Institute for
Interlaboratory Studies

Results of Proficiency Test
Transformer Oil (fresh)
November 2023

Organized by: Institute for Interlaboratory Studies
Spijkenisse, The Netherlands

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CONTENTS

1 INTRODUCTION

Since 2001 the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for the analysis of Transformer Oil (fresh) based on the latest version of IEC60296 and ASTM D3487 every year. During the annual proficiency testing program of 2023 it was decided to continue the round robin for the analysis of Transformer Oil (fresh).

In this interlaboratory study 63 laboratories in 33 countries registered for participation, see appendix 3 for the number of participants per country. In this report the results of the Transformer Oil (fresh) 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 Transformer Oil (fresh) in a 1-liter amber glass bottle labelled #23240.
The participants were requested to report rounded and unrounded test results. The unrounded test results were preferably used for statistical evaluation.

2.1 ACCREDITATION

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, is accredited in agreement with ISO/IEC17043:2010 (R007), since January 2000, by the Dutch Accreditation Council (Raad voor Accreditatie). This PT falls under the accredited scope. This ensures strict adherence to protocols for sample preparation and statistical evaluation and 100% confidentiality of participant's data. Feedback from the participants on the reported data is encouraged and customer's satisfaction is measured on regular basis by sending out questionnaires.

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 90 liters of Transformer Oil (fresh) was obtained from a local supplier. After homogenization 88 amber glass bottles of 1 L were filled and labelled #23240. The homogeneity of the subsamples was checked by the determination of Density at 20 °C in accordance with ASTM D4052 on 8 stratified randomly selected subsamples.

	Density at 20 °C in kg/m^3
sample #23240-1	873.46
sample #23240-2	873.47
sample #23240-3	873.44
sample #23240-4	873.47
sample #23240-5	873.47
sample #23240-6	873.47
sample #23240-7	873.46
sample #23240-8	873.47

Table 1: homogeneity test results of subsamples #23240

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/m^3
r (observed)	0.03
reference test method	ISO12185:96
0.3 x R (reference test method)	0.15

Table 2: evaluation of the repeatability of subsamples #23240

The calculated repeatability was 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 1 L bottle of Transformer Oil (fresh) labelled #23240 was sent on November 1st, 2023. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

The stability of Transformer Oil (fresh) 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: Total Acid Number (Potentiometric and Colorimetric), Appearance, Breakdown Voltage, Color ASTM, Density at 20 °C, Di-electric loss at 90 °C (Di-electric Dissipation Factor and Specific Resistance), Flash Point (C.O.C. and PMcc), Interfacial Surface Tension, Kinematic Viscosity at 40 °C, Water and Additives

(2,6-Ditertiary-butyl phenol (DBP), 2,6-Ditertiary-butyl paracresol (DBPC), Dibenzyl disulfide (DBDS), Benzotriazole (BTA) and Irgamet 39). Also, an extra question regarding stirring during the determination of the Breakdown Voltage was requested.

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

To get comparable test results a detailed report form and a letter of instructions are prepared. On the report form the reporting units are given as well as the 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(target) = (test result - average of PT) / target standard deviation

The z(target) scores are listed in the test result tables in appendix 1.

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

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

4 EVALUATION

In this proficiency test some problems were encountered with the dispatch of the samples. Four participants reported the test results after the final reporting date. All others reported the test results on time. Not all participants were able to report all tests requested.
In total 63 participants reported 493 numerical test results. Observed were 26 outlying test results, which is 5.3%. In proficiency tests outlier percentages of 3% - 7.5% are quite normal.

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

4.1 EVALUATION PER 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. D2668) and an added designation for the year that the test method was adopted or revised (e.g. D2668:07). When a method has been reapproved an “R” will be added and the year of approval (e.g. D2668:07R21).

Total Acid Number (Potentiometric): This determination may not be problematic. All reporting participants agreed on a value near or below the quantification limit of test method EN62021-1:03 and the application range of ASTM D664-A:18e2. Therefore, no z-sores are calculated.

Total Acid Number (Colorimetric): 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 D974:22.

Appearance: The determination was not problematic. Almost all reporting laboratories agreed on the appearance of the sample which was ‘Clear and Bright’ (Pass).

Breakdown Voltage: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of IEC60156:18.

Color ASTM: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ISO2049:96.

Density at 20 °C: The group of participants had difficulty to meet the target requirements. Five statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of ISO12185:96.

DD-Factor at 90 °C: The group of participants met the target requirements. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of EN60247:04.

Specific Resistance at 90 °C: The group of participants had difficulty to meet the target requirements. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirements of EN60247:04.

Please note that it is well known that specific resistance of new oils can vary over a wide range. This is due to randomly tiny amounts of impurities (maybe present in the air or in the test cell) which can dramatically change the value. In used oils, however, due to already present ion flow of the polar compounds, these problems are not observed.

Flash Point COC: 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 D92:18 and ISO2592:17.

Flash Point PMcc: The group of participants met the target requirements. No statistical outliers were observed. The calculated reproducibility is in agreement with the requirements of ISO2719-A:16 and ASTM D93-A:20.

Interfacial Surface Tension: The group of participants met the target requirements. Five statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of ASTM D971:20.

Kinematic Viscosity at 40 °C: The group of participants met the target requirements. Six statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of ASTM D445:23.

Water: The group of participants met the target requirements. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirements of EN60814:97.

Additives: The majority of the participants agreed that 2,6-Ditertiary-butyl phenol (DBP), 2,6-Ditertiary-butyl paracresol (DBPC), Dibenzyl disulfide (DBDS), Benzotriazole (BTA) and Irgamet 39 were 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 reference test method and the reproducibility as found for the group of participating laboratories. The number of significant test results, the average, the calculated reproducibility (2.8 * standard deviation) and the target reproducibility derived from reference methods are presented in the next table.

Parameter	unit	n	average	2.8 * sd	R(lit)
Total Acid Number (Potentiometric)	mg KOH/g	27	0.007	0.006	(0.002)
Total Acid Number (Colorimetric)	mg KOH/g	24	0.008	0.016	0.04
Appearance		38	C&B	n.a.	n.a.
Breakdown Voltage	kV/2.5 mm	58	52.2	37.7	43.8
Color ASTM		48	L0.5 (0.25)	0.4	1
Density at 20 °C	kg/m^3	44	873.5	0.6	0.5
Di-electric Dissipation Factor		45	0.0011	0.0013	0.0024
Specific Resistance at 90 °C	GΩm	34	520.5	836.0	546.6
Flash Point C.O.C.	°C	22	155	20	18
Flash Point PMcc	°C	36	146	9	10
Interfacial Surface Tension	mN/m	39	47.5	4.5	4.8
Kinematic Viscosity at 40 °C	mm^2/s	38	9.971	0.115	0.122
Water	mg/kg	52	19.2	6.6	6.6

Table 3: reproducibilities of tests on sample #23240

For results between brackets no z-scores are calculated

C&B = Clear and Bright

Without further statistical calculations it can be concluded that for many tests there is a good compliance of the group of participating laboratories with the reference test methods. The problematic tests have been discussed in paragraph 4.1.

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

	November 2023	November 2022	November 2021	November 2020	November 2019
Number of reporting laboratories	63	57	64	59	48
Number of test results	493	437	436	404	377
Number of statistical outliers	26	19	20	28	24
Percentage of statistical outliers	5.3%	4.3%	4.6%	6.9%	6.4%

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	November 2023	November 2022	November 2021	November 2020	November 2019
Total Acid Number (Potentiometric)	(--)	(--)	(--)	(--)	(--)
Total Acid Number (Colorimetric)	++	++	++	++	++
Breakdown Voltage	+	+	+	+	+
Color ASTM	++	++	++	++	++
Density at 20 °C	-	+/-	+	+	+
Di-electric Dissipation Factor	+	+	+	+	+
Specific Resistance	-	-	-	--	-
Flash Point C.O.C.	-	+/-	+/-	+	+
Flash Point PMcc	+	+	+/-	+/-	+
Interfacial Surface Tension	+	+/-	-	-	+/-
Kinematic Viscosity at 40 °C	+/-	+/-	-	-	-
Water	+/-	+	+	+/-	-
DBPC Antioxidant Additive	n.e.	n.e.	n.e.	n.e.	n.e.

Table 5. comparison of determinations performances to the reference test methods

For results between brackets no z-scores are calculated.

