Results of Proficiency Test
Transformer Oil (used)
November 2019

CONTENTS

Appendices:

1   INTRODUCTION

Since 2014 the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for used Transformer Oil and for Furanics in used Transformer Oil, both in accordance with the latest applicable version of the specification IEC60296 and/or ASTM D3487 every year. During the annual proficiency testing (PT) program 2019/2020, it was decided to continue the PT for the analyses of used Transformer Oil and the PT for the determination of Furanics in used Transformer Oil.

In this interlaboratory study 72 laboratories in 35 different countries registered for participation for the PT on used Transformer Oil and 52 laboratories in 29 different countries registered for participation for the PT on Furanics in used Transformer Oil. In total 74 laboratories in 35 different countries registered for participation. See appendix 3 for the number of participants per PT and per country. In this report, the results of the 2019 proficiency tests on used Transformer Oil and Furanics in used 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). Sample analyses for fit-for-use and homogeneity testing were subcontracted to an ISO/IEC17025 accredited laboratory. Depending on registration it was decided to send for the PT on used Transformer Oil 1 bottle of 1L labelled #19241 and/or for the PT on Furanics in used Transformer Oil 1 bottle of 100mL labelled #19242. 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 100 liters of used Transformer Oil obtained from a third party was used for the preparation of the subsamples for the regular analyses. After homogenization 103 amber glass bottles of 1L were filled and labelled #19241. The homogeneity of the subsamples #19241 was checked by determination of Density in accordance with ASTM D4052 on 8 stratified randomly selected samples.

	Density at 20°C in kg/m^3
Sample #19241-1	877.56
Sample #19241-2	877.57
Sample #19241-3	877.56
Sample #19241-4	877.57
Sample #19241-5	877.57
Sample #19241-6	877.57
Sample #19241-7	877.57
Sample #19241-8	877.57

Table 1: homogeneity test results of subsamples #19241

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

	Density at 20°C in kg/m^3
r (observed)	0.01
reference test method	ISO3675:98
0.3 * R (ref. test method)	0.36

Table 2: evaluation of the repeatability of subsamples #19241

The calculated repeatability was less than 0.3 times the corresponding reproducibility of the reference test method. Therefore, homogeneity of the subsamples was assumed.

The necessary bulk material for the PT on Furanics in used Transformer Oil was prepared by mixing a batch of approximately 400mL of used Transformer Oil, highly positive on Furanics with approximately 7L of fresh Transformer Oil. After homogenisation 70 amber glass bottles of 100mL were filled and labelled #19242. The homogeneity of the subsamples #19242 was checked by determination of Density in accordance with ASTM D4052 on 8 stratified randomly selected samples.

	Density at 20°C in kg/m^3
Sample #19242-1	875.33
Sample #19242-2	875.33
Sample #19242-3	875.34
Sample #19242-4	875.35
Sample #19242-5	857.34
Sample #19242-6	875.34
Sample #19242-7	875.35
Sample #19242-8	875.35

Table 3: homogeneity test results of subsamples #19242

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

	Density at 20°C in kg/m^3
r (observed)	0.02
reference test method	ISO3675:98
0.3 * R (ref. test method)	0.36

Table 4: evaluation of the repeatability of subsamples #19242

The calculated repeatability was less than 0.3 times the corresponding reproducibility of the reference test method. Therefore, homogeneity of the subsamples was assumed.

To each of the participating laboratories, depending on the registration, 1 bottle of 1L labelled #19241 and/or 1 bottle of 100mL labelled #19242 was sent on October 23, 2019. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

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

2.6 ANALYSES

The participants were requested to determine on sample #19241: Total Acidity (Potentiometric and Colorimetric), Breakdown Voltage, Density at 20°C, Di-electric Dissipation Factor (DDF) at 90°C and Specific Resistance at 90°C, Flash Point (C.O.C. and PMcc), Interfacial Surface Tension, Kinematic Viscosity at 40°C and Water. Also, some analytical details were asked for the Total Acidity (Potentiometric) and for the Breakdown Voltage determination.
The participants were requested to determine on sample #19242: Total Furanic Compounds, 2-Acetyl Furan, 2-Furfural, 2-Furfurylalcohol, 5-Hydroxy Methyl-2-Furfural and 5-Methyl-2-Furfural.

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

To get comparable test results, a detailed report form and a letter of instructions are prepared. On the report form the reporting units are given as well as the 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 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 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 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.

According to ISO5725 the original test results per determination were submitted to Dixon's and/or 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 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. 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 or ISO 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, like Horwitz or an estimated reproducibility based on former iis proficiency tests.

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

The z-scores were calculated according to:

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

The $z_{(target)}$ scores are listed in the result tables in appendix 1.

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

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

4   EVALUATION

In this proficiency test no major problems were encountered with the dispatch of the samples. For the PT on used Transformer Oil: two participants reported test results after the final reporting date and five participants did not report any test results at all.
For the PT on Furanics in used Transformer Oil: one participant reported the test results after the final reporting date and seven participants did not report any test results at all.
Not all laboratories were able to report all analyses requested. In total 70 participants reported 678 numerical test results. Observed were 24 outlying test results, which is 3.5% 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.

4.1   EVALUATION PER SAMPLE AND PER TEST

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

For the Furanics the observed reproducibilities were compared against the (strict) reproducibilities estimated from the Horwitz equation. It is remarkable that the precision requirements of IEC61198:93 are stricter than the requirements estimated from the Horwitz equation.

In the iis PT reports, ASTM test methods are referred to with a number (e.g. D974) and an added designation for the year that the test method was adopted or revised (e.g. D974:14e2). In case that a method has been reapproved the year is given between brackets. The latter was not the case for this report.

Sample #19241

Acidity, Total (Potentiometric): This determination was problematic. No statistical outliers were observed. However, the calculated reproducibility is not in agreement with the requirements of ASTM D664-A:18e2 (BEP- 60mL/125mL and IP- 60mL/ 125mL) nor with the requirements of EN62021-1:03.

Acidity, Total (Colorimetric): This determination was problematic depending on the test method used. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ASTM D974:14e2, but not at all in agreement with the very strict requirements of EN162021-2:07.

Breakdown Voltage: This determination was problematic. Five statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of EN60156:95. There was no significant difference between the test results with stirring and the test results without stirring.
The reproducibility of EN60156:95 was determined from Figure 3 of method EN60156:95, according to the iis memo 1702 (see lit. 18).
Some participants remarked that "sludge" was present in the sample: it appeared that most of them had a good z-score.

Density at 20°C: This determination was problematic. Five statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of ISO3675:98 nor with the requirements of ASTM D4052:18a, ISO12185:96 or ASTM D7042:16e3.

DD-Factor: This determination was not problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the requirements of EN60247:04.

Specific Resistance: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of EN60247:04.

Flash Point C.O.C.: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in good agreement with the requirements of ASTM D92:18.

Flash Point PMcc: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ISO2719-B:16, and also with the requirements of ISO2719-A:16, ASTM D93-A:18, but is not in agreement with the requirements of ASTM D93-B:18.

Interfacial Surface Tension: This determination was very problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is not at all in agreement with the requirements of ASTM D971:12.

Kinematic Viscosity: Till 2017 a precision statement for used oils was not present in ASTM D445. In the versions of 2017 and 2019 of ASTM D445 a precision statement is given for used (in-service) formulated oils. However, it appears that this reproducibility is very strict. Therefore, iis has estimated a reproducibility on used oils for Kinematic Viscosity at 40°C based from previous PTs (see iis memo 1401, lit. 17). This reproducibility has been used for the evaluations.
This determination was problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is not in agreement with the requirements of iis memo 1401, nor with the strict requirements of ASTM D445:19.

Water: This determination was problematic depending on the test method used. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is not at all in agreement with the requirements of EN60814:98 and ASTM D1533:12, but is in agreement with the requirements of ASTM D6304:16e1.

Sample #19242

Total Furanics: This determination was not problematic. One statistical outlier was observed. The calculated reproducibility after rejection of the statistical outlier is in agreement with the estimated reproducibility using the Horwitz equation based on 3 components, but is not in agreement with the strict requirements of IEC61198:93.

2-Furfural: This determination was not problematic. Five statistical outliers were observed. However, the calculated reproducibility after rejection of the statistical outliers is in agreement with the estimated reproducibility using the Horwitz equation (1 component), but is not in agreement with the strict requirements of IEC61198:93.

2-Furfurylalcohol: This determination may be problematic. No statistical outliers were observed, but three test results were excluded. The calculated reproducibility after rejection of the suspect data is not in agreement with the estimated reproducibility using the Horwitz equation (1 component), nor with the strict requirements of IEC61198:93.

5-Methyl-2-Furfural: This determination was not problematic. Four statistical outliers were observed. However, the calculated reproducibility after rejection of the statistical outliers is in agreement with the estimated reproducibility using the Horwitz equation (1 component), but not in agreement with the strict requirements of IEC61198:93.

Other Furanics: The majority of participants agreed that 5-Hydroxymethyl-2-Furfural and 2-Acetyl Furan were near or below the level of quantification. Therefore, these components were not further evaluated. 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 relevant reference test method or as declared by the estimated target reproducibility using the Horwitz equation and the reproducibility as found for the group of participating laboratories. The number of significant test results, the average results, the calculated reproducibility (2.8 * standard deviation) and the target reproducibility derived from literature reference test methods (in casu ASTM, EN standards) or based on previous proficiency tests or the estimated target reproducibility are presented in the next tables.

Parameter	unit	n	average	2.8 * sd	R(lit)
Acidity, total (Potentiometric)	g KOH/kg	40	0.036	0.031	0.022
Acidity, total (Colorimetric)	g KOH/kg	40	0.032	0.033	0.04
Breakdown Voltage	kV/2.5 mm	54	11.7	10.3	5.6
Density at 20°C	kg/m^3	50	877.5	1.5	1.2
Di-electric Dissipation Factor at 90°C		56	0.009	0.007	0.013
Specific Resistance at 90°C	GΩm	46	28.3	15.2	29.7
Flash Point C.O.C.	°C	19	156.8	16.2	18
Flash Point PMcc	°C	38	147.0	11.2	16
Interfacial Surface Tension	mN/m	53	24.8	5.5	2.5
Kinematic Viscosity at 40°C	mm^2/s	42	9.362	0.259	0.169
Water	mg/kg	60	70.1	34.9	12.6

Table 5: reproducibilities of tests on sample #19241

Component	unit	n	average	2.8 * sd	R(target)
Total Furanics	mg/kg	32	0.86	0.31	0.68
2-Furfural	mg/kg	40	0.34	0.09	0.18
2-Furfurylalcohol	mg/kg	40	0.21	0.15	0.12
5-Methyl-2-Furfural	mg/kg	41	0.32	0.10	0.17

Table 6: reproducibilities of tests on sample #19242

Without further statistical calculations, it could be concluded that for many tests there is a good compliance of the group of participating laboratories with the relevant reference test methods. The problematic tests 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	70	75	74	76	68
Number of test results	678	805	667	660	561
Number of statistical outliers	24	41	35	31	25
Percentage outliers	3.5%	5.1%	5.2%	4.7%	4.5%

Table 7: 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 against the requirements of the respective reference test methods. The conclusions are given the following table.

