	
858	D2340	28		0.52	
860	D2340	32		1.38	
863	D2340	26		0.08	
868	D2340	31		1.16	
869	D2340	30		0.95	
913		----		----	
1117	D2340	11		-3.15	
1189	D2340	1.74		-5.14	
1264	D2340	45		4.18	
1509	D2340	24.25		-0.29	
1515		----		----	
1823	D2340	25.867		0.06	
1862	D2340	27.7		0.45	
1880	D2340	42.96		3.74	
1935	D2340	16.7		-1.92	
6198		----		----	
6201	D2340	15.8		-2.11	
6202	D2340	22		-0.78	
6262	D2340	21		-0.99	
6396	D2340	45.77		4.34	
7014		----		----	
9008		----		----	
normality		OK			
n		27			
outliers		0			
mean (n)		25.609			
st.dev. (n)		11.5827			
R(calc.)		32.432			
st.dev.(D2340:18)		4.6429			
R(D2340:23)		13			



Determination of Polymer on sample #23180; results in mg/kg

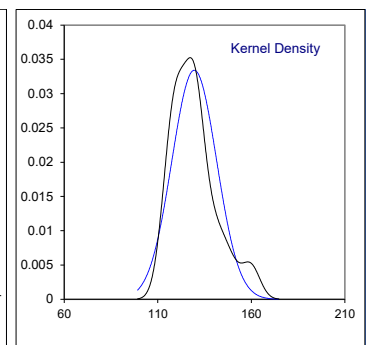
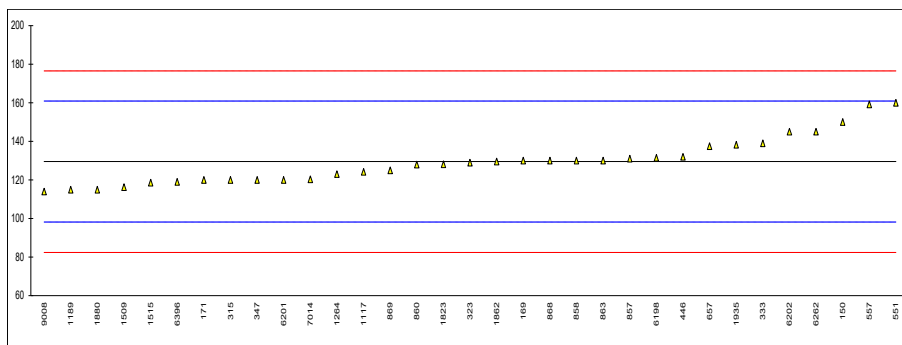
lab	method	value	mark	z(targ)	remarks
150	D2121-A	<1		----	
169	D2121-A	1		----	
171	D2121-A	<1.0		----	
273		----		----	
315	D2121-A	<1		----	
323	D2121-A	1		----	
333	D2121-A	1		----	
347	D2121-A	<1		----	
446	D2121-A	1		----	
551	D2121-A	1		----	
557	D2121-A	1.7		----	
657	D2121-A	0.636		----	
857	D2121-A	<1		----	
858	D2121-A	<1		----	
860	D2121-A	<1		----	
863	D2121-A	<1		----	
868	D2121-A	<1		----	
869	D2121-A	<1		----	
913		----		----	
1117	D2121-A	1.103		----	
1189		<1		----	
1264	D2121-A	2.0		----	
1509	D2121-A	0.698		----	
1515	D2121-A	0.078527		----	
1823	D2121-A	0.077		----	
1862	D2121-A	<1		----	
1880	D2121-A	1.0		----	
1935	D2121-A	0.15		----	
6198	D2121-A	<1.0		----	
6201	D2121-A	<1		----	
6202	D2121-A	1.7		----	
6262	D2121-A	<1		----	
6396	D2121-A	1.16		----	
7014	D2121-A	<1		----	
9008	D2121-A	1.0		----	
	n	30			
	mean (n)	≤1			