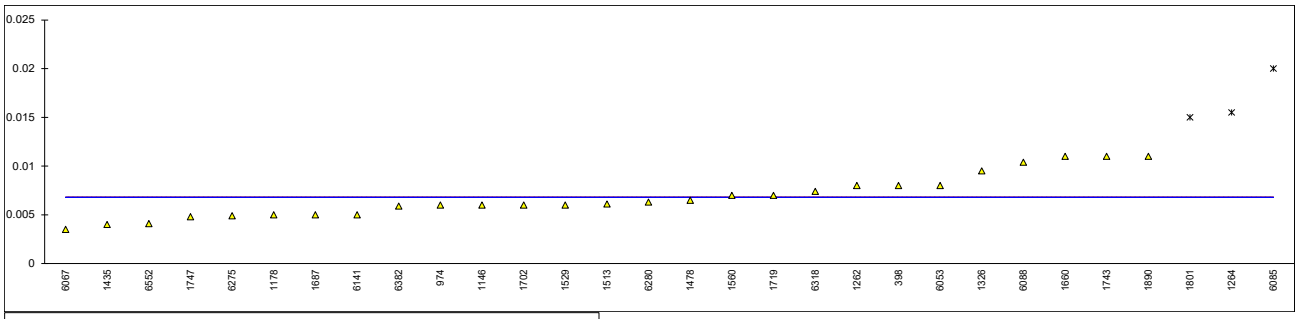
The following performance categories were used:

++ : 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 Total Acid Number (Potentiometric) on sample #23240; results in mg KOH/g

lab	method	value	mark	z(targ)	remarks
173		-----		-----	
179		-----		-----	
273		-----		-----	
325	D664-A	<0.02		-----	
360		-----		-----	
398	EN62021-1	0.008		-----	
446		-----		-----	
614		-----		-----	
657	D664-A	<0.01		-----	
862	D664-A	<0.10		-----	
901		-----		-----	
912		-----		-----	
963		-----		-----	
974	D664-A	0.006		-----	
1146	D664-A	0.006		-----	
1178	IEC62021-1	0.005		-----	
1262	EN62021-1	0.008		-----	
1264	D664-A	0.0155	R(0.05)	-----	
1304		-----		-----	
1306		-----		-----	
1326	IEC62021-1	0.0095		-----	
1381		-----		-----	
1435	IEC62021-1	0.004		-----	
1442		-----		-----	
1458		-----		-----	
1461		-----		-----	
1478	IEC62021-1	0.0065		-----	
1513	IEC62021-1	0.0061		-----	
1529	IEC62021-1	0.006		-----	
1560	IEC62021-1	0.007		-----	
1660	IEC62021-1	0.011		-----	
1687	D664-A	0.005		-----	
1702	IEC62021-1	0.006		-----	
1719	D664-A	0.007		-----	
1743	IEC62021-1	0.011		-----	
1747	IEC62021-1	0.0048		-----	
1801	EN62021-1	0.015	R(0.05)	-----	
1885		-----		-----	
1890	ISO6619	0.011		-----	
6000		-----		-----	
6007		-----		-----	
6015		-----		-----	
6053	IEC62021-1	0.008	C	-----	First reported 0.015
6067	IEC62021-1	0.0035		-----	
6071	IEC62021-1	<0.01		-----	
6085	D8045	0.02	R(0.05)	-----	
6088	IEC62021-1	0.0104		-----	
6141	D664-A	0.005		-----	
6167		-----		-----	
6169		-----		-----	
6253		-----		-----	
6275	IEC62021-1	0.0049		-----	
6278		-----		-----	
6280	IEC62021-1	0.0063		-----	
6283	IEC62021-1	<0,01		-----	
6318	IEC62021-1	0.0074		-----	
6361		-----		-----	
6367		-----		-----	
6382	IEC62021-1	0.00589		-----	
6422		-----		-----	
6428		-----		-----	
6446	D664-A	<0.03		-----	
6552	IEC62021-1	0.0041		-----	
	normality	OK			
	n	27			
	outliers	3			
	mean (n)	0.0068			
	st.dev. (n)	0.00220			
	R(calc.)	0.0062			
	st.dev.(EN62021-1:03)	(0.00068)			
	R(EN62021-1:03)	(0.0019)			Quantification limit EN62021-1: >0.014 mg KOH/g
Compare					
	R(D664-A:18e2, IP 60mL)	(0.0067)			Application Range D664-A: 0.1 – 150 mg KOH/g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6067
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974
1146
1702
1529
1513
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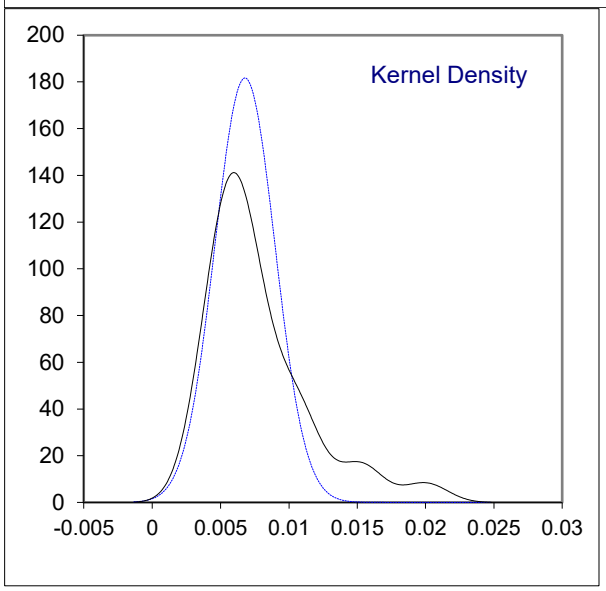
Kernel Density
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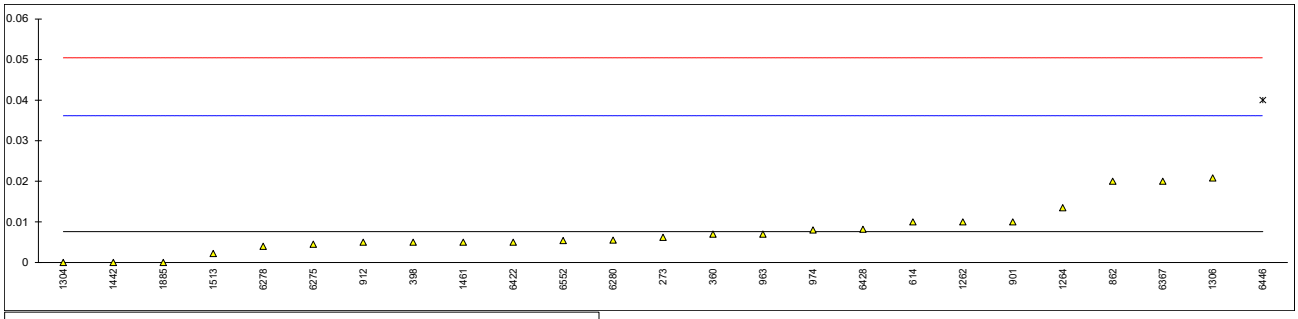
180
160
140
120
100
80
60
40
20
0
-0.005
0
0.005
0.01
0.015
0.02
0.025
0.03

Determination of Total Acid Number (Colorimetric) on sample #23240; results in mg KOH/g

lab	method	value	mark	z(targ)	remarks
173		-----		-----	
179		-----		-----	
273	D974	0.0062		-0.10	
325	D974	<0.02		-----	
360	EN62021-2	0.007		-0.04	
398	D974	0.005		-0.18	
446	D974	<0.025		-----	
614	D974	0.01		0.17	
657	D974	<0.02		-----	
862	D974	0.02		0.87	
901	D974	0.01		0.17	
912	D974	0.0050		-0.18	
963	D974	0.007		-0.04	
974	D974	0.008		0.03	
1146		-----		-----	
1178		-----		-----	
1262	ISO6618	0.010		0.17	
1264	D974	0.0135		0.41	
1304	In house	0.000		-0.53	
1306	D974	0.0208		0.92	
1326		-----		-----	
1381		-----		-----	
1435		-----		-----	
1442	IEC62021-2	0.00		-0.53	
1458	D974	<0.01		-----	
1461		0.005		-0.18	
1478		-----		-----	
1513	IEC62021-2	0.0022		-0.38	
1529		-----		-----	
1560		-----		-----	
1660		-----		-----	
1687		-----		-----	
1702		-----		-----	
1719		-----		-----	
1743		-----		-----	
1747		-----		-----	
1801		-----		-----	
1885	D974	0.000		-0.53	
1890		-----		-----	
6000		-----		-----	
6007		-----		-----	
6015		-----		-----	
6053		-----		-----	
6067		-----		-----	
6071		-----		-----	
6085		-----		-----	
6088		-----		-----	
6141		-----		-----	
6167		-----		-----	
6169		-----		-----	
6253		-----		-----	
6275	D974	0.0045		-0.22	
6278	D974	0.004		-0.25	
6280	IEC62021-2	0.0055		-0.15	
6283	IEC62021-2	<0,01		-----	
6318		-----		-----	
6361		-----		-----	
6367	IEC62021-2	0.02		0.87	
6382		-----		-----	
6422	IEC62021-2	0.005		-0.18	
6428	EN62021-2	0.0082		0.04	
6446	D974	0.04	R(0.01)	2.27	
6552	D974	0.0054		-0.15	

normality	suspect
n	24
outliers	1
mean (n)	0.0076
st.dev. (n)	0.00589
R(calc.)	0.0165
st.dev.(D974:22)	0.01429
R(D974:22)	0.04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0.02
0.01
0
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1442
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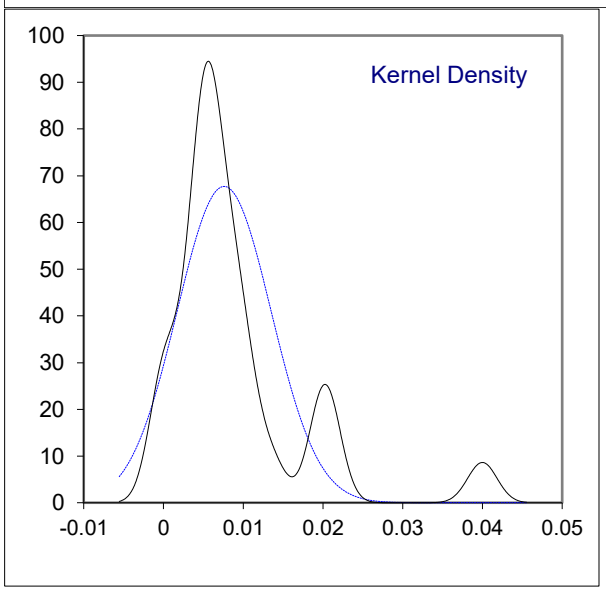
1461
6422
6552
6280
273
360
963
974
6428
614
1262
901
1264
862
6367
1306
6446