Parameter	November 2019	November 2018	November 2017	November 2016	November 2015
Acidity, total (Potentiometric)	-	--	--	-	-
Acidity, total (Colorimetric)	+	+/-	++	++	++
Breakdown Voltage	-	--	+/-	+/-	++
Density at 20°C	-	+/-	+	+/-	+
Di-electric Dissipation Factor at 90°C	+	++	++	++	++
Specific Resistance at 90°C	+	+	++	++	++
Flash Point C.O.C.	+	+	++	+/-	n.e.
Flash Point PMcc	+	+	++	+	+
Interfacial Surface Tension	--	--	--	--	--
Kinematic Viscosity at 40°C	-	-	--	+	-
Water	--	--	-	+/-	+/-
Total Furanics	++	++	++	++	+
2-Acetyl Furan	n.e.	+	n.e.	n.e.	n.e.
2-Furfural	++	+	++	+/-	-

Parameter	November 2019	November 2018	November 2017	November 2016	November 2015
2-Furfurylalcohol	-	+/-	n.e.	+/-	-
5-Hydroxymethyl-2-Furfural	n.e.	+	n.e.	n.e.	n.e.
5-Methyl-2-Furfural	+	+	n.e.	+	+

Table 8: comparison determinations against 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 Acidity, Total (Potentiometric) on sample #19241; results in g KOH/kg

lab	method	value	mark	z(targ)	End Point	Vol. solv.	remarks
179	D664	0.01		-3.38	Inflection Point	125 mL	
237	D664-A	<0.1		-----	Inflection Point	125 mL	
325	D664-A	0.015		-2.74	Buffer End Point (pH 10)	125 mL	
331	D664mod	0.04		0.46	---	---	
398	D664-A	0.04955		1.68	Buffer End Point (pH 11)	125 mL	
445	IEC62021-1	0.04		0.46	Buffer End Point (pH 11)	60 mL	
511		-----		-----	---	---	
614		-----		-----	---	---	
862	D664-A	0.04		0.46	Inflection Point	60 mL	
902		-----		-----	---	---	
912		-----		-----	---	---	
913		-----		-----	---	---	
963		-----		-----	---	---	
974	D664-A	0.024		-1.59	Buffer End Point (pH 10)	125 mL	
975	D664-A	0.04		0.46	Inflection Point	60 mL	
1072	Inhouse	0.0300		-0.82	Inflection Point	60 mL	
1135	D664-A	0.03		-0.82	Inflection Point	125 mL	
1137		-----		-----	---	---	
1146	D664-A	0.050		1.74	Buffer End Point (pH 11)	125 mL	
1156	IEC62021-1	0.043		0.84	Buffer End Point (pH 11)	---	
1178	IEC62021-1	0.038		0.20	Buffer End Point (pH 11.5)	40 mL	
1262	EN62021-1	0.035		-0.18	Inflection Point	60 mL	
1264	D664-A	0.053		2.12	Inflection Point	60 mL	
1301	IEC62021-1	0.05		1.74	---	---	
1304		-----		-----	---	---	
1306		-----		-----	---	---	
1352		-----		-----	---	---	
1367		-----		-----	---	---	
1374	D664-A	0.036		-0.05	Buffer End Point (pH 10)	60 mL	
1430		-----		-----	---	---	
1435	IEC62021-1	0.030		-0.82	Buffer End Point (pH 11.5)	100 mL	
1442		-----		-----	---	---	
1444		-----		-----	---	---	
1458		-----		-----	---	---	
1461		-----		-----	---	---	
1478	IEC62021-1	0.0464		1.28	Buffer End Point (pH 11)	---	
1505		-----		-----	---	---	
1513	IEC62021-1	0.030		-0.82	Buffer End Point (pH 11.5)	20 mL	
1545		-----		-----	---	---	
1560	IEC62021-1	0.03		-0.82	---	---	
1660	IEC62021-1	0.020		-2.10	---	---	
1687	D664-A	0.033		-0.44	Buffer End Point (pH 10)	60 mL	
1702	IEC62021-1	0.025		-1.46	---	---	
1719	D664-A	0.0315		-0.63	Inflection Point	60 mL	
1743	IEC62021-1	0.03		-0.82	Buffer End Point (pH 11)	60 mL	
1801	EN62021-1	0.046		1.23	Buffer End Point (pH 11)	125 mL	
1885		-----		-----	---	---	
1888	EN62021-1	0.040		0.46	Buffer End Point (pH 11)	60 mL	
1890	ISO6619	0.052		1.99	Inflection Point	60 mL	
1891		-----		-----	---	---	
1897		-----		-----	---	---	
1923	EN62021-1	0.0396		0.41	Inflection Point	60 mL	
1924	EN62021-1	0.0308		-0.72	Buffer End Point (pH 11.5)	25 mL	
1925	EN62021-1	0.0405		0.52	Buffer End Point (pH 11)	60 mL	
1955	D664-A	0.022		-1.85	Buffer End Point (pH 10)	60 mL	
1958		-----		-----	---	---	
6015		-----		-----	---	---	
6036	EN62021-1	0.0405		0.52	Buffer End Point (pH 11)	---	
6053	IEC62021-1	0.046	C	1.23	---	---	fr. 0.146
6067		-----		-----	---	---	
6085		-----		-----	---	---	
6088	IEC62021-1	0.0276		-1.13	Inflection Point	60 mL	
6099	IEC62021-1	0.060		3.02	Buffer End Point (pH 11)	60 mL	
6124	D664-A	0.05		1.74	---	---	
6140		-----		-----	---	---	
6166		-----		-----	---	---	
6167		-----		-----	---	---	
6255	IEC62021-1	0.0275		-1.14	Inflection Point	60 mL	
6264		-----		-----	---	---	
6275	IEC62021-1	0.035		-0.18	Buffer End Point (pH 11.5)	25 mL	
6278		-----		-----	---	---	
6280		-----		-----	---	---	

		Only D664	Only EN/IEC 62021-1
normality	OK	OK	OK
n	40	14	23
outliers	0	0	0
mean (n)	0.0364	0.0346	0.0370
st.dev. (n)	0.01090	0.01356	0.00927
R(calc.)	0.0305	0.0380	0.0259
st.dev.(D664-A:18e2, BEP-60mL)	0.00781	0.00742	---
R(D664-A:18e2, BEP 60mL)	0.0219	0.0208	---
compare			
R(EN62021-1:03)	0.0127	---	0.0129
R(D664-A:18e2, IP-125mL)	0.0069	0.0065	---
R(D664-A:18e2, IP-60mL)	0.0266	0.0255	---
R(D664-A:18e2, BEP-125mL)	0.0097	0.0092	---
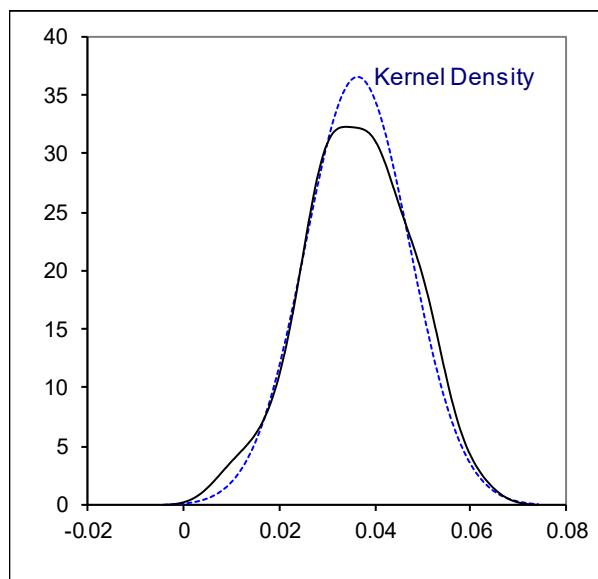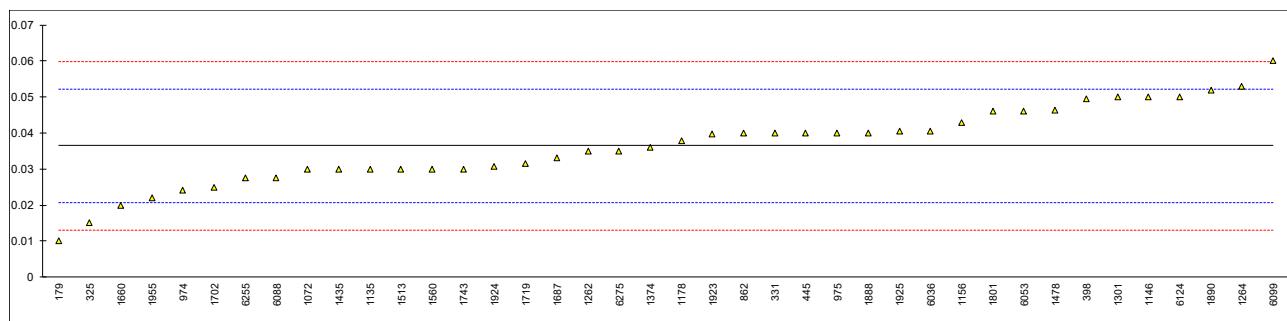
Determination of Acidity, Total (Colorimetric) on sample #19241; results in g KOH/kg

lab	method	value	mark	z(targ)	remarks
179	D974	0.03		-0.12	
237	D974	0.033		0.09	
325		-----		-----	
331		-----		-----	
398	D974	0.0528		1.48	
445	D974	0.032		0.02	
511	D974	0.0326		0.06	
614	D974	0.03		-0.12	
862	D974	0.03		-0.12	
902	D974	0.05		1.28	
912		-----		-----	
913	D974	0.03		-0.12	
963	D974	0.033		0.09	
974	D974	0.03		-0.12	
975	D974	0.03		-0.12	
1072	IEC62021-2	0.0307		-0.07	
1135	D974	0.03		-0.12	
1137		-----		-----	
1146		-----		-----	
1156		-----		-----	
1178		-----		-----	
1262	ISO6618	0.066		2.40	
1264	D974	0.0525		1.46	
1301	IEC62021-2	0.04		0.58	
1304	INH-122	0.0195		-0.85	
1306	D974	0.02052		-0.78	
1352	IEC62021-2	0.0283		-0.24	
1367	IP139	0.035		0.23	
1374		-----		-----	
1430	EN62021-2	0.0355		0.27	
1435		-----		-----	
1442	IEC62021-2	0.02		-0.82	
1444		-----		-----	
1458	D974	0.036		0.30	
1461		-----		-----	
1478		-----		-----	
1505	D974	0.031		-0.05	
1513	IEC62021-2	0.030		-0.12	
1545	D974	0.044		0.86	
1560		-----		-----	
1660		-----		-----	
1687		-----		-----	
1702		-----		-----	
1719		-----		-----	
1743	ISO6618	0.04		0.58	
1801		-----		-----	
1885	D974	0.030		-0.12	
1888		-----		-----	
1890		-----		-----	
1891	IEC62021-2	0.03		-0.12	
1897	IEC62021-2	0.027		-0.33	
1923		-----		-----	
1924		-----		-----	
1925		-----		-----	
1955	IEC62021-2	0.01897		-0.89	
1958	EN62021-2	0.005		-1.87	
6015	D974	0.010		-1.52	
6036		-----		-----	
6053		-----		-----	
6067		-----		-----	
6085	D974	0.04		0.58	
6088		-----		-----	
6099		-----		-----	
6124		-----		-----	
6140	D974	0.029		-0.19	
6166	D974	0.03		-0.12	
6167		-----		-----	
6255		-----		-----	
6264		-----		-----	
6275	D974	0.041		0.65	
6278	D974	0.024		-0.54	
6280	IEC62021-2	0.0097		-1.54	