Determination of Total Sulfur on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D5453	<1.0		----	
169		----		----	
171	D5453	<1.0		----	
273		----		----	
315	D7183	0.17		----	
323	D5453	<1		----	
333	D5453	<0.5		----	
347	D5453	<1		----	
446		----		----	
551	D5453	<1		----	
557		----		----	
657	D5453	0.1		----	
857	D5453	<1		----	
858	D5453	<1		----	
860	D5453	<1		----	
863	D5453	<1.0		----	
868	D5453	<1		----	
869		----		----	
913		----		----	
1117	D5453	0.0514		----	
1189	D5453	0.29		----	
1264	D5453	<1.0		----	
1509	D5453	0.05		----	
1515		----		----	
1823	D5453	<1.0		----	
1862	D5453	<1		----	
1880	D5453	<0.1		----	
1935	D5453	0.04		----	
6198	D5453	<1.0		----	
6201	D5453	0.07		----	
6202	D5453	<0.09		----	
6262	D5453	0		----	
6396	D5453	0.27		----	
7014	D5453	<1		----	
9008	D5453	<0.1		----	
	n	28			
	mean (n)	<1			application range D5453:19a: 1-8000 mg/kg

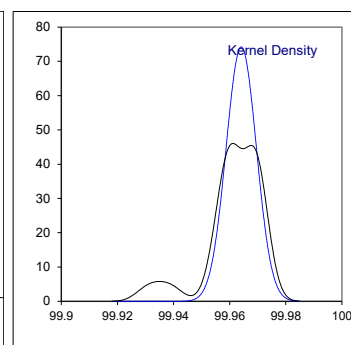
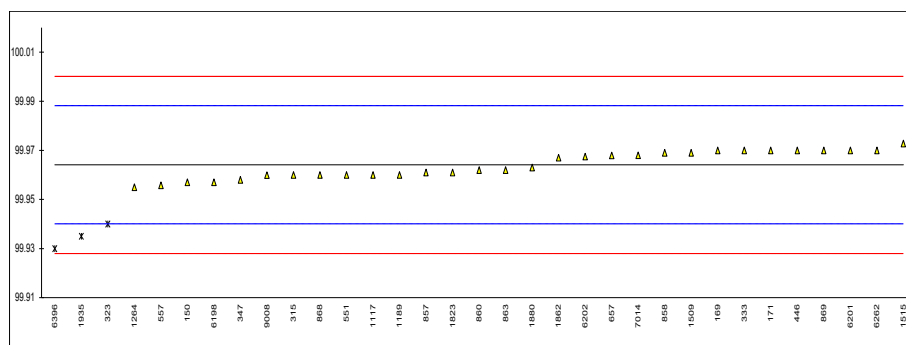
Determination of Water on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	E1064	150		1.31	
169	E1064	130		0.03	
171	E1064	120		-0.61	
273		----		----	
315	E1064	120		-0.61	
323	E1064	129		-0.03	
333	E1064	139		0.61	
347	E1064	120		-0.61	
446	E203	132		0.16	
551	E1064	160		1.95	
557	E1064	159.2		1.89	
657	E1064	137.5		0.51	
857	E1064	131		0.10	
858	E1064	130		0.03	
860	E1064	128		-0.10	
863	E1064	130		0.03	
868	E1064	130		0.03	
869	E1064	125		-0.29	
913		----		----	
1117	E1064	124.2		-0.34	
1189		115		-0.92	
1264	E1064	123		-0.41	
1509	E1064	116.25		-0.84	
1515	E1064	118.6		-0.70	
1823	E1064	128.1		-0.09	
1862	E1064	129.5		0.00	
1880	E1064	115		-0.92	
1935	E1064	138.3		0.56	
6198	E1064	131.5		0.13	
6201	E1064	120	C	-0.61	first reported 0.012 mg/kg
6202	E1064	145		0.99	
6262	E1064	145		0.99	
6396	E1064	119.0		-0.67	
7014	E1064	120.3		-0.59	
9008	E1064	114		-0.99	
normality		suspect			
n		33			
outliers		0			
mean (n)		129.50			
st.dev. (n)		11.943			
R(calc.)		33.44			
st.dev.(E1064:23)		15.681			
R(E1064:23)		43.91			