Kernel Density
100
90
80
70
60
50
40
30
20
10
0
-0.01
0
0.01
0.02
0.03
0.04
0.05

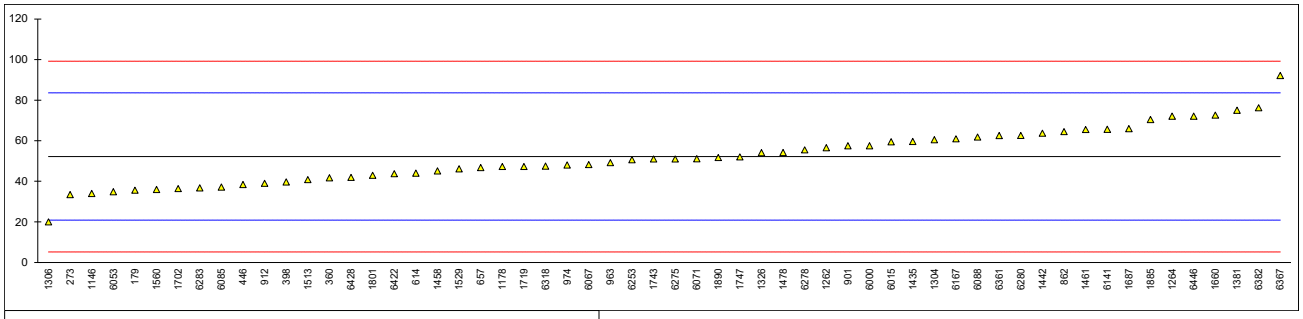
Determination of Appearance on sample #23240;

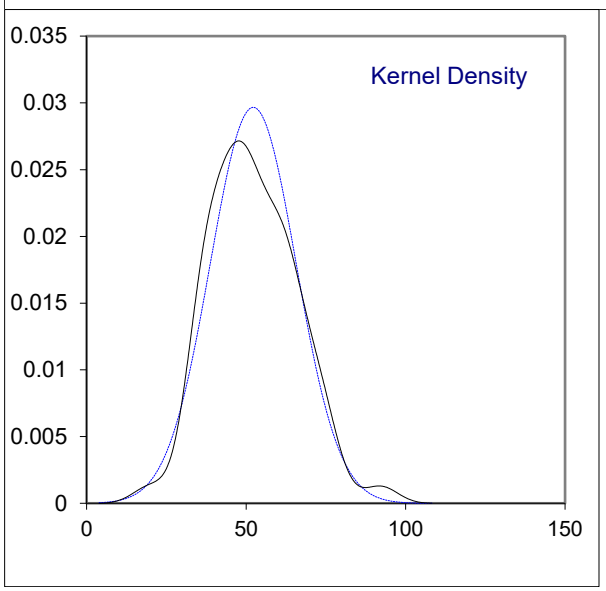
lab	method	value	mark	z(targ)	remarks
173	Visual	C&B		-----	
179	Visual	BRT/CLR		-----	
273	Visual	Bright & Clear		-----	
325	Visual	colorless		-----	
360	Visual	Clear and Bright		-----	
398	Visual	CLEAR		-----	
446		Pass		-----	
614		-----		-----	
657	Visual	Clear		-----	
862		-----		-----	
901		-----		-----	
912		-----		-----	
963	D1524	Bright & Clear		-----	
974	Visual	Clear & Bright		-----	
1146	Visual	Clear		-----	
1178	Visual	clear		-----	
1262	IEC60296	bright and clear		-----	
1264	Visual	Bright and clear		-----	
1304		-----		-----	
1306	Visual	Clear		-----	
1326		-----		-----	
1381		-----		-----	
1435	Visual	clear		-----	
1442	Visual	clear		-----	
1458	Visual	clear bright		-----	
1461		-----		-----	
1478	Visual	clear		-----	
1513	Visual	Clear, without visible contaminants		-----	
1529	Visual	clear		-----	
1560	Visual	Clear & Bright		-----	
1660	Visual	Clear		-----	
1687		-----		-----	
1702	Visual	Clear		-----	
1719		-----		-----	
1743	Visual	Clear		-----	
1747		-----		-----	
1801	Visual	<0.5		-----	
1885	Visual	clear bright		-----	
1890	Visual	CLEAR		-----	
6000		-----		-----	
6007		-----		-----	
6015		-----		-----	
6053	Visual	Straw		-----	
6067		-----		-----	
6071		-----		-----	
6085		-----		-----	
6088	Visual	clear and bright		-----	
6141	Visual	Clear & Bright		-----	
6167		-----		-----	
6169		-----		-----	
6253		-----		-----	
6275	Visual	Clear		-----	
6278	Visual	Clear & Bright		-----	
6280	Visual	Clear		-----	
6283	Visual	clear		-----	
6318		-----		-----	
6361	Visual	Clear		-----	
6367	Visual	Clear & Bright		-----	
6382	Visual	Clear, free from sediment		-----	
6422		-----		-----	
6428	Visual	Clear&Bright		-----	
6446	Visual	Bright / Clear		-----	
6552		-----		-----	
	n	38			
	mean (n)	Bright & Clear			

Determination of Breakdown Voltage on sample #23240, results in kV/2.5 mm

lab	method	value	mark	z(targ)	Stirred or not stirred	remarks
173		-----		-----	---	
179	D877	35.6		-1.06	---	
273	IEC60156	33.4		-1.20	---	
325		-----		-----	---	
360	EN60156	41.7		-0.67	Stirred continuously including breakdowns	
398	IEC60156	39.7		-0.80	Stirred continuously excluding breakdowns	
446	IEC60156	38.4		-0.88	Stirred continuously excluding breakdowns	
614	IEC60156	44		-0.52	Stirred continuously including breakdowns	
657	IEC60156	46.8		-0.34	Not stirred	
862	IEC60156	64.5		0.79	---	
901	D877	57.5		0.34	Stirred continuously including breakdowns	
912	IEC60156	39		-0.84	---	
963	IEC60156	49.2		-0.19	---	
974	IEC60156	48		-0.27	---	
1146	IEC60156	34		-1.16	Stirred continuously including breakdowns	
1178	IEC60156	47.3		-0.31	Stirred continuously excluding breakdowns	
1262	EN60156	56.6		0.28	Stirred continuously including breakdowns	
1264	IEC60156	72.1		1.27	Not stirred	
1304	IEC60156	60.5		0.53	Stirred continuously including breakdowns	
1306	IEC60156	20		-2.06	Stirred continuously including breakdowns	
1326	IEC60156	54.1		0.12	---	
1381	IEC60156	75.0		1.46	Stirred continuously excluding breakdowns	
1435	IEC60156	59.6		0.47	Stirred continuously excluding breakdowns	
1442	IEC60156	63.7		0.73	Stirred continuously excluding breakdowns	
1458	IEC60156	45.1		-0.45	Stirred continuously including breakdowns	
1461	IEC60156	65.5		0.85	Stirred continuously including breakdowns	
1478	IEC60156	54.2		0.13	Stirred continuously including breakdowns	
1513	IEC60156	40.8		-0.73	Stirred continuously including breakdowns	
1529	IEC60156	46.1		-0.39	Stirred continuously excluding breakdowns	
1560	IEC60156	36		-1.03	Stirred continuously including breakdowns	
1660	IEC60156	72.6		1.30	Stirred continuously including breakdowns	
1687	IEC60156	65.9		0.87	Stirred continuously excluding breakdowns	
1702	IEC60156	36.4		-1.01	Stirred continuously including breakdowns	
1719	IEC60156	47.3		-0.31	Stirred continuously including breakdowns	
1743	IEC60156	51		-0.08	Not stirred	
1747	IEC60156	52		-0.01	Stirred continuously including breakdowns	
1801	EN60156	42.9		-0.59	Stirred continuously including breakdowns	
1885	IEC60156	70.4		1.16	Not stirred	
1890	IEC60156	51.7		-0.03	---	
6000	EN60156	57.5		0.34	Stirred continuously including breakdowns	
6007		-----		-----	---	
6015	EN60156	59.50		0.47	Stirred continuously excluding breakdowns	
6053	IEC60156	34.9		-1.10	Stirred continuously including breakdowns	
6067	IEC60156	48.2		-0.26	Stirred continuously excluding breakdowns	
6071	IEC60156	51.1		-0.07	---	
6085	IEC60156	37.1		-0.96	Stirred continuously including breakdowns	
6088	IEC60156	61.8		0.61	Stirred continuously including breakdowns	
6141	IEC60156	65.6		0.86	Stirred continuously including breakdowns	
6167	IEC60156	60.9		0.56	Stirred continuously including breakdowns	
6169		-----		-----	Stirred continuously excluding breakdowns	
6253	EN60156	50.6		-0.10	Not stirred	
6275	IEC60156	51		-0.08	---	
6278	IEC60156	55.5		0.21	Stirred continuously including breakdowns	
6280	IEC60156	62.6		0.66	Stirred continuously including breakdowns	
6283	IEC60156	36.8		-0.98	Stirred continuously excluding breakdowns	
6318	IEC60156	47.533		-0.30	Stirred continuously including breakdowns	
6361	IEC60156	62.5		0.66	Stirred continuously including breakdowns	
6367	IEC60156	92.1	C	2.55	Stirred continuously including breakdowns	First reported 97
6382	IEC60156	76.2		1.53	Stirred continuously including breakdowns	
6422	IEC60156	43.7		-0.54	Stirred continuously including breakdowns	
6428	EN60156	41.9		-0.66	Stirred continuously including breakdowns	
6446	IEC60156	72.10		1.27	Stirred continuously including breakdowns	
6552		-----		-----	---	

normality	OK
n	58
outliers	0
mean (n)	52.20
st.dev. (n)	13.450
R(calc.)	37.66
st.dev.(IEC60156:18)	15.661
R(IEC60156:18)	43.85