		Only ASTM D974/ISO6618/IP139	Only EN/IEC 62021-1
normality	suspect	not OK	suspect
n	40	28	12
outliers	0	0	0
mean (n)	0.0317	0.0347	0.0275
st.dev. (n)	0.01161	0.01094	0.00988
R(calc.)	0.0325	0.0306	0.0277
st.dev.(D974:14e2)	0.01429	0.01429	---
R(D974:14e2)	0.04	0.04	---
compare			
R(EN62021-2:07)	0.0063	---	0.0055
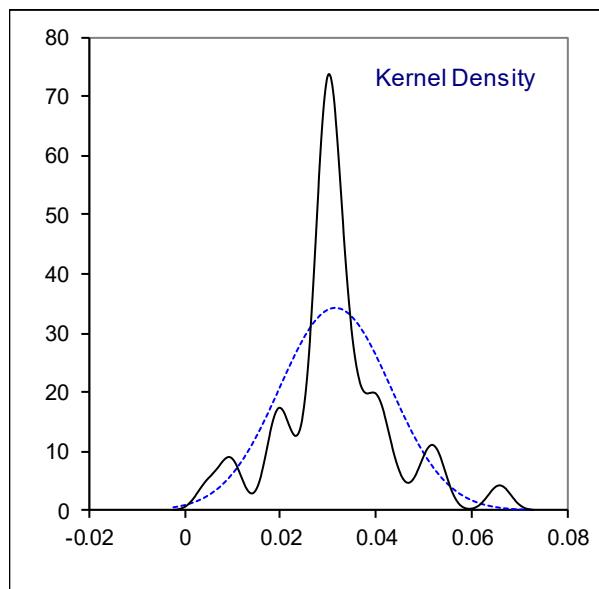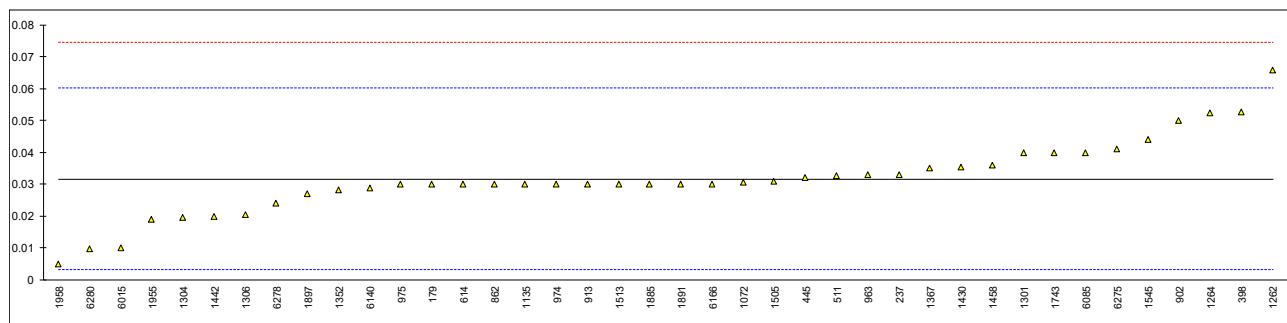
Determination of Breakdown Voltage on sample #19241, results in kV/2.5 mm

lab	method	value	mark	z(targ)	stirred	remarks
179	D877	18.2		3.25	Yes	
237		-----		-----	---	
325		-----		-----	---	
331	EN60156	12.3		0.30	---	
398	EN60156	15.50		1.90	No	
445	EN60156	13.6		0.95	Yes	
511		-----		-----	---	
614	EN60156	17.3		2.80	Yes	
862	IEC60156	5.6		-3.04	No	
902	IEC60156	17.5		2.90	Yes	
912		-----		-----	---	
913		-----		-----	---	
963	IEC60156	7.6		-2.04	Yes	
974	EN60156	15.1		1.70	Yes	
975	IEC60156	8.0		-1.84	Yes	
1072	EN60156	12.8		0.55	Yes	
1135	IEC60156	13		0.65	No	
1137		-----		-----		
1146	IEC60156	9.6		-1.04	Yes	
1156	IEC60156	10.7		-0.49	No	
1178	EN60156	14.2		1.25	Yes	
1262	EN60156	6.3		-2.69	Yes	
1264	IEC60156	13.7	C	1.00	No	first reported 35.0
1301	EN60156	12.0		0.15	---	
1304	INH-124	8.58		-1.55	Yes	
1306		-----		-----	---	
1352	IEC60156	8.7		-1.49	No	
1367	EN60156	13.275		0.79	Yes	
1374	IEC60156	6.4		-2.64	Yes	
1430	EN60156	9.87		-0.91	Yes	
1435		-----		-----	---	
1442	IEC60156	18.8		3.55	Yes	
1444		-----		-----	---	
1458	IEC60156	12.1		0.20	Yes	
1461		-----		-----	---	
1478	IEC60156	10.6		-0.54	Yes	
1505	IEC60156	12.3		0.30	---	
1513	IEC60156	11.6		-0.04	Yes	
1545	IEC60156	10.9		-0.39	---	
1560	IEC60156	14.9		1.60	Yes	
1660	IEC60156	0.5	R(0.05)	-5.58	---	
1687	EN60156	10.9		-0.39	No	
1702	IEC60156	30	C,R(0.05)	9.14	---	first reported 25.4
1719	IEC60156	9.2		-1.24	Yes	
1743	IEC60156	17		2.65	No	
1801	EN60156	8.5		-1.59	Yes	
1885	IEC60156	33.8	R(0.01)	11.03	No	
1888	EN60156	18.3		3.30	Yes	
1890	IEC60156	7.6		-2.04	Yes	
1891	IEC60156	7.7		-1.99	Yes	
1897	IEC60156	8.3		-1.69	Yes	
1923	EN60156	10.7		-0.49	Yes	
1924	EN60156	8.25		-1.72	No	
1925	EN60156	9.1		-1.29	No	
1955	IEC60156	12.05		0.18	Yes	
1958	IEC60156	27.6	C,R(0.05)	7.94	Yes	first reported 32.0
6015	EN60156	10.75		-0.47	Yes	
6036	EN60156	8.1		-1.79	No	
6053	IEC60156	12.9		0.60	---	
6067		-----		-----	---	
6085	IEC60156	23.8	R(0.05)	6.04	Yes	
6088	IEC60156	13		0.65	Yes	
6099	IEC60156	6.9		-2.39	No	
6124	IEC60156	6.9		-2.39	---	
6140	IEC60156	11.7		0.01	---	
6166		-----		-----	---	
6167	IEC60156	10.9		-0.39	Yes	
6255	IEC60156	7.5		-2.09	Yes	
6264		-----		-----	---	
6275	IEC60156	17.73		3.01	Yes	
6278	IEC60156	17.9		3.10	No	
6280	IEC60156	18.33		3.31	---	

		Only 'stirred'	Only 'not stirred'
normality	OK	OK	OK
n	54	33	15
outliers	5	2	1
mean (n)	11.690	11.774	11.237
st.dev. (n)	3.6895	3.8006	3.6543
R(calc.)	10.331	10.642	10.232
st.dev.(EN60156:95)	2.0043	2.0189	1.9267
R(EN60156:95)	5.612	5.653	5.395

Kernel Density
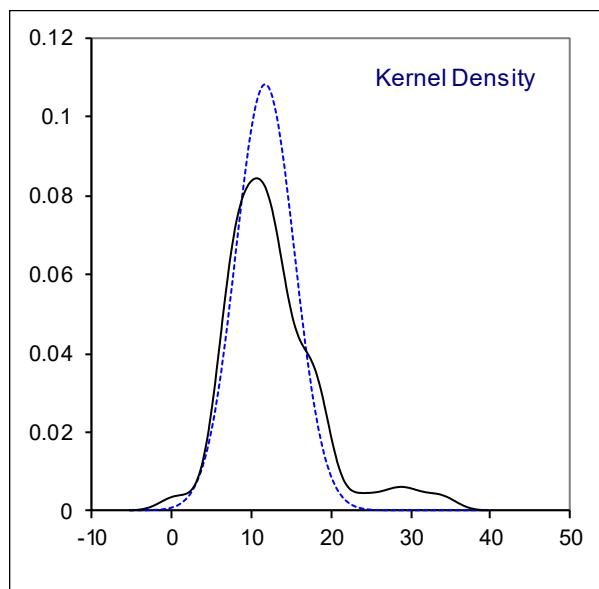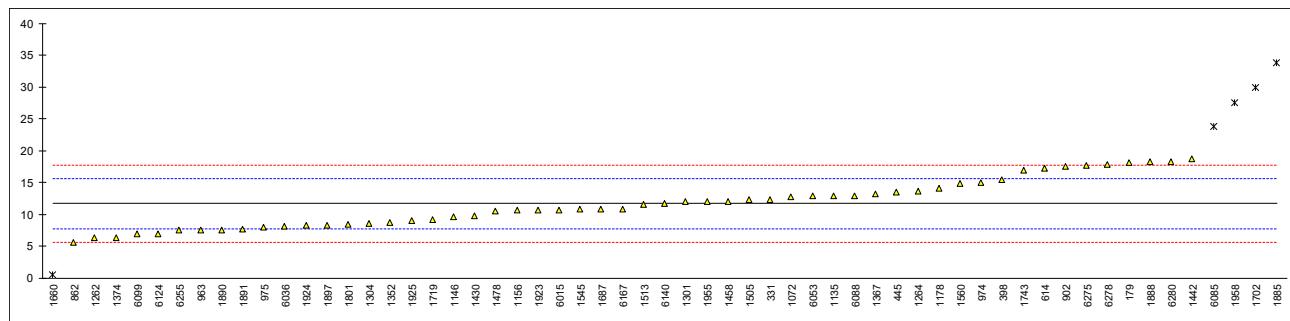
Determination of Density at 20°C on sample #19241; results in kg/m^3

lab	method	value	mark	z(targ)	remarks
179	D4052	877.8		0.67	
237	D4052	877.6		0.20	
325	D4052	877.7		0.43	
331	ISO12185	877.55		0.08	
398	ISO12185	877.54		0.06	
445	IP365	877.6		0.20	
511	D4052	877.6		0.20	
614	D4052	877.8		0.67	
862	D4052	877.6		0.20	
902	D4052	877.59		0.18	
912		-----		-----	
913	D4052	877.6		0.20	
963	D4052	877.7		0.43	
974	D4052	877.6		0.20	
975	D4052	877.4		-0.27	
1072	ISO3675	876.6		-2.13	
1135	ISO3675	877.6		0.20	
1137		-----		-----	
1146	D4052	877.5		-0.03	
1156		-----		-----	
1178	ISO12185	877.6		0.20	
1262	D4052	877.50		-0.03	
1264	D4052	877.6	C	0.20	first reported 0.8776 kg/m^3
1301	ISO3675	877.7		0.43	
1304		-----		-----	
1306	D4052	877.4		-0.27	
1352	D4052	877.3		-0.50	
1367	ISO3675	877.7		0.43	
1374	D4052	876.1		-3.30	
1430	D4052	877.6		0.20	
1435	D4052	877.3	C	-0.50	first reported 0.8773 kg/m^3
1442	ISO12185	877.6		0.20	
1444		-----		-----	
1458	D4052	877.5		-0.03	
1461	ISO3675	877.00		-1.20	
1478	ISO12185	877.3		-0.50	
1505	D7042	882.0	R(0.01)	10.47	
1513	ISO12185	877.735		0.52	
1545	ISO3675	877.0		-1.20	
1560		-----		-----	
1660	D7042	876.4		-2.60	
1687	ISO12185	877.57		0.13	
1702	ISO3675	877.7		0.43	
1719		-----		-----	
1743		877.0		-1.20	
1801	ISO3675	877.5		-0.03	
1885	D1298	874	C,R(0.01)	-8.20	reported 0.874 kg/m^3
1888		-----		-----	
1890	ISO12185	877.6		0.20	
1891		-----		-----	
1897		-----		-----	
1923		-----		-----	
1924	D7777	876.8	C	-1.67	first reported 880.6
1925		-----		-----	
1955	D7042	877.9		0.90	
1958	ISO3675	878.9		3.23	
6015	ISO12185	877.80		0.67	
6036	ISO3675	877		-1.20	
6053		-----		-----	
6067		-----		-----	
6085	D7042	877.87		0.83	
6088	ISO3675	878.60	C	2.53	first reported 879.18
6099	ISO12185	878.4		2.07	
6124	ISO3675	877.7		0.43	
6140	D7042	882.0	R(0.01)	10.47	
6166		-----		-----	
6167		-----		-----	
6255	ISO3675	876		-3.53	
6264		-----		-----	
6275	D1298	878.64		2.63	
6278	D1298	882	C,R(0.01)	10.47	first reported 0.822 kg/m^3
6280	ISO12185	860	C,R(0.01)	-40.87	first reported 0.86 kg/m^3