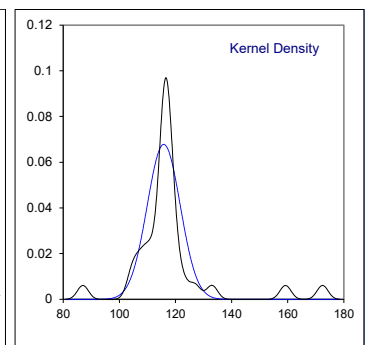
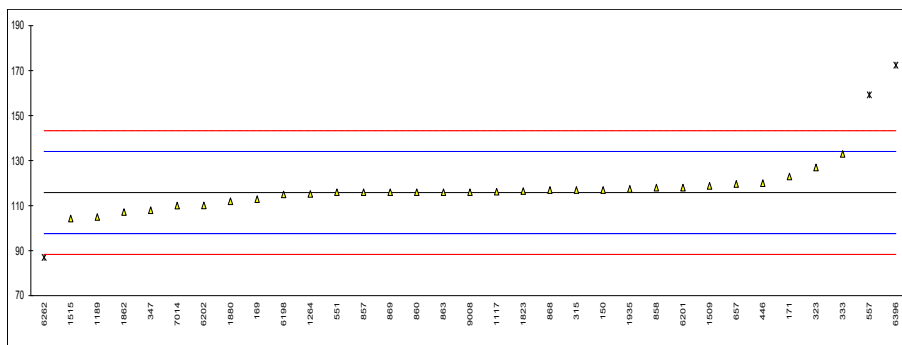
Determination of Purity by GC on sample #23180; results in %M/M

lab	method	value	mark	z(targ)	remarks
150	D5135	99.957		-0.59	
169	D5135	99.97	C	0.49	first reported 99.94
171	D5135	99.97		0.49	
273		-----		-----	
315	D5135	99.96		-0.34	
323	D5135	99.94	R(0.01)	-2.00	
333	D5135	99.97		0.49	
347	D5135	99.958		-0.51	
446	D5135	99.97		0.49	
551	D5135	99.96		-0.34	
557	D5135	99.955797		-0.69	
657	D5135	99.9679		0.32	
857	D5135	99.961		-0.26	
858	D5135	99.969		0.41	
860	D5135	99.962		-0.17	
863	D5135	99.962		-0.17	
868	D7504	99.96		-0.34	
869	D5135	99.97		0.49	
913		-----		-----	
1117	D5135	99.96		-0.34	
1189		99.96		-0.34	
1264	D5135	99.955		-0.76	
1509	D5135	99.969		0.41	
1515	D5135	99.97277		0.72	
1823	D5135	99.961		-0.26	
1862	D5135	99.967		0.24	
1880	D7504	99.963		-0.09	
1935	In house	99.935	C,R(0.01)	-2.42	first reported 99.997
6198	D5135	99.957		-0.59	
6201	D5135	99.97		0.49	
6202	D5135	99.9675		0.28	
6262	D5135	99.97		0.49	
6396	D5135	99.93	R(0.01)	-2.83	
7014	D5135	99.968		0.33	
9008	D7504	99.9599		-0.35	
normality		OK			
n		30			
outliers		3			
mean (n)		99.9641			
st.dev. (n)		0.00537			
R(calc.)		0.0150			
st.dev.(D5135:21)		0.01203			
R(D5135:21)		0.0337			