120
100
80
60
40
20
0
1306 273 1146 6053 179 1560 1702 6283 6085 446 912 398 1513 360 6428 1801 6422 614 1458 1529 657 1178 1719 6318 974 6067 963 6253 1743 6275 6071 1890 1747 1326 1478 6278 1262 901 6000 6015 1435 1304 6167 6088 6361 6280 1442 862 1461 6141 1687 1885 1264 6446 1660 1381 6382 6367

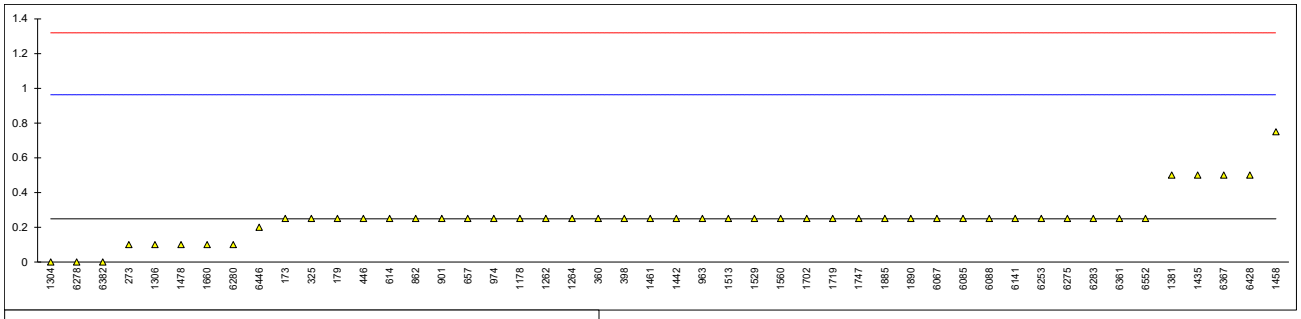

Kernel Density
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150

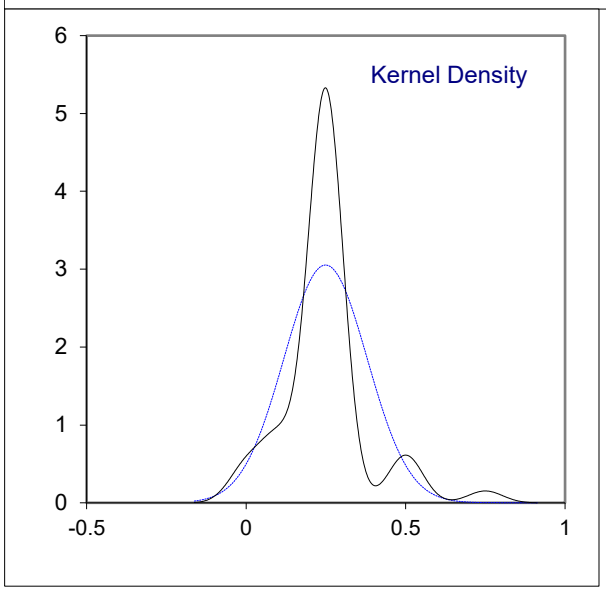
Determination of Color ASTM on sample #23240

lab	method	value	iis conversion *)	mark	z(targ)	remarks
173	D1500	L0.5	0.25		0.00	
179	D1500	L0.5	0.25		0.00	
273	D1500	0.10	0.10		-0.42	
325	D6045	L0.5	0.25		0.00	
360	ISO2049	< 0.5	0.25		0.00	
398	D1500	L0.5	0.25		0.00	
446	ISO2049	<0.5	0.25		0.00	
614	D1500	<0.5	0.25		0.00	
657	D1500	L0.5	0.25		0.00	
862	D1500	L0.5	0.25		0.00	
901	D1500	L0.5	0.25		0.00	
912		-----	-----		-----	
963	D1500	L0.5	0.25		0.00	
974	D1500	L0.5	0.25		0.00	
1146		-----	-----		-----	
1178	ISO2049	L0.5	0.25		0.00	
1262	ISO2049	L 0.5	0.25		0.00	
1264	D1500	L0.5	0.25		0.00	
1304	D1500	0.0	0.0		-0.70	
1306	D1500	0.1	0.1		-0.42	
1326		-----	-----		-----	
1381	ISO2049	0.5	0.5		0.70	
1435	D1500	0.5	0.5		0.70	
1442	ISO2049	L0,5	0.25		0.00	
1458	D1500	L1.0	0.75		1.40	
1461	ISO2049	L0,5	0.25		0.00	
1478	ISO2049	0.1	0.1		-0.42	
1513	ISO2049	L0,5	0.25		0.00	
1529	ISO2049	0-0.5	0.25		0.00	
1560	ISO2049	L0.5	0.25		0.00	
1660	D1500	0.1	0.1		-0.42	
1687		-----	-----		-----	
1702	D1500	L 0.5	0.25		0.00	
1719		<0.5	0.25		0.00	
1743	In house	Colorless	Colorless		-----	
1747	ISO2049	<0.5	0.25		0.00	
1801		-----	-----		-----	
1885	D1500	<0.5	0.25		0.00	
1890	D1500	<0,5	0.25		0.00	
6000		-----	-----		-----	
6007		-----	-----		-----	
6015		-----	-----		-----	
6053		-----	-----		-----	
6067	ISO2049	L0.5	0.25		0.00	
6071		-----	-----		-----	
6085	D1500	< 0.5	0.25		0.00	
6088	D1500	L0.5	0.25		0.00	
6141	D1500	L0.5	0.25		0.00	
6167		-----	-----		-----	
6169		-----	-----		-----	
6253	ISO2049	L0.5	0.25		0.00	
6275	D1500	L 0.5	0.25		0.00	
6278	D1500	0.0	0.0		-0.70	
6280	D1500	0.1	0.1		-0.42	
6283	D1500	L0,5	0.25		0.00	
6318		-----	-----		-----	
6361	D1500	L0.5	0.25		0.00	
6367	D1500	0.5	0.5		0.70	
6382	ISO2049	0.0	0.0		-0.70	
6422		-----	-----		-----	
6428	ISO2049	0.5	0.5		0.70	
6446	ISO2049	0.2	0.2		-0.14	
6552	ISO2049	L0.5	0.25		0.00	

normality	Not OK
n	48
outliers	0
mean (n)	0.25
st.dev. (n)	0.131
R(calc.)	0.37
st.dev.(ISO2049:96)	0.357
R(ISO2049:96)	1

*) In the calculation of the mean, standard deviation and the reproducibility in this column, a reported value of ‘L y’ or ‘<y’ is changed to y-0.25 (for example L0.5 is changed into 0.25)

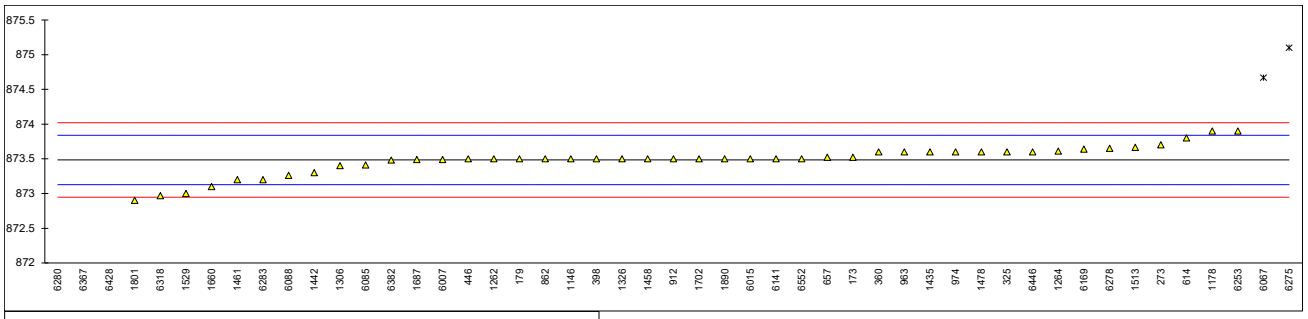

1.4
1.2
1
0.8
0.6
0.4
0.2
0
1304
6278
6382
273
1306
1478
1660
6280
6446
173
325
179
446
614
862
901
657
974
1178
1262
1264
360
398
1461
1442
963
1513
1529
1560
1702
1719
1747
1885
1890
6067
6085
6088
6141
6253
6275
6283
6361
6552
1381
1435
6367
6428
1458