normality	not OK
n	50
outliers	5
mean (n)	877.514
st.dev. (n)	0.5370
R(calc.)	1.504
st.dev.(ISO3675:98)	0.4286
R(ISO3675:98)	1.2
compare	
R(D4052:18a)	0.5
R(ISO12185:96)	0.5
R(D7042:16e3)	1.3
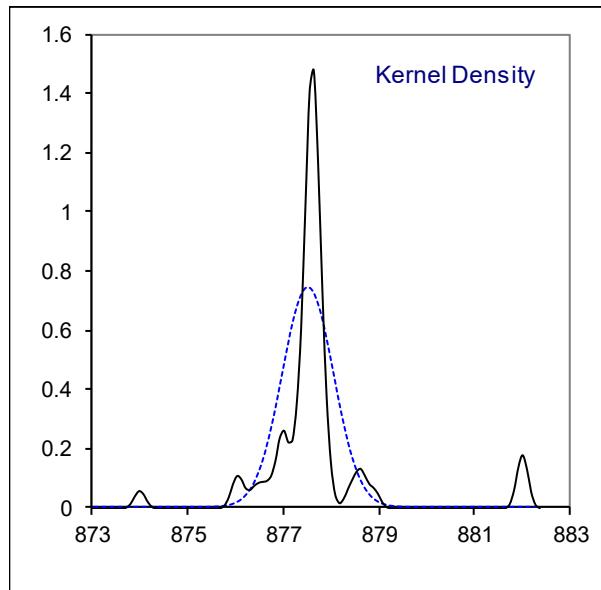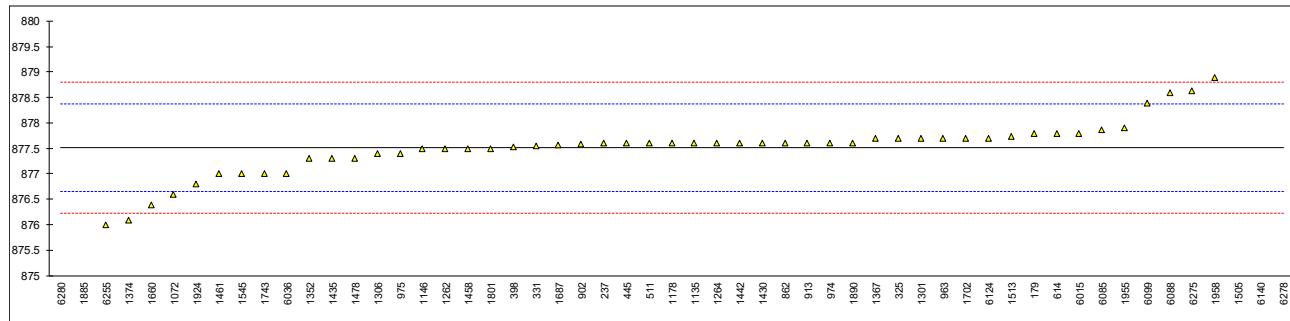
Determination of Di-electric Dissipation Factor (DDF) at 90°C on sample #19241

lab	method	value	mark	z(targ)	freq. (Hz)	remarks
179		-----		-----	-----	
237	IEC60247	0.008202		-0.26	50	
325		-----		-----	-----	
331	D924	0.015518		1.32	60	
398	EN60247	0.006515		-0.62	60	
445	EN60247	0.00867		-0.16	50	
511	D924	0.007356		-0.44	-----	
614		-----		-----	-----	
862	IEC60247	0.0084		-0.22	-----	
902	EN60247	0.010		0.13	50	
912		-----		-----	-----	
913		-----		-----	-----	
963	EN60247	0.0072		-0.47	-----	
974	EN60247	0.007469		-0.42	60	
975	IEC60247	0.006		-0.73	50	
1072	EN60247	0.00606		-0.72	50	
1135	IEC60247	0.0099		0.11	50	
1137		-----		-----	-----	
1146		-----		-----	-----	
1156	IEC60247	0.00981		0.09	-----	
1178	IEC60247	0.00719		-0.48	50.0	
1262	EN60247	0.00886		-0.12	50	
1264	IEC60247	0.013214		0.82	50	
1301	EN60247	0.00845		-0.21	-----	
1304	INH-125	0.010997		0.34	50	
1306	IEC60247	0.008228		-0.25	-----	
1352	IEC60247	0.00850		-0.19	-----	
1367	EN60247	0.006240		-0.68	55	
1374	IEC60247	0.011246		0.40	-----	
1430	EN60247	0.016946		1.62	-----	
1435	IEC60247	0.0088		-0.13	-----	
1442	IEC60247	0.009319		-0.02	50	
1444		-----		-----	-----	
1458	IEC60247	0.011257		0.40	50	
1461		-----		-----	-----	
1478	IEC60247	0.013513		0.88	50	
1505	IEC60247	0.010380		0.21	-----	
1513	IEC60247	0.01223		0.61	-----	
1545		-----		-----	-----	
1560	IEC60247	0.008097		-0.28	50	
1660	IEC60247	0.011153		0.38	-----	
1687	EN60247	0.01008		0.15	50	
1702	IEC60247	0.00656		-0.61	-----	
1719	IEC60247	0.0106		0.26	50	
1743	IEC60247	0.01192		0.54	-----	
1801	EN60247	0.008214		-0.26	-----	
1885	IEC60247	0.02467	R(0.01)	3.29	-----	
1888	EN60247	0.007833		-0.34	-----	
1890	IEC60247	0.008969		-0.09	50	
1891	IEC60247	0.01139		0.43	-----	
1897	IEC60247	0.01468		1.14	-----	
1923	EN60247	0.00884		-0.12	-----	
1924	EN60247	0.008210		-0.26	-----	
1925	EN60247	0.00884		-0.12	-----	
1955	IEC60247	0.00977		0.08	-----	
1958	IEC60247	0.009657		0.05	50	
6015	EN60247	0.0080125		-0.30	50	
6036	EN60247	0.007047		-0.51	50	
6053		-----		-----	-----	
6067		-----		-----	-----	
6085	IEC60247	0.011058		0.36	-----	
6088	IEC60247	0.0066		-0.60	-----	
6099	IEC60247	0.010470		0.23	-----	
6124	IEC60247	0.008091		-0.28	50	
6140	IEC60247	0.012135		0.59	-----	
6166		-----		-----	-----	
6167		-----		-----	-----	
6255	IEC60247	0.00937		-0.01	-----	
6264		-----		-----	-----	
6275	IEC60247	0.007490		-0.41	50	
6278	IEC60247	0.00483		-0.98	-----	
6280	IEC60247	0.0103	C	0.19	-----	first reported 1.03

normality	suspect
n	56
outliers	1
mean (n)	0.00941
st.dev. (n)	0.002425
R(calc.)	0.00679
st.dev.(EN60247:04)	0.004646
R(EN60247:04)	0.01301
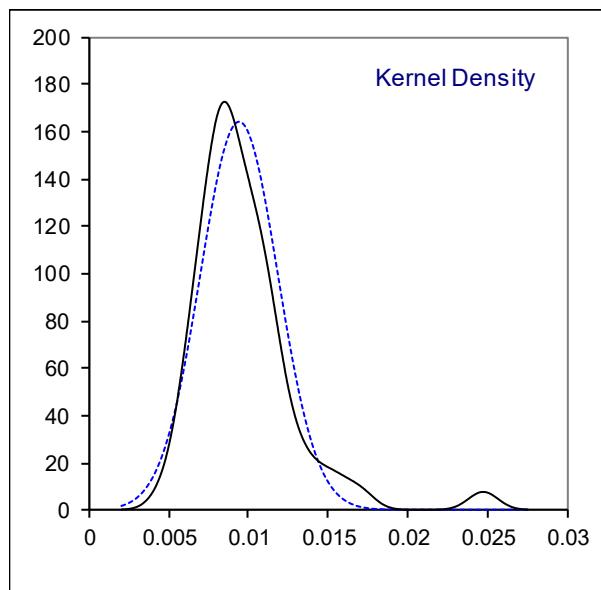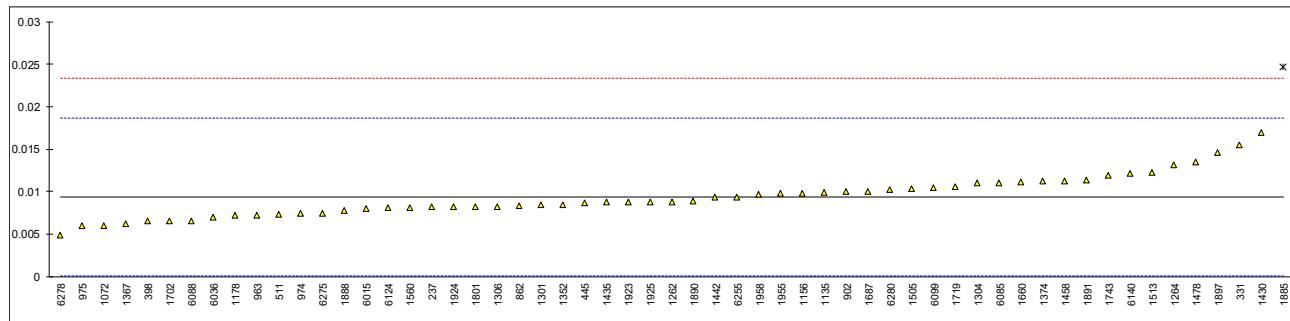
Determination of Specific Resistance at 90°C on sample #19241; results in GΩm

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237	IEC60247	29.32		0.10	
325		-----		-----	
331		15.31		-1.22	
398	EN60247	33.04		0.45	
445	EN60247	27.72		-0.06	
511		-----		-----	
614		-----		-----	
862	IEC60247	28.18		-0.01	
902	IEC60247	22.9		-0.51	
912		-----		-----	
913		-----		-----	
963		-----		-----	
974	EN60247	23.70		-0.43	
975		-----		-----	
1072	EN60247	38.54		0.96	
1135	IEC60247	26.7		-0.15	
1137		-----		-----	
1146		-----		-----	
1156	IEC60247	26.6		-0.16	
1178	IEC60247	38.8		0.99	
1262	EN60247	33.60		0.50	
1264	IEC60247	33.905		0.53	
1301	IEC60247	28	C	-0.03	first reported 2800 GΩm
1304	INH-125	26.53		-0.17	
1306	IEC60247	28.97		0.06	
1352	IEC60247	34.34		0.57	
1367	EN60247	35.57		0.68	
1374	IEC60247	20.88		-0.70	
1430		-----		-----	
1435		-----		-----	
1442	IEC60247	29.53		0.12	
1444		-----		-----	
1458	IEC60247	25.14		-0.30	
1461		-----		-----	
1478	IEC60247	22.98		-0.50	
1505	IEC60247	25.86		-0.23	
1513		-----		-----	
1545		-----		-----	
1560	IEC60247	31.55		0.31	
1660	IEC60247	29.15		0.08	
1687	EN60247	24.17		-0.39	
1702	IEC60247	31.14		0.27	
1719	IEC60247	25.37		-0.28	
1743	IEC60247	35		0.63	
1801		-----		-----	
1885	IEC60247	30	C	0.16	first reported 72
1888	EN60247	37.82		0.90	
1890	IEC60247	28.04		-0.03	
1891	IEC60247	23.78		-0.43	
1897	IEC60247	20.15		-0.77	
1923		-----		-----	
1924	EN60247	19.32		-0.85	
1925		-----		-----	
1955	IEC60247	26.595		-0.16	
1958	IEC60247	24.82	C	-0.33	first reported 248.2 GΩm
6015	EN60247	30.730		0.23	
6036		-----		-----	
6053		-----		-----	
6067		-----		-----	
6085		-----		-----	
6088	IEC60247	33		0.44	
6099	IEC60247	21.60		-0.63	
6124	IEC60247	28.87		0.05	
6140	IEC60247	22.01		-0.59	
6166		-----		-----	
6167		-----		-----	
6255	IEC60247	28.6		0.03	
6264		-----		-----	
6275	IEC60247	36.18		0.74	
6278	IEC60247	34.535	C	0.59	reported 3453.5 GΩm
6280	IEC60247	23.6		-0.44	