Determination of Ethylbenzene on sample #23180; results in mg/kg

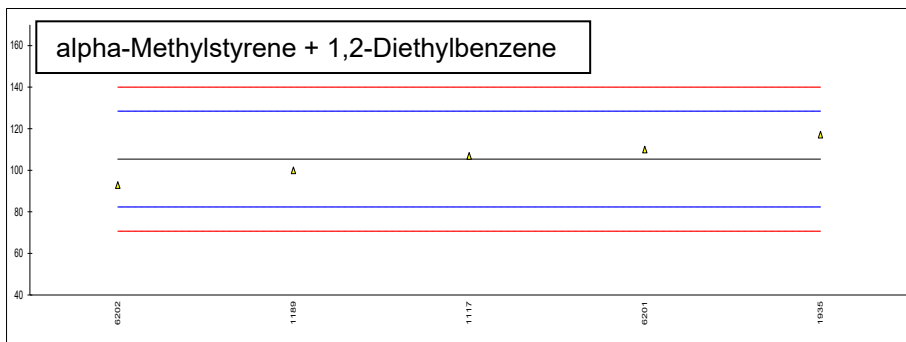
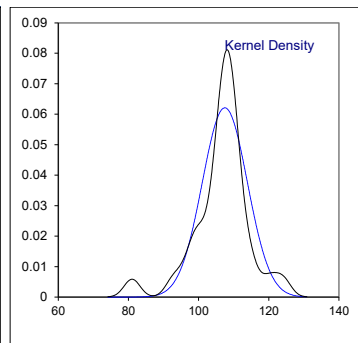
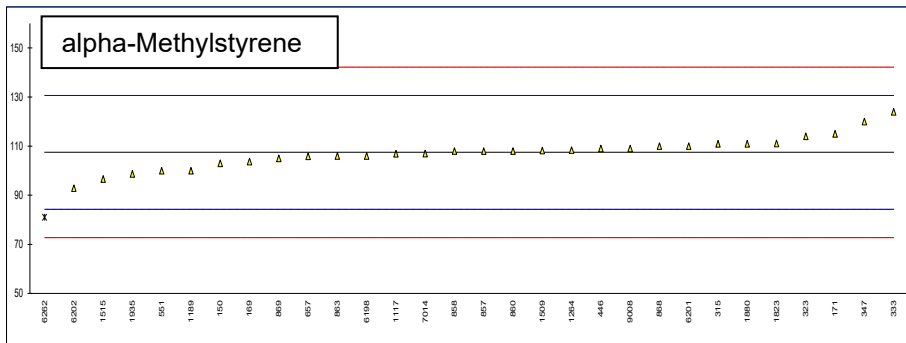
lab	method	value	mark	z(targ)	remarks
150	D5135	117		0.13	
169	D5135	112.9		-0.32	
171	D5135	123		0.79	
273		----		----	
315	D5135	117		0.13	
323	D5135	127		1.22	
333	D5135	133		1.88	
347	D5135	108		-0.85	
446	D5135	120		0.46	
551	D5135	116		0.02	
557	D5135	159.2	C,R(0.01)	4.74	first reported 344.575
657	D5135	119.6423		0.42	
857	D5135	116		0.02	
858	D5135	118		0.24	
860	D5135	116		0.02	
863	D5135	116		0.02	
868	D7504	117		0.13	
869	D5135	116		0.02	
913		----		----	
1117	D5135	116.165		0.04	
1189		105		-1.18	
1264	D5135	115.2		-0.07	
1509	D5135	118.82		0.33	
1515	D5135	104.3		-1.26	
1823	D5135	116.47		0.07	
1862	D5135	107.2		-0.94	
1880	D7504	112		-0.42	
1935	In house	117.5		0.18	
6198	D5135	115		-0.09	
6201	D5135	118		0.24	
6202	D5135	110.1		-0.62	
6262	D5135	87	R(0.01)	-3.15	
6396	D5135	172.41	R(0.01)	6.19	
7014	D5135	110.06		-0.63	
9008	D7504	116		0.02	
normality		suspect			
n		30			
outliers		3			
mean (n)		115.81			
st.dev. (n)		5.888			
R(calc.)		16.49			
st.dev.(D5135:21)		9.150			
R(D5135:21)		25.62			



Determination of alpha-Methylstyrene, 1,2-Diethylbenzene and sum of alpha-Methylstyrene + 1,2-Diethylbenzene on sample #23180; results in mg/kg