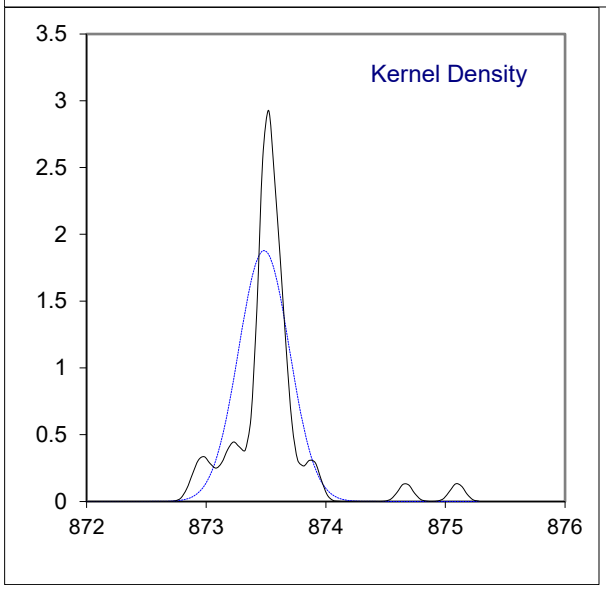

Kernel Density
6
5
4
3
2
1
0
-0.5
0
0.5
1

Determination of Density at 20 °C on sample #23240; results in kg/m^3

lab	method	value	mark	z(targ)	remarks
173	D4052	873.52		0.20	
179	D4052	873.5	C	0.09	First reported 0.8735 kg/m^3
273	D4052	873.7		1.21	
325	D4052	873.6	C	0.65	First reported 0.8736 kg/m^3
360	ISO12185	873.6		0.65	
398	ISO12185	873.5		0.09	
446	ISO12185	873.5		0.09	
614	D4052	873.8		1.77	
657	D4052	873.52		0.20	
862	D4052	873.5		0.09	
901		-----		-----	
912	ISO12185	873.5		0.09	
963	D4052	873.6		0.65	
974	D4052	873.6		0.65	
1146	D4052	873.5		0.09	
1178	ISO12185	873.9		2.33	
1262	ISO3675	873.5		0.09	
1264	D4052	873.61		0.71	
1304		-----		-----	
1306	D4052	873.4	C	-0.47	Reported 0.8734 kg/m^3
1326	D4052	873.5		0.09	
1381		-----		-----	
1435	D4052	873.6		0.65	
1442	D7042	873.30		-1.03	
1458	D4052	873.5		0.09	
1461	ISO3675	873.2		-1.59	
1478	ISO12185	873.6		0.65	
1513	ISO12185	873.665		1.01	
1529	In house	873		-2.71	
1560		-----		-----	
1660	D7042	873.1	C	-2.15	First reported 0.8731 kg/m^3
1687	ISO12185	873.49		0.03	
1702	ISO12185	873.5		0.09	
1719		-----		-----	
1743		-----		-----	
1747		-----		-----	
1801	ISO3675	872.9	C	-3.27	First reported 0.8729 kg/m^3
1885		-----		-----	
1890	ISO12185	873.5		0.09	
6000		-----		-----	
6007	ISO12185	873.49		0.03	
6015	ISO12185	873.50		0.09	
6053		-----		-----	
6067	D4052	874.666667	C,R(0.01)	6.62	First reported 0.874666667 kg/m^3
6071		-----		-----	
6085	D7042	873.41		-0.41	
6088	ISO3675	873.26	C	-1.25	First reported 872.26
6141	D4052	873.5		0.09	
6167		-----		-----	
6169	ISO12185	873.64		0.87	
6253	ISO3675	873.9		2.33	
6275	D1298	875.1	R(0.01)	9.05	
6278	D1298	873.65		0.93	
6280	ISO12185	863	R(0.01)	-58.71	
6283	D4052	873.2	C	-1.59	First reported 0.8732 kg/m^3
6318	ISO3675	872.969	C	-2.88	First reported 0.870604
6361		-----		-----	
6367	ISO3675	868	R(0.01)	-30.71	
6382	DIN51757	873.48		-0.02	
6422		-----		-----	
6428	ISO3675	871	R(0.01)	-13.91	
6446	ISO12185	873.6		0.65	
6552	ISO12185	873.5		0.09	

normality	suspect
n	44
outliers	5
mean (n)	873.484
st.dev. (n)	0.2124
R(calc.)	0.595
st.dev.(ISO12185:96)	0.1786
R(ISO12185:96)	0.5

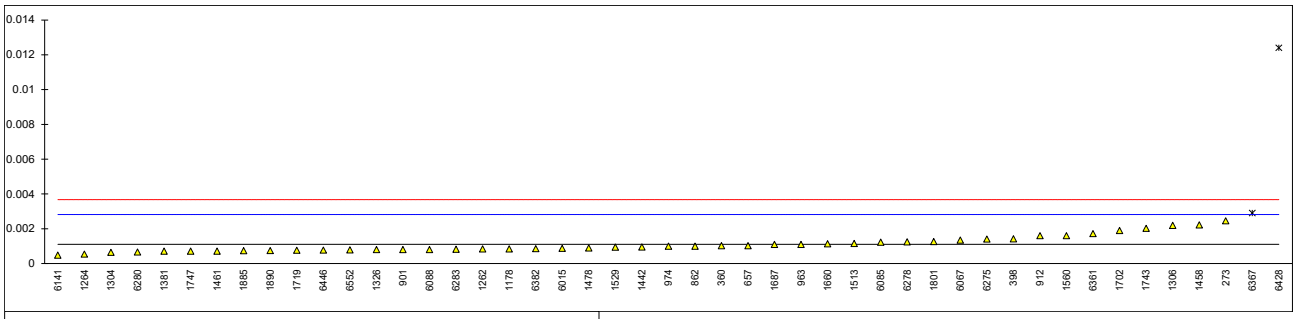

875.5
875
874.5
874
873.5
873
872.5
872
6280 6367 6428 1801 6318 1529 1660 1461 6283 6088 1442 1306 6085 6382 1687 6007 446 1262 179 862 1146 398 1326 1458 912 1702 1890 6015 6141 6552 657 173 360 963 1435 974 1478 325 6446 1264 6169 6278 1513 273 614 1178 6253 6067 6275

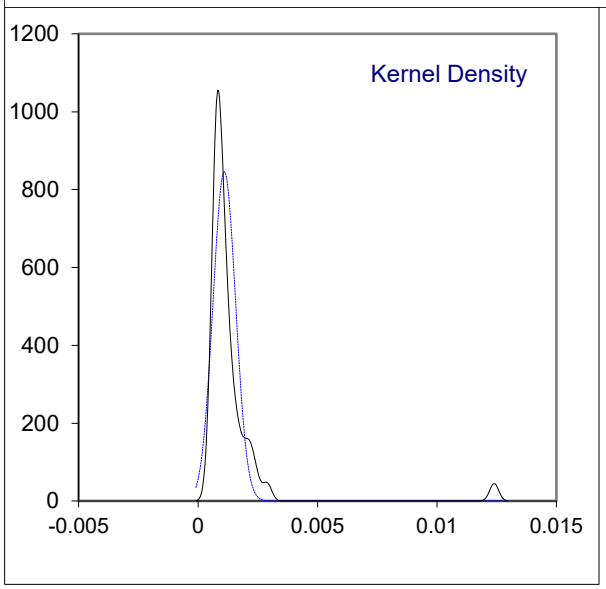

Kernel Density
3.5
3
2.5
2
1.5
1
0.5
0
872
873
874
875
876

Determination of Di-electric Dissipation Factor (DDF) at 90 °C on sample #23240

lab	method	value	mark	z(targ)	frequency	remarks
173		-----		-----	-----	
179		-----		-----	-----	
273	IEC60247	0.00245		1.57	-----	
325		-----		-----	-----	
360	EN60247	0.001019		-0.10	-----	
398	IEC60247	0.00142		0.37	60	
446	EN60247	<0.001		-----	50	
614		-----		-----	-----	
657	IEC60247	0.001025		-0.09	50	
862	IEC60247	0.0010		-0.12	50	
901	IEC60247	0.0008		-0.36	-----	
912	EN60247	0.0016		0.58	-----	
963	IEC60247	0.0011		-0.01	60	
974	IEC60247	0.0010		-0.12	50	
1146		-----		-----	-----	
1178	IEC60247	0.00084		-0.31	-----	
1262	EN60247	0.00084		-0.31	50	
1264	IEC60247	0.000541		-0.66	60	
1304	IEC60247	0.000646		-0.54	50	
1306	IEC60247	0.002189		1.27	-----	
1326	IEC60247	0.0008		-0.36	-----	
1381	IEC60247	0.00071		-0.46	-----	
1435	IEC60247	<0.0010		-----	-----	
1442	IEC60247	0.00095		-0.18	55	
1458	IEC60247	0.002218		1.30	50	
1461	IEC60247	0.000712		-0.46	-----	
1478	IEC60247	0.000894		-0.25	-----	
1513	IEC60247	0.00115		0.05	-----	
1529	IEC60247	0.00094		-0.19	-----	
1560	IEC60247	0.0016		0.58	50	
1660	IEC60247	0.001134		0.03	60	
1687	IEC60247	0.001097		-0.01	50	
1702	IEC60247	0.001892		0.92	-----	
1719	IEC60247	0.00076		-0.41	-----	
1743	IEC60247	0.00202		1.07	-----	
1747	IEC60247	0.000710		-0.46	-----	
1801	EN60247	0.00126		0.18	-----	
1885	IEC60247	0.000738		-0.43	60	
1890	IEC60247	0.000741		-0.43	50Hz	
6000		-----		-----	-----	
6007		-----		-----	-----	
6015	EN60247	0.0008705		-0.28	50	
6053		-----		-----	-----	
6067	IEC60247	0.001347		0.28	-----	
6071		-----		-----	-----	
6085	IEC60247	0.001227		0.14	55	
6088	IEC60247	0.0008		-0.36	50	
6141	IEC60247	0.0004845		-0.73	60	
6167		-----		-----	-----	
6169		-----		-----	-----	
6253		-----		-----	-----	
6275	IEC60247	0.0014		0.34	-----	
6278	IEC60247	0.00124		0.16	-----	
6280	IEC60247	0.000656		-0.53	-----	
6283	IEC60247	0.000821		-0.33	-----	
6318		-----		-----	-----	
6361	IEC60247	0.00172		0.72	-----	
6367	IEC60247	0.0029	R(0.05)	2.10	50	
6382	IEC60247	0.000855		-0.29	-----	
6422		-----		-----	-----	
6428	EN60247	0.0124	R(0.01)	13.22	-----	
6446	IEC60247	0.00077		-0.39	-----	
6552	IEC60247	0.00079		-0.37	2.15	