normality	OK
n	46
outliers	0
mean (n)	28.3075
st.dev. (n)	5.41336
R(calc.)	15.1574
st.dev.(EN60247:04)	10.61531
R(EN60247:04)	29.7229
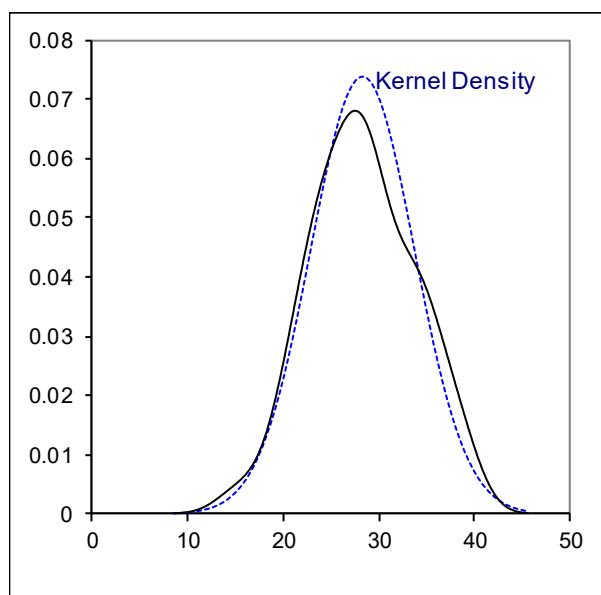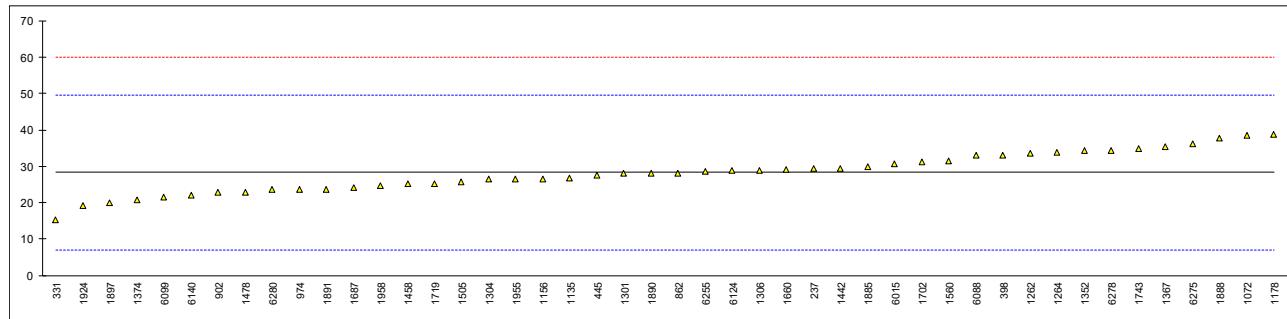
Determination of Flash Point C.O.C. on sample #19241; results in °C

lab	method	value	mark	z(targ)	remarks
179	D92	154		-0.44	
237	D92	158.0		0.19	
325	D92	160		0.50	
331	D92	157		0.03	
398		-----		-----	
445	D92	166		1.43	
511		-----		-----	
614		-----		-----	
862	D92	158		0.19	
902		-----		-----	
912		-----		-----	
913		-----		-----	
963	D92	152		-0.75	
974	D92	156.0		-0.13	
975	D92	148		-1.37	
1072		-----		-----	
1135	D92	150.0		-1.06	
1137		-----		-----	
1146		-----		-----	
1156		-----		-----	
1178		-----		-----	
1262	ISO2592	156		-0.13	
1264	D92	162		0.81	
1301	ISO2592	154.0		-0.44	
1304		-----		-----	
1306		-----		-----	
1352		-----		-----	
1367	D92	154		-0.44	
1374		-----		-----	
1430		-----		-----	
1435	D92	148.0		-1.37	
1442	ISO2592	166.0		1.43	
1444		-----		-----	
1458		-----		-----	
1461		-----		-----	
1478		-----		-----	
1505		-----		-----	
1513		-----		-----	
1545		-----		-----	
1560		-----		-----	
1660		-----		-----	
1687		-----		-----	
1702		-----		-----	
1719		-----		-----	
1743		-----		-----	
1801		-----		-----	
1885		-----		-----	
1888		-----		-----	
1890		-----		-----	
1891		-----		-----	
1897		-----		-----	
1923		-----		-----	
1924		-----		-----	
1925		-----		-----	
1955		-----		-----	
1958	D92	154		-0.44	
6015	ISO2592	158.0		0.19	
6036		-----		-----	
6053		-----		-----	
6067		-----		-----	
6085		-----		-----	
6088		-----		-----	
6099		-----		-----	
6124		-----		-----	
6140		-----		-----	
6166		-----		-----	
6167		-----		-----	
6255		-----		-----	
6264		-----		-----	
6275	D92	168.3		1.79	
6278		-----		-----	
6280		-----		-----	

normality	OK
n	19
outliers	0
mean (n)	156.81
st.dev. (n)	5.773
R(calc.)	16.17
st.dev.(D92:18)	6.429
R(D92:18)	18

Kernel Density
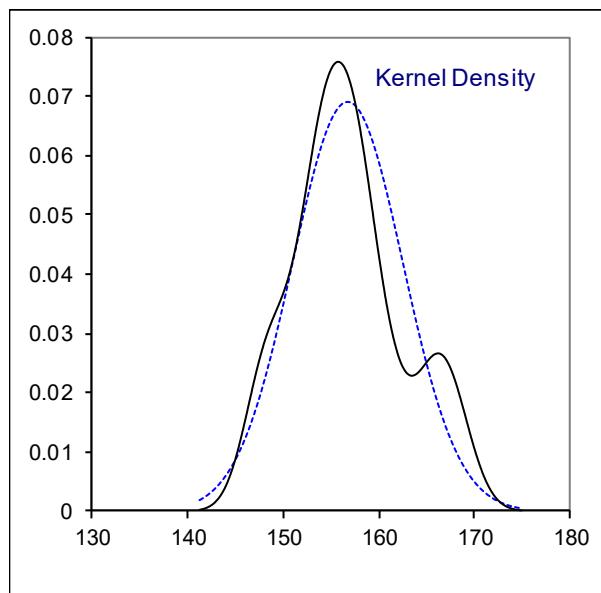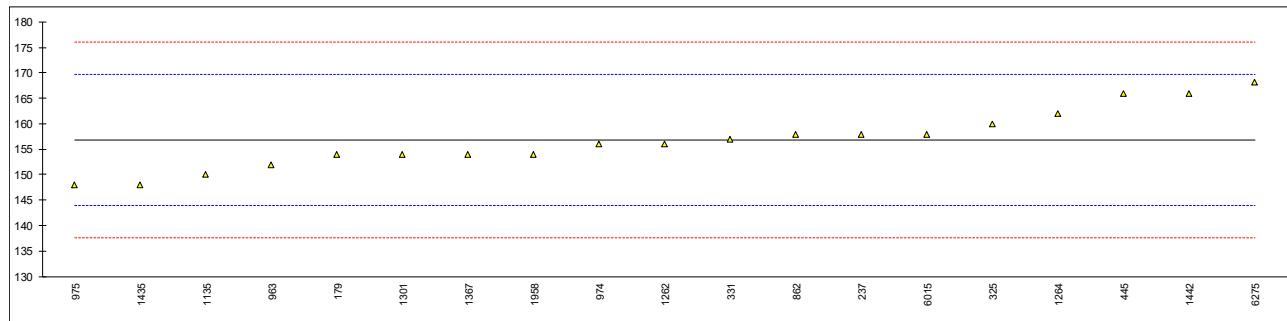
Determination of Flash Point PMcc on sample #19241; results in °C

lab	method	value	mark	z(targ)	remarks
179		-----		-----	
237	D93-B	152.0		0.88	
325	D93-A	150		0.53	
331	D93-A	151.65		0.82	
398		-----		-----	
445	IP34-A	145.0		-0.34	
511	D93-B	149		0.36	
614		-----		-----	
862	D93-A	141		-1.04	
902	D93-A	145		-0.34	
912		-----		-----	
913	D93-A	142		-0.87	
963	D93-A	144		-0.52	
974	D93-A	148.0		0.18	
975	D93-A	146		-0.17	
1072	ISO2719-A	155		1.41	
1135	ISO2719-A	147.5		0.10	
1137		-----		-----	
1146	D93-A	142.5		-0.78	
1156		-----		-----	
1178		-----		-----	
1262	D93-A	150.0		0.53	
1264	D93-A	148		0.18	
1301	ISO2719-A	142.0		-0.87	
1304	INH-115	142.2		-0.83	
1306	D93-A	143		-0.69	
1352		-----		-----	
1367		-----		-----	
1374	D93-A	141.1		-1.02	
1430	D93-A	152		0.88	
1435	D93-A	149.5		0.45	
1442	ISO2719-A	141.0		-1.04	
1444		-----		-----	
1458		-----		-----	
1461	ISO2719-A	152		0.88	
1478	ISO2719-A	147.5		0.10	
1505	D93-A	145.0		-0.34	
1513	ISO2719-A	154.0		1.23	
1545	ISO2719-A	150		0.53	
1560	ISO2719-A	146.5		-0.08	
1660	D93	148		0.18	
1687		-----		-----	
1702	ISO2719-A	144.5		-0.43	
1719		-----		-----	
1743	ISO2719-A	145		-0.34	
1801		-----		-----	
1885		-----		-----	
1888	D93-B	156		1.58	
1890		-----		-----	
1891		-----		-----	
1897		-----		-----	
1923		-----		-----	
1924	ISO2719-A	146.56		-0.07	
1925		-----		-----	
1955		-----		-----	
1958		-----		-----	
6015	ISO2719-A	146.0		-0.17	
6036		-----		-----	
6053		-----		-----	
6067		-----		-----	
6085		-----		-----	
6088		-----		-----	
6099		-----		-----	
6124		-----		-----	
6140	D93-A	145.0		-0.34	
6166	IP34-A	145		-0.34	
6167		-----		-----	
6255		-----		-----	
6264		-----		-----	
6275	D93-A	145.68		-0.22	
6278		-----		-----	
6280		-----		-----	

normality	OK
n	38
outliers	0
mean (n)	146.95
st.dev. (n)	3.996
R(calc.)	11.19
st.dev.(ISO2719-B:16)	5.714
R(ISO2719-B:16)	16
compare	
R(ISO2719-A:16)	10.43
R(D93-A:18)	10.43
R(D93-B:18)	10
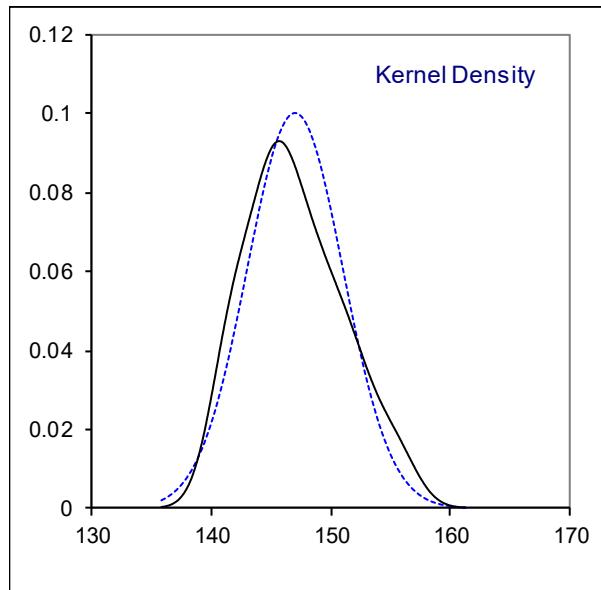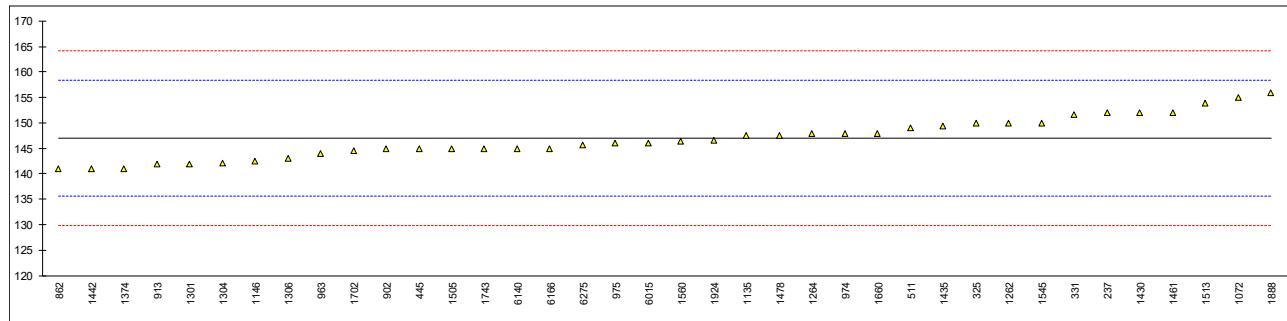
Determination of Interfacial Surface Tension on sample #19241; results in mN/m