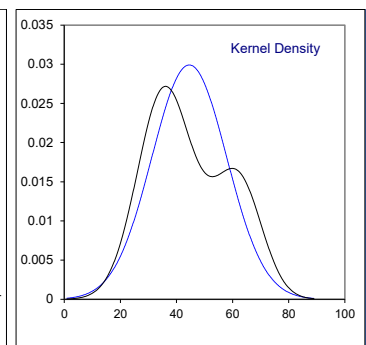
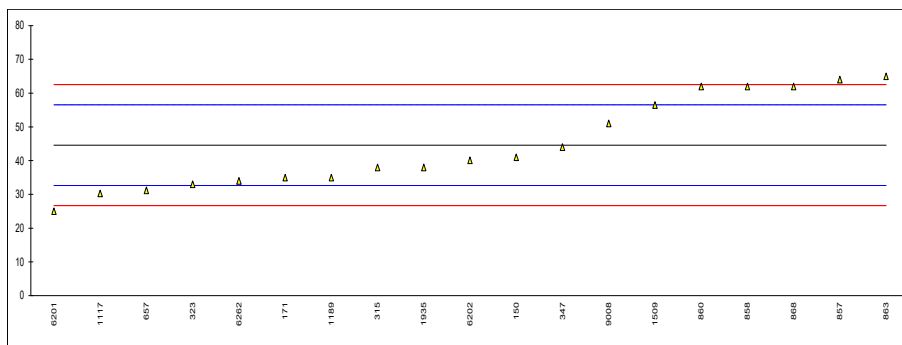
lab	method	alpha-MS	mark	z(targ)	1,2-DeB	mark	z(targ)	sum	mark	z(targ)
150	D5135	103		-0.38	----		----	----		----
169	D5135	103.7		-0.32	----		----	----		----
171	D5135	115		0.65	----		----	----		----
273		----		----	----		----	----		----
315	D5135	111		0.31	----		----	----		----
323	D5135	114		0.56	----		----	----		----
333	D5135	124		1.43	----		----	----		----
347	D5135	120		1.08	----		----	----		----
446	D5135	109		0.13	----		----	----		----
551	D5135	100		-0.64	----		----	----		----
557		----		----	----		----	----		----
657	D5135	105.8547		-0.14	----		----	----		----
857	D5135	108		0.05	----		----	----		----
858	D5135	108		0.05	----		----	----		----
860	D5135	108		0.05	----		----	----		----
863	D5135	106		-0.13	----		----	----		----
868	D7504	110		0.22	----		----	----		----
869	D5135	105		-0.21	----		----	----		----
913		----		----	----		----	----		----
1117	D5135	106.919		-0.05	0		----	106.919		0.13
1189		100		-0.64	<1		----	100		-0.47
1264	D5135	108.4		0.08	----		----	----		----
1509	D5135	108.16		0.06	----		----	----		----
1515	D5135	96.6		-0.94	----		----	----		----
1823	D5135	111.08		0.31	----		----	----		----
1862		----		----	----		----	----		----
1880	D7504	111		0.31	----		----	----		----
1935	In house	98.7		-0.76	10.38		----	117.16	E	1.02
6198	D5135	106		-0.13	----		----	----		----
6201	D5135	110		0.22	<10		----	110		0.40
6202	D5135	92.86		-1.26	<10		----	92.86		-1.09
6262	D5135	81	R(0.05)	-2.28	----		----	----		----
6396		----		----	----		----	----		----
7014	D5135	106.98		-0.04	----		----	----		----
9008	D7504	109		0.13	<10		----	----		----
	normality	suspect						unknown		
	n	29						5		
	outliers	1						0		
	mean (n)	107.46						105.39		
	st.dev. (n)	6.423						9.330		
	R(calc.)	17.98						26.12		
	st.dev.(D5135:21)	11.584						11.546		
	R(D5135:21)	32.44						32.33		