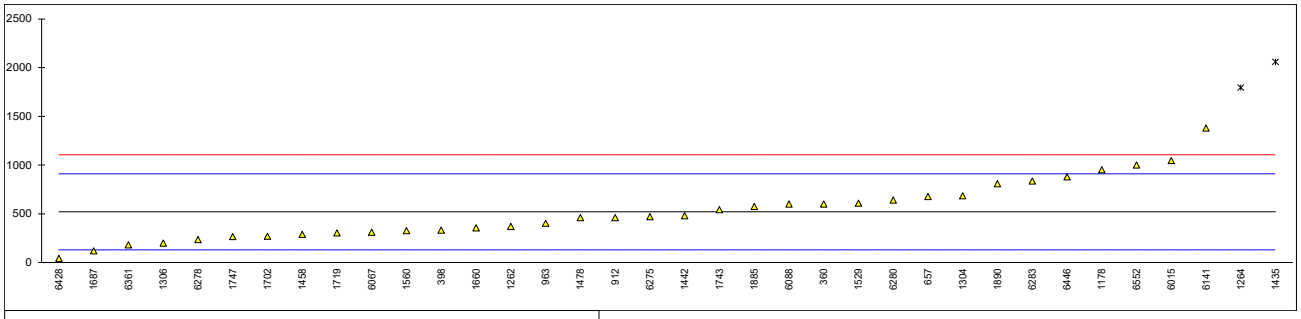
normality	not OK
n	45
outliers	2
mean (n)	0.001106
st.dev. (n)	0.0004715
R(calc.)	0.001320
st.dev.(EN60247:04)	0.0008545
R(EN60247:04)	0.002393

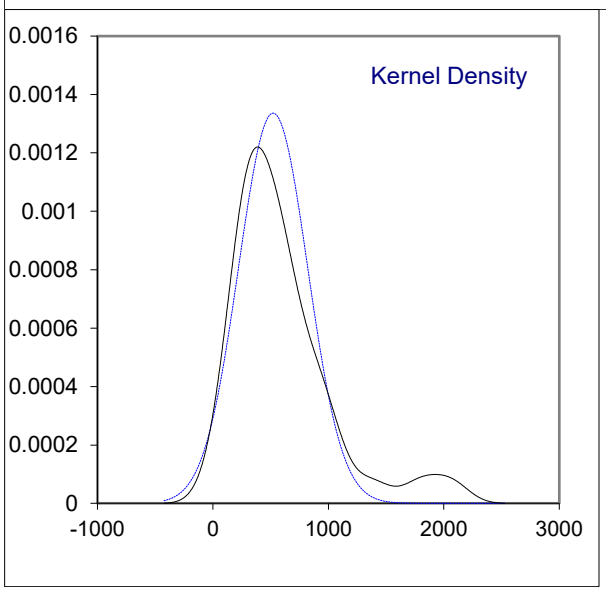

0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
6141 1264 1304 6280 1381 1747 1461 1885 1890 1719 6446 6552 1326 901 6088 6283 1262 1178 6382 6015 1478 1529 1442 974 862 360 657 1687 963 1660 1513 6085 6278 1801 6067 6275 398 912 1560 6361 1702 1743 1306 1458 273 6367 6428


Kernel Density
1200
1000
800
600
400
200
0
-0.005
0
0.005
0.01
0.015

Determination of Specific Resistance at 90 °C on sample #23240; results in GΩm

lab	method	value	mark	z(targ)	remarks
173		-----		-----	
179		-----		-----	
273		-----		-----	
325		-----		-----	
360	EN60247	600.2		0.41	
398	IEC60247	331.82		-0.97	
446		-----		-----	
614		-----		-----	
657	IEC60247	676.06		0.80	
862		-----		-----	
901		-----		-----	
912	EN60247	460.4		-0.31	
963	IEC60247	401.6		-0.61	
974		-----		-----	
1146		-----		-----	
1178	IEC60247	951.3		2.21	
1262	EN60247	370.0		-0.77	
1264	IEC60247	1795	R(0.01)	6.53	
1304	IEC60247	684.74		0.84	
1306	IEC60247	199.01		-1.65	
1326		-----		-----	
1381		-----		-----	
1435	IEC60247	2060	R(0.01)	7.89	
1442	IEC60247	480.00		-0.21	
1458	IEC60247	289.1		-1.19	
1461		-----		-----	
1478	IEC60247	460.26		-0.31	
1513		-----		-----	
1529	IEC60247	608.9		0.45	
1560	IEC60247	325.83		-1.00	
1660	IEC60247	355.26		-0.85	
1687	IEC60247	118.67		-2.06	
1702	IEC60247	269.48		-1.29	
1719	IEC60247	303		-1.11	
1743	IEC60247	542		0.11	
1747	IEC60247	265.03		-1.31	
1801		-----		-----	
1885	IEC60247	575.35		0.28	
1890	IEC60247	808.84		1.48	
6000		-----		-----	
6007		-----		-----	
6015	EN60247	1045.000		2.69	
6053		-----		-----	
6067	IEC60247	311.28		-1.07	
6071		-----		-----	
6085		-----		-----	
6088	IEC60247	600		0.41	
6141	IEC60247	1380		4.40	
6167		-----		-----	
6169		-----		-----	
6253		-----		-----	
6275	IEC60247	470		-0.26	
6278	IEC60247	236.25		-1.46	
6280	IEC60247	641.22		0.62	
6283	IEC60247	835.91		1.62	
6318		-----		-----	
6361	IEC60247	181.45		-1.74	
6367		-----		-----	
6382		-----		-----	
6422		-----		-----	
6428	EN60247	41.94		-2.45	
6446	IEC60247	878.62		1.83	
6552	IEC60247	1000		2.46	
	normality	OK			
	n	34			
	outliers	2			
	mean (n)	520.545			
	st.dev. (n)	298.5543			
	R(calc.)	835.952			
	st.dev.(EN60247:04)	195.2043			
	R(EN60247:04)	546.572			

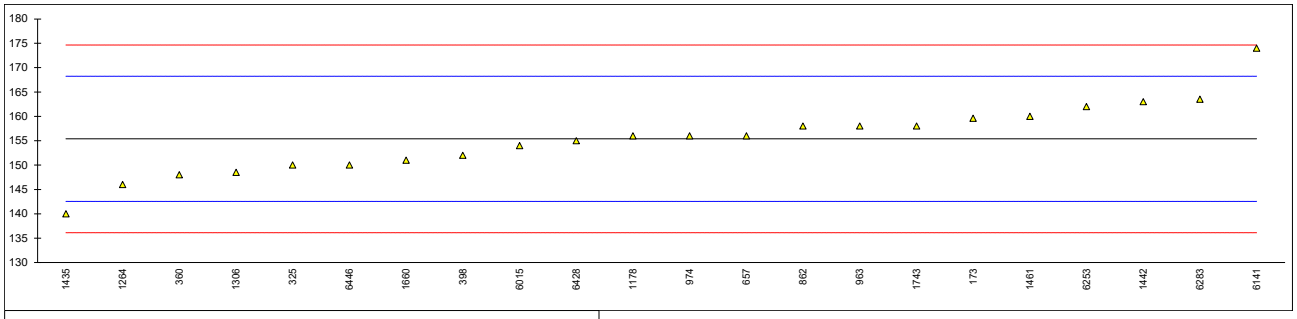

2500
2000
1500
1000
500
0
6428
1687
6361
1306
6278
1747
1702
1458
1719
6067
1560
398
1660
1262
963
1478
912
6275
1442
1743
1885
6088
360
1529
6280
657
1304
1890
6283
6446
1178
6552
6015
6141
1264
1435

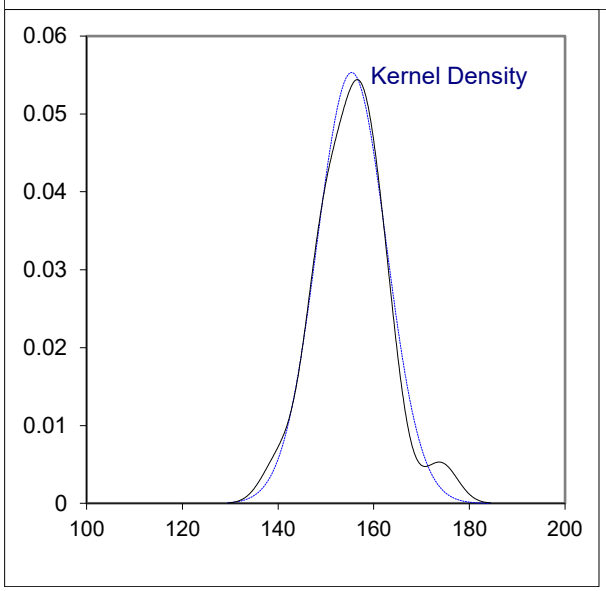

Kernel Density
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
-1000
0
1000
2000
3000

Determination of Flash Point C.O.C. on sample #23240; results in °C

lab	method	value	mark	z(targ)	remarks
173	D92	159.6		0.65	
179		-----		-----	
273		-----		-----	
325	D92	150		-0.84	
360	ISO2592	148		-1.15	
398	D92	152		-0.53	
446		-----		-----	
614		-----		-----	
657	D92	156		0.09	
862	D92	158		0.41	
901		-----		-----	
912		-----		-----	
963	D92	158		0.41	
974	D92	156		0.09	
1146		-----		-----	
1178	ISO2592	156.0		0.09	
1262		-----		-----	
1264	D92	146		-1.46	
1304		-----		-----	
1306	D92	148.5		-1.07	
1326		-----		-----	
1381		-----		-----	
1435	D92	140.0		-2.39	
1442	ISO2592	163.0		1.18	
1458		-----		-----	
1461	ISO2592	160		0.72	
1478		-----		-----	
1513		-----		-----	
1529		-----		-----	
1560		-----		-----	
1660	D92	151		-0.68	
1687		-----		-----	
1702		-----		-----	
1719		-----		-----	
1743	ISO2592	158		0.41	
1747		-----		-----	
1801		-----		-----	
1885		-----		-----	
1890		-----		-----	
6000		-----		-----	
6007		-----		-----	
6015	ISO2592	154.0		-0.22	
6053		-----		-----	
6067		-----		-----	
6071		-----		-----	
6085		-----		-----	
6088		-----		-----	
6141	D92	174		2.89	
6167		-----		-----	
6169		-----		-----	
6253	ISO2592	162		1.03	
6275		-----		-----	
6278		-----		-----	
6280		-----		-----	
6283	D92	163.5		1.26	
6318		-----		-----	
6361		-----		-----	
6367		-----		-----	
6382		-----		-----	
6422		-----		-----	
6428	ISO2592	155		-0.06	
6446	ISO2592	150		-0.84	
6552		-----		-----	

normality	suspect	
n	22	
outliers	0	
mean (n)	155.39	
st.dev. (n)	7.212	
R(calc.)	20.19	
st.dev.(D92:18)	6.429	
R(D92:18)	18	Is equal to ISO2592:17