lab	method	value	mark	z(targ)	remarks
179	D971	29		4.74	
237	D971	25.0		0.23	
325		-----		-----	
331	EN14210	17.675	R(0.05)	-8.04	
398		-----		-----	
445	D971	25.5		0.79	
511	D971	25.04		0.27	
614	D971	26		1.36	
862	D971	26.4		1.81	
902	D971	24.02		-0.88	
912		-----		-----	
913		-----		-----	
963	D971	23.9		-1.02	
974	D971	26.5		1.92	
975	D971	23.8		-1.13	
1072	D971	24.40		-0.45	
1135	D971	23.5		-1.47	
1137		-----		-----	
1146		-----		-----	
1156	D971	25.4		0.68	
1178	D971	25.6		0.90	
1262	D971	24.1		-0.79	
1264	D971	22.8135		-2.24	
1301	D971	25.2		0.45	
1304	INH-123	26.45		1.86	
1306	D971	23.65		-1.30	
1352	D971	25.1		0.34	
1367	D971	26.91		2.38	
1374	D971	24.56		-0.27	
1430	D971	21.0		-4.29	
1435	D971	25.2		0.45	
1442	IEC62961	25.08		0.32	
1444		-----		-----	
1458	D971	23.95		-0.96	
1461		-----		-----	
1478	D971	23.5		-1.47	
1505	D971	27.4		2.94	
1513	D971	24.46		-0.38	
1545	D971	25.15		0.40	
1560	D971	24.7		-0.11	
1660	D971	22.7		-2.37	
1687	D971	22.1	C	-3.05	first reported 13.8
1702	D971	26.460		1.87	
1719	D2285	27.5		3.05	
1743	D971	21.3		-3.95	
1801	D971	25.28		0.54	
1885	D971	29.1		4.86	
1888	ISO6295	22.3		-2.82	
1890		-----		-----	
1891	D971	25.4		0.68	
1897	D971	24.7		-0.11	
1923		-----		-----	
1924	D971	25.75		1.07	
1925		-----		-----	
1955		-----		-----	
1958		-----		-----	
6015	D971	24.315		-0.55	
6036	EN62961	24.2		-0.68	
6053		-----		-----	
6067		-----		-----	
6085	D971	23.26		-1.74	
6088	ISO6295	26.37		1.77	
6099	EN14210	22.7		-2.37	
6124	D971	24.27		-0.60	
6140	D971	27.4		2.94	
6166		-----		-----	
6167		-----		-----	
6255	ISO6295	21.1		-4.18	
6264		-----		-----	
6275	D971	23.4		-1.58	
6278	D971	30.3		6.21	
6280	D971	21.2		-4.06	

normality	OK
n	53
outliers	1
mean (n)	24.800
st.dev. (n)	1.9793
R(calc.)	5.542
st.dev.(D971:12)	0.8857
R(D971:12)	2.480
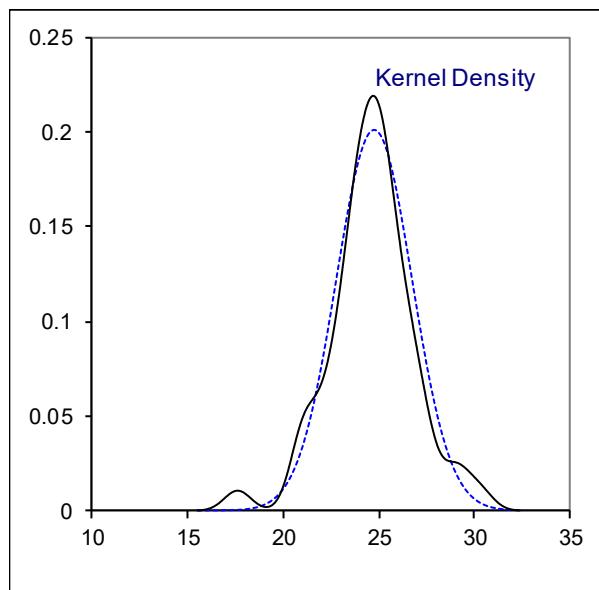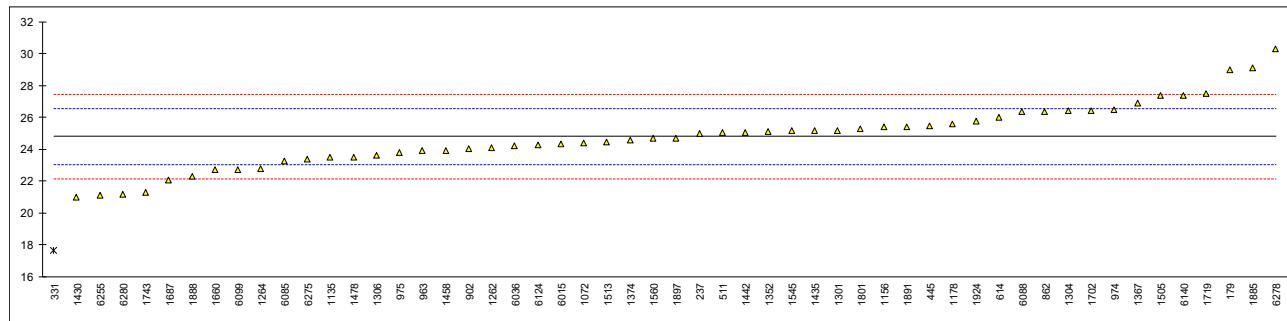
Determination of Kinematic Viscosity at 40°C on sample #19241; results in mm²/s

lab	method	value	mark	z(targ)	remarks
179	D445	9.36		-0.03	
237	D445	9.338	C	-0.39	first reported 9.578
325	D445	9.3135		-0.80	
331	D7279 corr. to D445	9.205		-2.60	
398		-----		-----	
445	D445	9.3209		-0.68	
511		-----		-----	
614		-----		-----	
862	D445	9.3525		-0.15	
902	D445	9.288		-1.23	
912		-----		-----	
913	D445	9.254		-1.79	
963	D445	9.338		-0.39	
974	D445	9.275		-1.44	
975	D7042	9.364		0.04	
1072	ISO3104	9.37		0.14	
1135	D445	9.331		-0.51	
1137		-----		-----	
1146	D445	9.3765		0.25	
1156		-----		-----	
1178	ISO3104	9.4826		2.01	
1262	D445	9.339		-0.38	
1264	D7042	9.4296		1.13	
1301	ISO3104	9.377		0.25	
1304		-----		-----	
1306	D445	9.303		-0.98	
1352	D7042	9.3935		0.53	
1367		-----		-----	
1374	D445	9.205		-2.60	
1430	D445	9.411		0.82	
1435	D7042	9.432		1.17	
1442	D7042	9.4175		0.93	
1444		-----		-----	
1458		-----		-----	
1461	ISO3104	9.4719		1.83	
1478	D7042	9.3312		-0.51	
1505	D7042	9.4133		0.86	
1513	ISO3104	9.286		-1.26	
1545		-----		-----	
1560	ISO3104	9.339		-0.38	
1660	D7042	9.3725		0.18	
1687		-----		-----	
1702	D7042	9.3705		0.15	
1719		-----		-----	
1743	D7279 corr. to D445	9.160		-3.35	
1801	ISO3104	9.61		4.12	
1885		-----		-----	
1888	D445	9.19		-2.85	
1890	ISO3104	9.3231		-0.64	
1891		-----		-----	
1897		-----		-----	
1923		-----		-----	
1924	ISO3104	9.38960		0.46	
1925		-----		-----	
1955	D7042	9.3797		0.30	
1958	D445	9.549		3.11	
6015		-----		-----	
6036		-----		-----	
6053		-----		-----	
6067		-----		-----	
6085	D7042	9.3661		0.07	
6088		-----		-----	
6099		-----		-----	
6124	D7042	9.5630	C	3.34	first reported 9.8642
6140	D7042	9.4001		0.64	
6166		-----		-----	
6167		-----		-----	
6255		-----		-----	
6264		-----		-----	
6275	D445	9.402003		0.67	
6278	D445	8.858	R(0.01)	-8.37	
6280		-----		-----	

normality	suspect
n	42
outliers	1
mean (n)	9.3618
st.dev. (n)	0.09244
R(calc.)	0.2588
st.dev.(iis memo 1401)	0.06018
R(iis memo 1401)	0.1685
compare	
R(D445:19)	0.0280

Kernel Density
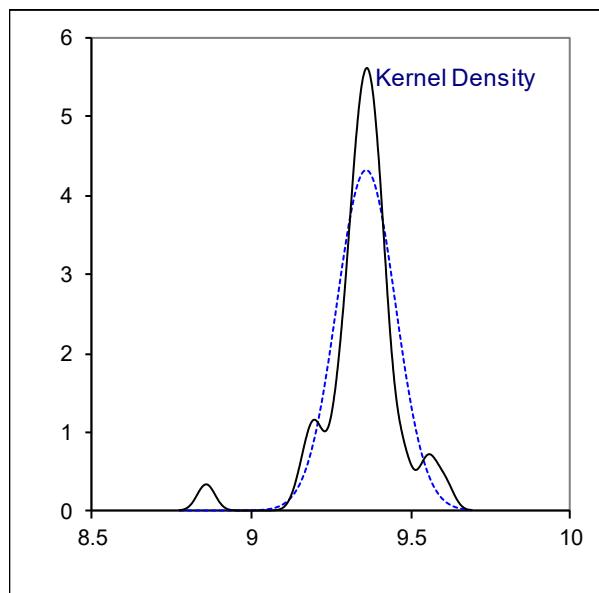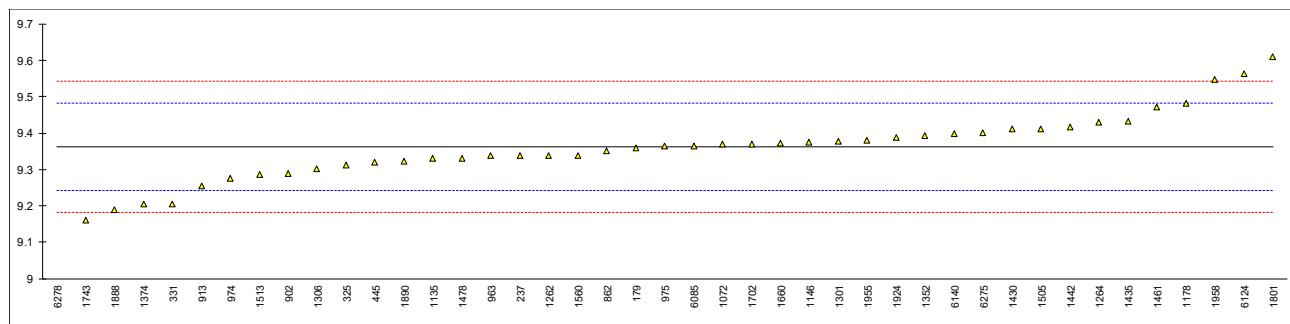
Determination of Water on sample #19241; results in mg/kg