Lab 1935 calculation difference, iis calculated 109.08



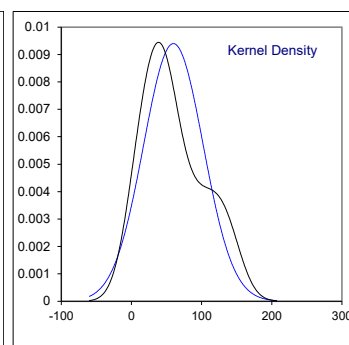
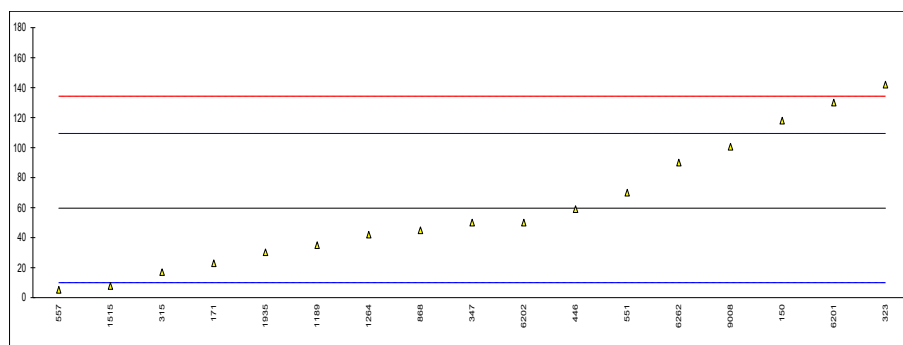
Determination of Benzaldehyde on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D5135	41		-0.60	
169		----		----	
171	D5135	35		-1.60	
273		----		----	
315	D5135	38		-1.10	
323	D5135	33		-1.94	
333		----		----	
347	D5135	44		-0.10	
446		----		----	
551		----		----	
557		----		----	
657	D5135Mod.	31.2134		-2.24	
857	D5135	64		3.25	
858	D5135	62		2.92	
860	D5135	62		2.92	
863	D5135	65		3.42	
868	D7504	62	C	2.92	first reported 72
869		----		----	
913		----		----	
1117	D5135	30.265		-2.40	
1189		35		-1.60	
1264		----		----	
1509	D5135	56.50		2.00	
1515		----		----	
1823		----		----	
1862		----		----	
1880		----		----	
1935	In house	38.0		-1.10	
6198		----		----	
6201	D5135	25		-3.28	
6202	D5135	40.1		-0.75	
6262	D5135	34	C	-1.77	first reported 0
6396		----		----	
7014		----		----	
9008	In house	51		1.07	
	normality	OK			
	n	19			
	outliers	0			
	mean (n)	44.58			
	st.dev. (n)	13.342			
	R(calc.)	37.36			
	st.dev.(D5135:21)	5.971			
	R(D5135:21)	16.72			



Determination of Non-aromatics on sample #23180; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D5135	118		2.34	
169		----		----	
171	D5135	23		-1.48	
273		----		----	
315	D5135	17		-1.72	
323	D5135	142		3.31	
333		----		----	
347	D5135	50		-0.39	
446	D5135	59		-0.03	
551	D5135	70		0.41	
557	D5135	5.235		-2.19	
657		----		----	
857		----		----	
858		----		----	
860		----		----	
863		----		----	
868	D7504	45		-0.59	
869		----		----	
913		----		----	
1117		----		----	
1189		35		-0.99	
1264	D5135	42		-0.71	
1509		----		----	
1515	D5135	7.8		-2.09	
1823		----		----	
1862		----		----	
1880		----		----	
1935	In house	30.25		-1.18	
6198		----		----	
6201	D5135	130		2.83	
6202	D5135	50.0		-0.39	
6262	D5135	90		1.22	
6396		----		----	
7014		----		----	
9008	D7504	100.6610		1.65	
normality		OK			
n		17			
outliers		0			
mean (n)		59.70			
st.dev. (n)		42.457			
R(calc.)		118.88			
st.dev.(D5135:21)		24.876			
R(D5135:21)		69.65			