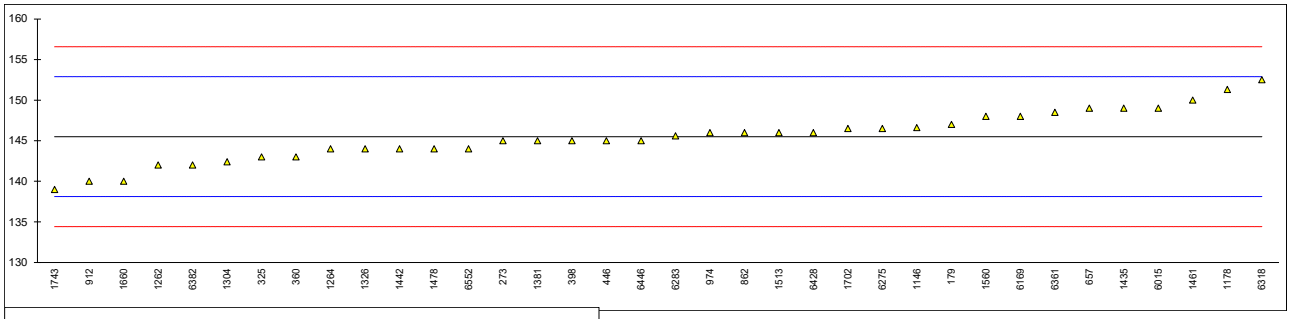

180
175
170
165
160
155
150
145
140
135
130
1435
1264
360
1306
325
6446
1660
398
6015
6428
1178
974
657
862
963
1743
173
1461
6253
1442
6283
6141

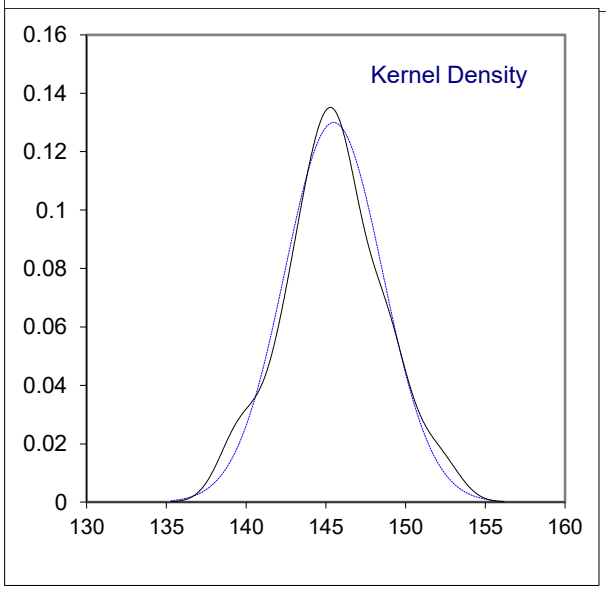

Kernel Density
0.06
0.05
0.04
0.03
0.02
0.01
0
100
120
140
160
180
200

Determination of Flash Point PMcc on sample #23240; results in °C

lab	method	value	mark	z(targ)	remarks
173		-----		-----	
179	D93-A	147		0.41	
273	D93-A	145		-0.13	
325	D93-A	143.0		-0.68	
360	ISO2719-A	143.0		-0.68	
398	D93-A	145		-0.13	
446	ISO2719-A	145		-0.13	
614		-----		-----	
657	D93-A	149		0.95	
862	D93-A	146		0.14	
901		-----		-----	
912	ISO2719	140		-1.49	
963		-----		-----	
974	D93-A	146		0.14	
1146	D93-A	146.6		0.30	
1178	ISO2719-A	151.3		1.57	
1262	ISO2719-A	142.0		-0.95	
1264	D93-A	144		-0.41	
1304	In house	142.4		-0.84	
1306		-----		-----	
1326	D93-A	144.0		-0.41	
1381	ISO2719-A	145.0		-0.13	
1435	D93-A	149.0		0.95	
1442	ISO2719-A	144.0		-0.41	
1458		-----		-----	
1461	ISO2719-A	150		1.22	
1478	ISO2719-A	144.0		-0.41	
1513	ISO2719-A	146.0		0.14	
1529		-----		-----	
1560	ISO2719-A	148		0.68	
1660	D93-A	140		-1.49	
1687		-----		-----	
1702	ISO2719-A	146.5		0.27	
1719		-----		-----	
1743	ISO2719-A	139		-1.76	
1747		-----		-----	
1801		-----		-----	
1885		-----		-----	
1890		-----		-----	
6000		-----		-----	
6007		-----		-----	
6015	ISO2719-A	149.0		0.95	
6053		-----		-----	
6067		-----		-----	
6071		-----		-----	
6085		-----		-----	
6088		-----		-----	
6141		-----		-----	
6167		-----		-----	
6169	ISO2719-A	148.0		0.68	
6253		-----		-----	
6275	D93-A	146.5		0.27	
6278		-----		-----	
6280		-----		-----	
6283	D93-A	145.6		0.03	
6318	ISO2719-A	152.5		1.90	
6361	ISO2719-A	148.5		0.81	
6367		-----		-----	
6382	ISO2719-A	142		-0.95	
6422		-----		-----	
6428	ISO2719-A	146		0.14	
6446	ISO2719-A	145		-0.13	
6552	ISO2719-A	144.0		-0.41	

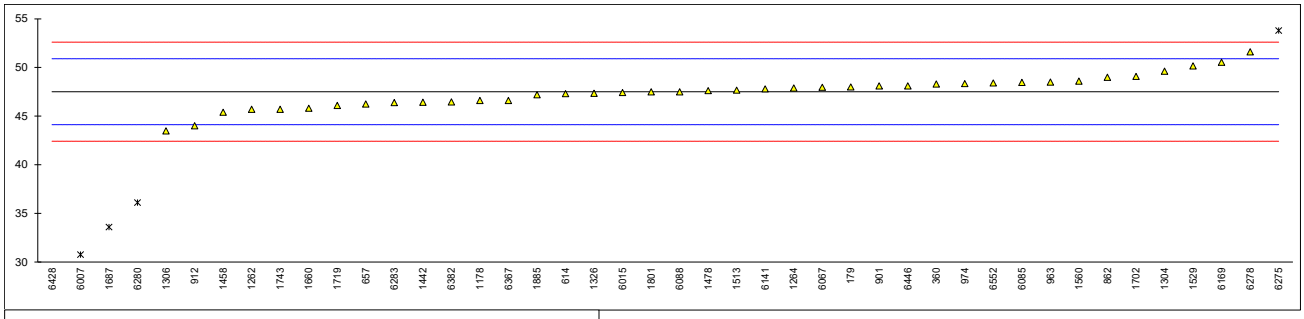
	normality	OK	
	n	36	
	outliers	0	
	mean (n)	145.50	
	st.dev. (n)	3.068	
	R(calc.)	8.59	
	st.dev.(ISO2719-A:16)	3.689	
	R(ISO2719-A:16)	10.33	Is equal to ASTM D93-A:20

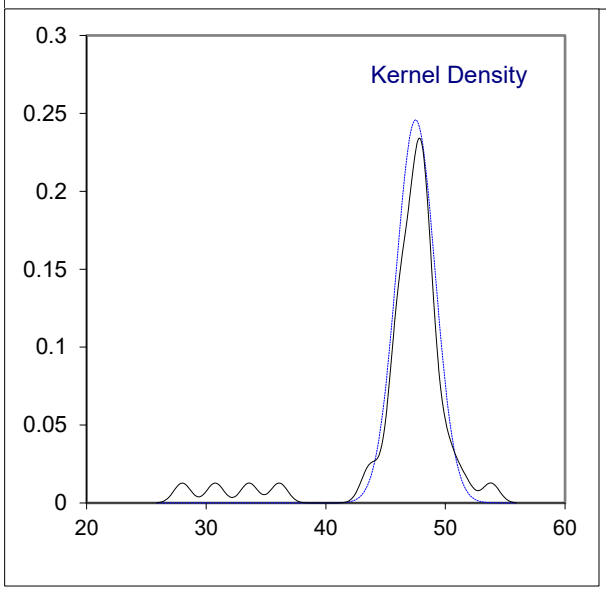

160
155
150
145
140
135
130
1743
912
1660
1262
6382
1304
325
360
1264
1326
1442
1478
6552
273
1381
398
446
6446
6283
974
862
1513
6428
1702
6275
1146
179
1560
6169
6361
657
1435
6015
1461
1178
6318


Kernel Density
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
130
135
140
145
150
155
160