lab	method	value	mark	z(targ)	remarks
179	D1533	41		-6.48	
237	D6304-C	54.2		-3.54	
325	D6304-C	40.5		-6.59	
331	D6304-A	61		-2.02	
398	D6304-C	83		2.89	
445	IEC60814	50.0		-4.47	
511		-----		-----	
614	IEC60814	58		-2.69	
862	D6304-A	9	R(0.01)	-13.62	
902	D6304-C	54.5		-3.47	
912		-----		-----	
913		-----		-----	
963	D1533	85		3.33	
974	D1533	84		3.11	
975	D6304-A	86		3.55	
1072	EN60814	64.0		-1.35	
1135	IEC60814	65		-1.13	
1137		-----		-----	
1146	D6304-C	77.3		1.61	
1156	IEC60814	78.2		1.81	
1178	IEC60814	56.9		-2.94	
1262	EN60814	87		3.78	
1264	D1533	88.066		4.02	
1301	IEC60814	93		5.12	
1304	INH-121	77.4		1.64	
1306	D1533	81.9		2.64	
1352	IEC60814	66.18		-0.87	
1367	D1533	68.65		-0.31	
1374	IEC60814	67.8		-0.50	
1430	EN60814	59		-2.47	
1435	IEC60814	66.6		-0.77	
1442	IEC60814	72.0		0.43	
1444		-----		-----	
1458	IEC60814	69.1		-0.21	
1461		-----		-----	
1478	IEC60814	77.1		1.57	
1505	D1533	72.1		0.45	
1513	IEC60814	73.6		0.79	
1545	IEC60814	62.75		-1.63	
1560	IEC60814	66		-0.91	
1660	IEC60814	56		-3.14	
1687	EN60814	85.9		3.53	
1702	IEC60814	75.0		1.10	
1719	IEC60814	42.7		-6.10	
1743	IEC60814	50		-4.47	
1801	EN60814	77.65		1.69	
1885	D1533	70		-0.01	
1888	IEC60814	50.83		-4.29	
1890	IEC60814	86.47		3.66	
1891	IEC60814	78.4		1.86	
1897	IEC60814	66.0		-0.91	
1923	EN60814	76.9		1.52	
1924	EN60814	78.00		1.77	
1925	EN60814	76.75		1.49	
1955	IEC60814	73.0667		0.67	
1958	IEC60814	66		-0.91	
6015		-----		-----	
6036	IEC60814	66.1		-0.88	
6053	IEC60814	77.3		1.61	
6067		-----		-----	
6085	IEC60814	71.6651		0.36	
6088	D1533	79		1.99	
6099	IEC60814	82.6		2.80	
6124	IEC60814	76		1.32	
6140	D1533	70.0		-0.01	
6166		-----		-----	
6167		-----		-----	
6255	IEC60814	66.7		-0.75	
6264		-----		-----	
6275	IEC60814	67.093		-0.66	
6278	D1533	60.04		-2.24	
6280	IEC60814	90.71		4.60	

|	
normality	OK
n	60
outliers	1
mean (n)	70.062
st.dev. (n)	12.4470
R(calc.)	34.852
st.dev.(EN60814:98)	4.4841
R(EN60814:98)	12.555
compare	
R(D1533:12)	14
R(D6304:16e1)	216.253 mass injection
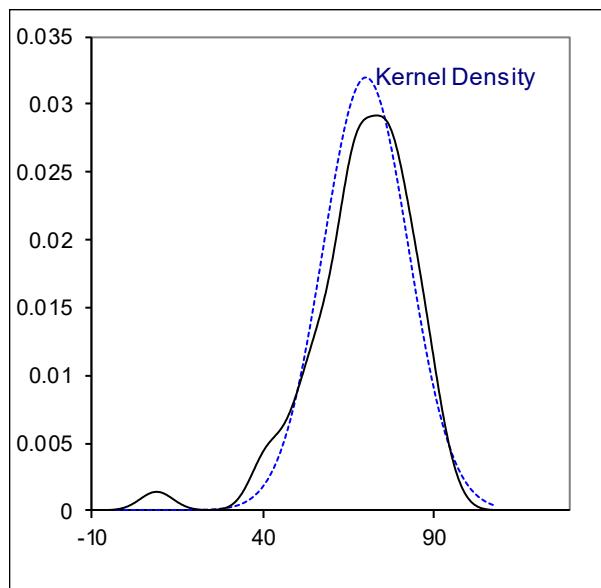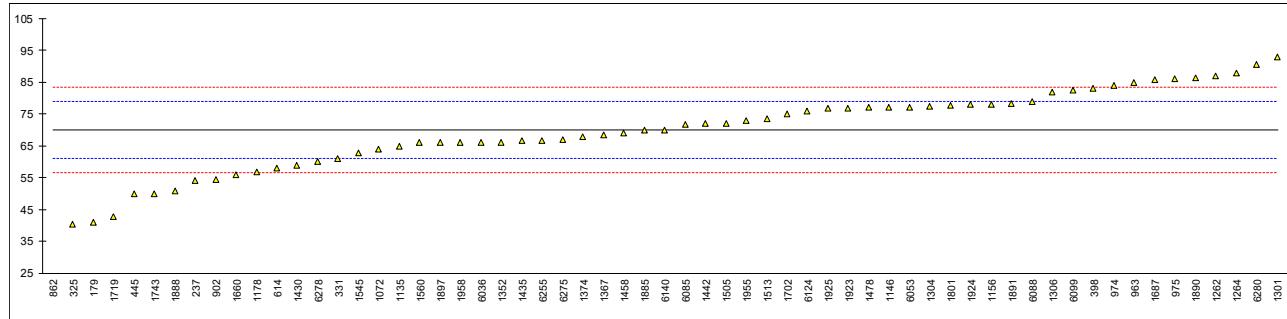
Determination of Total Furanics on sample #19242; results in mg/kg

lab	method	value	mark	z(targ)	remarks
331		-----		-----	
398		-----		-----	
445	EN61198	0.93		0.29	
614	IEC61198	1.08		0.91	
862	IEC61198	0.985		0.52	
902	D5837	1.0044		0.60	
912		-----		-----	
963	D5837	0.844		-0.06	
974		-----		-----	
975	IEC61198	0.839		-0.08	
1072	EN61198	0.889		0.12	
1135	IEC61198	0.90		0.17	
1137		-----		-----	
1156	IEC61198	0.937		0.32	
1178	IEC61198	0.9070		0.20	
1264	D5837	0.735		-0.51	
1301	IEC61198	0.813		-0.19	
1304	INH-126	0.884		0.10	
1306	IEC61198	0.973606		0.47	
1352	IEC61198	0.80343		-0.23	
1367	EN61198	0.784		-0.31	
1374	D5837	0.874		0.06	
1430		-----		-----	
1435		-----		-----	
1442		-----		-----	
1444		-----		-----	
1458	IEC61198	0.810		-0.20	
1478		-----		-----	
1505	D5837	0.583		-1.13	
1513		-----		-----	
1529		-----		-----	
1545	IEC61198	0.8313		-0.11	
1560		-----		-----	
1660	IEC61198	0.658		-0.83	
1702		-----		-----	
1743		-----		-----	
1801	EN61198	0.69645		-0.67	
1885	D5837	0.752		-0.44	
1888		-----		-----	
1891	IEC61198	0.912		0.22	
1897	IEC61198	0.972		0.46	
1955	IEC61198	0.842657		-0.07	
1958	EN61198	0.935		0.31	
6015	EN61198	1.3901	R(0.01)	2.18	
6036	EN61198	0.689		-0.70	
6067	IEC61198	0.8285		-0.13	
6085		-----		-----	
6124	IEC61198	0.974		0.47	
6140	D5837	0.971		0.46	
6141	D5837	0.857945		-0.01	
6264		-----		-----	
6278		-----		-----	

normality	OK		
n	32		
outliers	1		
mean (n)	0.8592		
st.dev. (n)	0.11035		
R(calc.)	0.3090		
st.dev.(Horwitz 3 comp)	0.24362		
R(Horwitz 3 comp)	0.6821	R(IEC61198:93) = 0.1289	
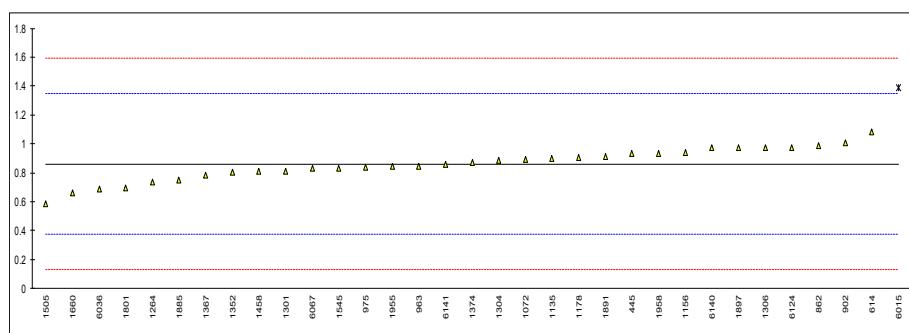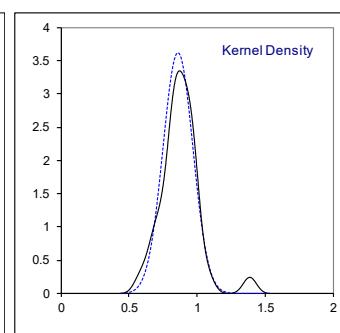
Determination of 2-Furfural on sample #19242; results in mg/kg

lab	method	value	mark	z(targ)	remarks
331		-----		-----	
398		-----		-----	
445	EN61198	0.37		0.54	
614	IEC61198	0.34		0.07	
862	IEC61198	0.380		0.70	
902	D5837	0.3015		-0.54	
912		-----		-----	
963	D5837	0.303		-0.51	
974		-----		-----	
975	IEC61198	0.3		-0.56	
1072	EN61198	0.347		0.18	
1135	IEC61198	0.35		0.23	
1137		-----		-----	
1156	IEC61198	0.345		0.15	
1178	IEC61198	0.3154		-0.32	
1264	D5837	0.295		-0.64	
1301	IEC61198	0.311		-0.39	
1304	INH-126	0.358		0.35	
1306	IEC61198	0.392521		0.90	
1352	IEC61198	0.28350		-0.82	
1367	EN61198	0.297		-0.61	
1374	D5837	0.340		0.07	
1430	EN61198	0.35		0.23	
1435	IEC61198	0.311		-0.39	
1442	IEC61198	0.30		-0.56	
1444		-----		-----	
1458	IEC61198	0.3205		-0.24	
1478	IEC61198	0.354		0.29	
1505	D5837	0.353	C	0.28	first reported 0.034
1513	IEC61198	0.306		-0.47	
1529	IEC61198	0.319		-0.26	
1545	IEC61198	0.2993		-0.57	
1560	IEC61198	0.335		-0.01	
1660	IEC61198	0.381		0.72	
1702	IEC61198	0.385		0.78	
1743	IEC61198	0.34		0.07	
1801	EN61198	0.33965		0.06	
1885	D5837	0.283		-0.83	
1888	EN61198	0.335		-0.01	
1891	IEC61198	0.347		0.18	
1897	IEC61198	0.388		0.83	
1955	IEC61198	0.321479		-0.22	
1958	EN61198	0.225	R(0.05)	-1.75	
6015	EN61198	0.6158	R(0.01)	4.43	
6036	EN61198	0.318		-0.28	
6067	IEC61198	0.1743	R(0.05)	-2.55	
6085	In house	0.2	R(0.05)	-2.14	
6124	IEC61198	0.394		0.92	
6140	D5837	0.357	C	0.34	first reported 0.127
6141	D5837	0.356312		0.33	
6264		-----		-----	
6278	D5837	0.217	R(0.05)	-1.87	