APPENDIX 2

Other reported components on sample #23180; results in mg/kg

lab	Benzene	Toluene		Sum m- and p-Xylenes	Iso-Propylbenzene (Cumene)	o-Xylene
150	<10	<10	C	<10	<10	<10
169	1.5	----		----	----	----
171	<1.0	<10		<10	<10	<10
273	----	----		----	----	----
315	<1	<10		<20	<10	<10
323	<1	1		<10	<10	<10
333	<1	----		<10	<10	----
347	<1	----		----	<10	----
446	<10	<10		<10	<10	<10
551	<3	5		<3	<3	<3
557	3.34	<1		----	3.805	<1
657	1.1051	3.8702		<10	4.0719	<10
857	<3	<3		<3	<3	<3
858	<10	<10		<10	<10	<10
860	<1	<3		<3	<3	<3
863	<10	<10		----	<10	----
868	<2	<2		<2	<2	<2
869	<3	----		----	<3	----
913	----	----		----	----	----
1117	0	<5	C	0	0	0
1189	1.3	<1		25	<1	2
1264	2.6	5.0		<10	<10	<10
1509	<0.1	0.67		2.56	0	1.01
1515	0	2.4		0.6	0	0
1823	<0.2	<3		<3	4.64	<3
1862	<10	<10		<10	<10	<10
1880	<1	----		<10	<10	<10
1935	0	0		0	4.07	0
6198	<0.20	----		----	----	<3
6201	<1	1		<10	6	1
6202	<10	<10		<10	<10	<10
6262	0	0		3	0	0
6396	0	----		----	----	----
7014	<1	<1		<1	<1	<1
9008	<1	<1		<10	<10	<10

Lab 150 first reported 13

Lab 1117 first reported 13.889

Lab 1189 first reported 15

Other reported components on sample #23180; results in mg/kg - continued

lab	n-Propylbenzene	sum of m- and p-Ethyltoluenes	Phenylacetylene	3/4-Methylstyrenes	sum of Phenylacetylene + 3/4-Methylstyrenes
150	<10	<10	----	----	----
169	----	----	----	----	----
171	<10	----	----	----	----
273	----	----	----	----	----
315	<10	<20	<10	----	----
323	<10	<10	<10	----	----
333	----	----	<10	----	----
347	----	----	<10	----	----
446	----	----	<10	----	----
551	<3	----	----	----	----
557	----	----	<1	----	----
657	<10	<10	<10	<10	<10
857	<3	----	<3	----	----
858	<10	<10	<10	----	----
860	<3	<3	<3	----	----
863	<10	----	<10	----	----
868	<2	<2	<2	----	----
869	----	----	<3	----	----
913	----	----	----	----	----
1117	0	0	0	0	0
1189	<1	<1	<1	<1	<1
1264	<10	<10	1.3	----	----
1509	0.69	2.44	0.65	2.44	----
1515	0.4	0	1.3	0	1.3
1823	<3	----	<3	----	----
1862	<10	<10	----	----	----
1880	<10	<10	<10	----	----
1935	0	3.39	0	3.37	3.37
6198	<3	----	<3	----	----
6201	<10	<10	1	----	----
6202	<10	<10	<10	<10	<10
6262	----	----	0	----	----
6396	----	----	4.38	----	----
7014	<1	<1	<1	----	----
9008	<10	<10	<10	----	----

APPENDIX 3

Number of participants per country

2 labs in BELGIUM
2 labs in BRAZIL
1 lab in CANADA
8 labs in CHINA, People's Republic
1 lab in FINLAND
1 lab in FRANCE
1 lab in INDIA
1 lab in INDONESIA
1 lab in IRAN, Islamic Republic of
2 labs in KUWAIT
4 labs in NETHERLANDS
1 lab in RUSSIAN FEDERATION
1 lab in SAUDI ARABIA
2 labs in SINGAPORE
1 lab in SOUTH AFRICA
1 lab in SPAIN
1 lab in UNITED KINGDOM
4 labs 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	= calculation difference between reported test result and result calculated by iis
W	= test result withdrawn on request of participant
ex	= test result excluded from statistical evaluation
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
fr.	= first reported
f+?	= possibly a false positive test result?
f-?	= possibly a false negative test result?
SDS	= Safety Data Sheet

Literature

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