|		
normality	OK	
n	40	
outliers	5	
mean (n)	0.3356	
st.dev. (n)	0.03127	
R(calc.)	0.0875	
st.dev.(Horwitz)	0.06328	
R(Horwitz)	0.1772	R(IEC61198:93) = 0.0503
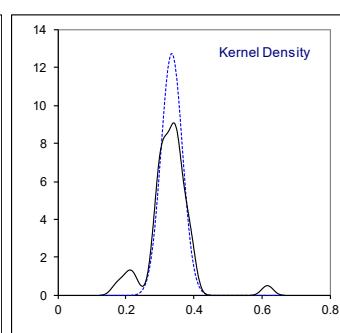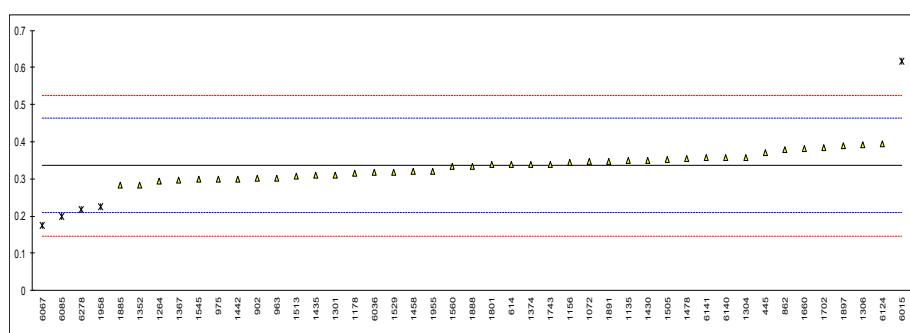
Determination of 2-Furfurylalcohol on sample #19242; results in mg/kg

lab	method	value	mark	z(targ)	remarks
331		-----		-----	
398		-----		-----	
445	EN61198	0.22		0.22	
614	IEC61198	0.26		1.16	
862	IEC61198	0.264		1.26	
902	D5837	0.3191		2.55	
912		-----		-----	
963	D5837	0.229		0.44	
974		-----		-----	
975	IEC61198	0.229		0.44	
1072	EN61198	0.212		0.04	
1135	IEC61198	0.22		0.22	
1137		-----		-----	
1156	IEC61198	0.248		0.88	
1178	IEC61198	0.2555		1.06	
1264	D5837	0.175		-0.83	
1301	IEC61198	0.196		-0.34	
1304	INH-126	0.178		-0.76	
1306	IEC61198	0.250636		0.94	
1352	IEC61198	0.15758		-1.24	
1367	EN61198	0.186		-0.57	
1374	D5837	0.209		-0.03	
1430	EN61198	0.15		-1.42	
1435	IEC61198	0.133		-1.82	
1442	IEC61198	<0,05		<-3.77	possibly a false negative test result?
1444		-----		-----	
1458	IEC61198	0.1808		-0.70	
1478	IEC61198	0.255		1.05	
1505	D5837	0.183		-0.64	
1513	IEC61198	0.181		-0.69	
1529	IEC61198	0.216		0.13	
1545	IEC61198	0.2145		0.10	
1560	IEC61198	0.187		-0.55	
1660	IEC61198	0.231	C	0.48	first reported 0
1702	IEC61198	0.242		0.74	
1743	IEC61198	0.21		-0.01	
1801		-----		-----	
1885	D5837	0.200		-0.24	
1888	EN61198	0.285		1.75	
1891	IEC61198	0.214		0.08	
1897	IEC61198	0.227		0.39	
1955	IEC61198	0.207792		-0.06	
1958	EN61198	0.365	C	3.63	first reported 0.350
6015	EN61198	0.2744	ex	1.50	test result excluded as ≥2 outliers in other furanics test results
6036	EN61198	0.084		-2.97	
6067	IEC61198	0.1039		-2.50	
6085	In house	0	ex	-4.94	test result excluded as zero is not a real value
6124	IEC61198	0.223		0.30	
6140	D5837	0.109		-2.38	
6141	D5837	0.206144		-0.10	
6264		-----		-----	
6278	D5837	0.131	ex	-1.87	test result excluded as ≥2 outliers in other furanics test results

normality	suspect	
n	40	
outliers	0 (+3 ex)	
mean (n)	0.2104	
st.dev. (n)	0.05377	
R(calc.)	0.1506	
st.dev.(Horwitz)	0.04257	
R(Horwitz)	0.1192	R(IEC61198:93) = 0.0316
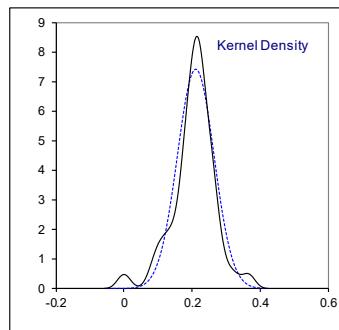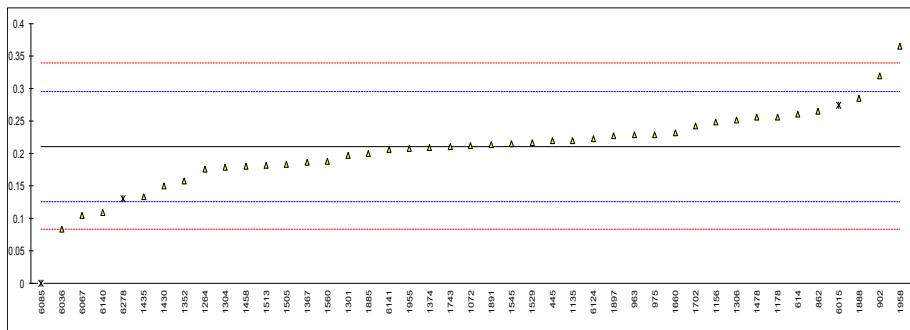
Determination of 5-Methyl-2-Furfural on sample #19242; results in mg/kg

lab	method	value	mark	z(targ)	remarks
331		-----		-----	
398		-----		-----	
445	EN61198	0.34		0.28	
614	IEC61198	0.49	R(0.05)	2.73	
862	IEC61198	0.341		0.30	
902	D5837	0.3418		0.31	
912		-----		-----	
963	D5837	0.312		-0.18	
974		-----		-----	
975	IEC61198	0.31		-0.21	
1072	EN61198	0.330		0.12	
1135	IEC61198	0.33		0.12	
1137		-----		-----	
1156	IEC61198	0.344		0.35	
1178	IEC61198	0.3362		0.22	
1264	D5837	0.232		-1.48	
1301	IEC61198	0.306		-0.27	
1304	INH-126	0.348		0.41	
1306	IEC61198	0.330449		0.13	
1352	IEC61198	0.30899		-0.22	
1367	EN61198	0.300		-0.37	
1374	D5837	0.325		0.04	
1430	EN61198	0.37		0.77	
1435	IEC61198	0.341		0.30	
1442	IEC61198	0.28		-0.70	
1444		-----		-----	
1458	IEC61198	0.3087		-0.23	
1478	IEC61198	0.351		0.46	
1505	D5837	0.268	C	-0.89	first reported 0.016
1513	IEC61198	0.298		-0.40	
1529	IEC61198	0.306		-0.27	
1545	IEC61198	0.2970		-0.42	
1560	IEC61198	0.366		0.71	
1660	IEC61198	0.277		-0.75	
1702	IEC61198	0.369		0.76	
1743	IEC61198	0.32		-0.05	
1801	EN61198	0.3568		0.56	
1885	D5837	0.269		-0.88	
1888	EN61198	0.331		0.13	
1891	IEC61198	0.351		0.46	
1897	IEC61198	0.357		0.56	
1955	IEC61198	0.312687		-0.16	
1958	EN61198	0.340		0.28	
6015	EN61198	0.4808	R(0.05)	2.58	
6036	EN61198	0.287		-0.58	
6067	IEC61198	0.4250		1.67	
6085	In house	0.1	R(0.01)	-3.64	
6124	IEC61198	0.357		0.56	
6140	D5837	0.264	C	-0.96	first reported 0.006
6141	D5837	0.295489		-0.45	
6264		-----		-----	
6278	D5837	0.191	R(0.05)	-2.15	

normality	OK		
n	41		
outliers	4		
mean (n)	0.3228		
st.dev. (n)	0.03591		
R(calc.)	0.1005		
st.dev.(Horwitz)	0.06122		
R(Horwitz)	0.1714	R(IEC61198:93) = 0.0484	
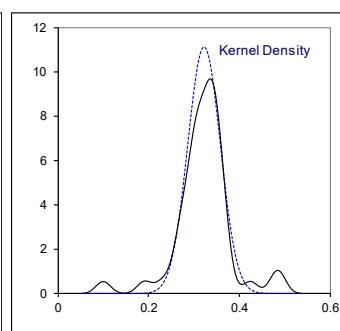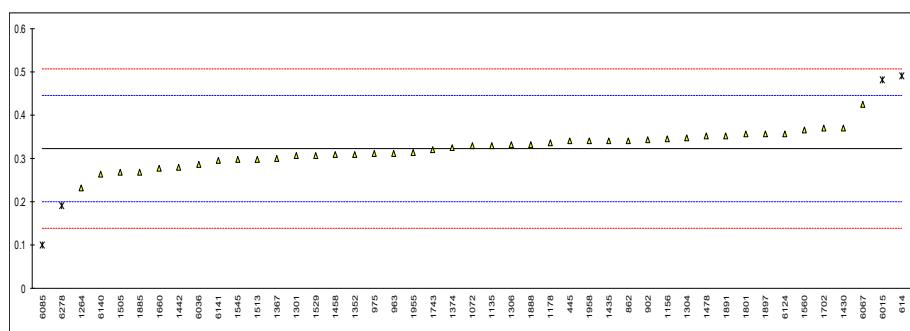
APPENDIX 2

Other reported Furanics in sample #19242, results in mg/kg

lab	2-Acetyl Furan	5-Hydroxymethyl-2-Furfural	
331	-----	-----	
398	-----	-----	
445	0.00	0.00	
614	<0.01	<0.01	
862	<0.05	<0.05	
902	0	0.042	
912	-----	-----	
963	<0.01	<0.01	
974	-----	-----	
975	<0.01	<0.01	
1072	<0,01	<0,01	
1135	<0.05	<0.05	
1137	-----	-----	
1156	0.000	0.00	
1178	0.0001	0.0001	
1264	Not detected	0.033	
1301	<0.01	<0.01	
1304	<0.01	<0.01	
1306	<0.03	<0.03	
1352	Not detected	0.05336	
1367	0.000	0.001	
1374	<0.01	<0.01	
1430	0.11	<0.02	
1435	0.00	0.00	
1442	<0,05	<0,05	
1444	-----	-----	
1458	<0.01	<0.01	
1478	0.00	0.00	
1505	0.549 C	0.009	C
1513	<0,05	<0,05	
1529	0.002	0.000	
1545	0.0136 C	0.0037	
1560	<0.05 C	0.008	
1660	0	0	
1702	Not Detected	Not Detected	
1743	<0.05	<0.05	
1801	-----	-----	
1885	0	0	
1888	<0.05	<0.05	
1891	<0.01	<0.01	
1897	<0.01	<0.01	
1955	0.000699	0.0000	
1958	<0.01	0.020	
6015	0.0050	0.0142	
6036	0	0	
6067	0.0000	0.0603	C
6085	0	0	
6124	0	0	
6140	0.552 C	0.012	C
6141	0	0	
6264	-----	-----	
6278	0	0	

Lab 1505 first reported 0.583 and 0.148 respectively
Lab 1545 first reported 0.0168
Lab 1560 first reported 0.031
Lab 6067 first reported 0.1253
Lab 6140 first reported 0.318 and 0.411 respectively

APPENDIX 3

Number of participants per country

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

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
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
fr.	= first reported
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   ISO 5725:86

5   ISO 5725, parts 1-6, 1994

6   ISO 13528:05

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 Analyses, 127, 1359-1364 (2002)

15   Bernard Rosner, Percentage Points for a Generalized ESD Many-Outlier Procedure, Technometrics, 25(2),165-172, (1983)

16   Horwitz, R. Albert, J. AOAC Int, 79, 3, 589, (1996)

17   iis memo 1401 'Precision data of Used Oils for Kinematic Viscosity (ASTM D445)', July 2014; R.G. Visser and C. Nijssen-Wester, Estimation of reproducibility and measurement uncertainty of a viscosity test method from proficiency test data, Accred Qual Assur 20, 125-129, (2015)

18   iis memo 1702 'Evaluation of the reproducibility of the Breakdown Voltage in Transformer Oils (fresh and used) as per EN60156:1998 based on Proficiency Tests performed from 2001 till 2016, December 2017