Determination of Interfacial Surface Tension on sample #23240; results in mN/m

lab	method	value	mark	z(targ)	remarks
173		-----		-----	
179	D971	48.0		0.29	
273		-----		-----	
325		-----		-----	
360	D971	48.3		0.47	
398		-----		-----	
446		-----		-----	
614	D971	47.3		-0.12	
657	D971	46.238		-0.75	
862	D971	49		0.88	
901	D971	48.1		0.35	
912	D971	44		-2.07	
963	D971	48.5		0.58	
974	D971	48.34		0.49	
1146		-----		-----	
1178	D971	46.6		-0.54	
1262	D971	45.7		-1.07	
1264	D971	47.89		0.22	
1304	In house	49.61		1.24	
1306	D971	43.48		-2.38	
1326	D971	47.35		-0.09	
1381		-----		-----	
1435		-----		-----	
1442	IEC62961	46.43		-0.64	
1458	D971	45.4		-1.24	
1461		-----		-----	
1478	D971	47.62		0.06	
1513	D971	47.67		0.09	
1529	D971	50.15		1.56	
1560	D971	48.6		0.64	
1660	D971	45.8		-1.01	
1687	D971	33.58	C,R(0.01)	-8.21	First reported 28.65
1702	D971	49.08		0.93	
1719	D971	46.09		-0.84	
1743	IEC62961	45.7	C	-1.07	First reported 37.4
1747		-----		-----	
1801	D971	47.5		-0.01	
1885	D971	47.2		-0.18	
1890		-----		-----	
6000		-----		-----	
6007	DIN14370	30.7519	R(0.01)	-9.88	
6015	D971	47.420		-0.05	
6053		-----		-----	
6067	D971	47.96666667		0.27	
6071		-----		-----	
6085	D971	48.461		0.56	
6088	ISO6295	47.5		-0.01	
6141	D971	47.8		0.17	
6167		-----		-----	
6169	EN14210	50.539		1.79	
6253		-----		-----	
6275	D971	53.8	R(0.05)	3.71	
6278	D971	51.6		2.41	
6280	D971	36.1	R(0.01)	-6.72	
6283		46.4		-0.65	
6318		-----		-----	
6361		-----		-----	
6367	D971	46.6		-0.54	
6382	ISO6295	46.46		-0.62	
6422		-----		-----	
6428	EN14210	28	R(0.01)	-11.50	
6446	D971	48.10		0.35	
6552	D971	48.4		0.52	
	normality	OK			
	n	39			
	outliers	5			
	mean (n)	47.510			
	st.dev. (n)	1.6223			
	R(calc.)	4.542			
	st.dev.(D971:20)	1.6968			
	R(D971:20)	4.751			

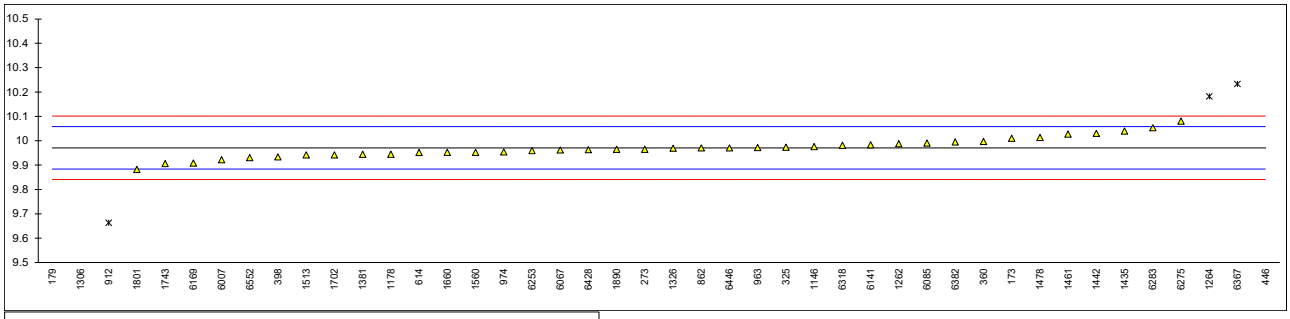

55
50
45
40
35
30
6428
6007
1687
6280
1306
912
1458
1262
1743
1660
1719
657
6283
1442
6382
1178
6367
1885
614
1326
6015
1801
6088
1478
1513
6141
1264
6067
179
901
6446
360
974
6552
6085
963
1560
862
1702
1304
1529
6169
6278
6275

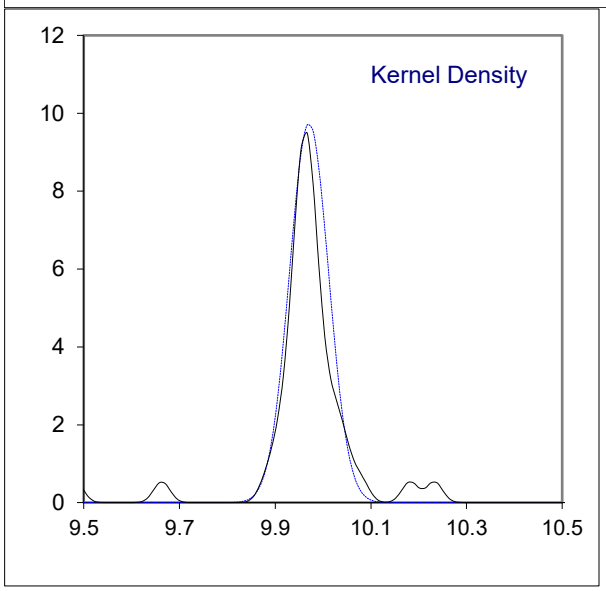

Kernel Density
0.3
0.25
0.2
0.15
0.1
0.05
0
20
30
40
50
60

Determination of Kinematic Viscosity at 40 °C on sample #23240; results in mm^2/s

lab	method	value	mark	z(targ)	remarks
173	D445	10.01		0.90	
179	D445	7.795	R(0.01)	-50.08	
273	D445	9.965		-0.14	
325	D445	9.973		0.05	
360	ISO3104	9.997		0.60	
398	D445	9.9332	C	-0.87	First reported 10.321
446	D445	10.842	R(0.01)	20.05	
614	D7042	9.9515		-0.45	
657		-----		-----	
862	D445	9.970		-0.02	
901		-----		-----	
912	D445	9.663	R(0.01)	-7.09	
963	D445	9.972		0.03	
974	D445	9.954		-0.39	
1146	D445	9.9756		0.11	
1178	D7042	9.9440		-0.62	
1262	ISO3104	9.988		0.39	
1264	D7042	10.182	R(0.01)	4.86	
1304		-----		-----	
1306	D445	9.4823	R(0.01)	-11.25	
1326	D445	9.969		-0.04	
1381	ISO3104	9.944		-0.62	
1435	D7042	10.04		1.59	
1442	D7042	10.03	C	1.36	First reported 9.82
1458		-----		-----	
1461	ISO3104	10.0272	C	1.30	First reported 10.1295
1478	D7042	10.013		0.97	
1513	ISO3104	9.9418		-0.67	
1529		-----		-----	
1560	ISO3104	9.952		-0.43	
1660	D7042	9.9519		-0.44	
1687		-----		-----	
1702	D7042	9.9419		-0.67	
1719		-----		-----	
1743	D445	9.906		-1.49	
1747		-----		-----	
1801	D445	9.8821		-2.04	
1885		-----		-----	
1890	ISO3104	9.9647		-0.14	
6000		-----		-----	
6007	DIN53300	9.9220		-1.12	
6015		-----		-----	
6053		-----		-----	
6067	D445	9.96166667		-0.21	
6071		-----		-----	
6085	D7042	9.9903		0.45	
6088		-----		-----	
6141	D445	9.9827		0.27	
6167		-----		-----	
6169	DIN16896	9.9082		-1.44	
6253	ISO3104	9.9591	C	-0.27	First reported 10.12
6275	D445	10.08		2.51	
6278		-----		-----	
6280		-----		-----	
6283	D7042	10.053		1.89	
6318	ISO3104	9.981	C	0.23	First reported 9.823
6361		-----		-----	
6367	ISO3104	10.233	R(0.05)	6.03	
6382	DIN51562-1	9.995		0.56	
6422		-----		-----	
6428	ISO3104	9.963		-0.18	
6446	D445	9.970		-0.02	
6552	D445	9.930		-0.94	

normality	OK
n	38
outliers	6
mean (n)	9.9709
st.dev. (n)	0.04093
R(calc.)	0.1146
st.dev.(D445:23)	0.04344
R(D445:23)	0.1216

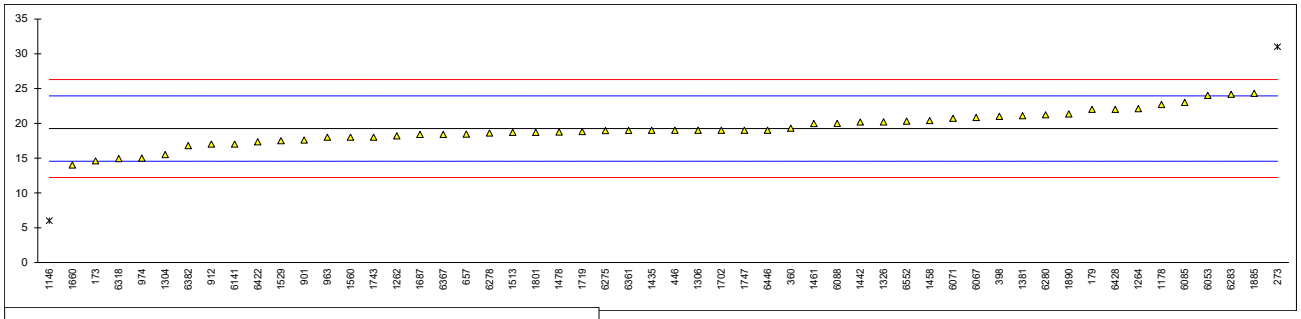

10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
9.7
9.6
9.5
179
1306
912
1801
1743
6169
6007
6552
398
1513
1702
1381
1178
614
1660
1560
974
6253
6067
6428
1890
273
1326
862
6446
963
325
1146
6318
6141
1262
6085
6382
360
173
1478
1461
1442
1435
6283
6275
1264
6367
446

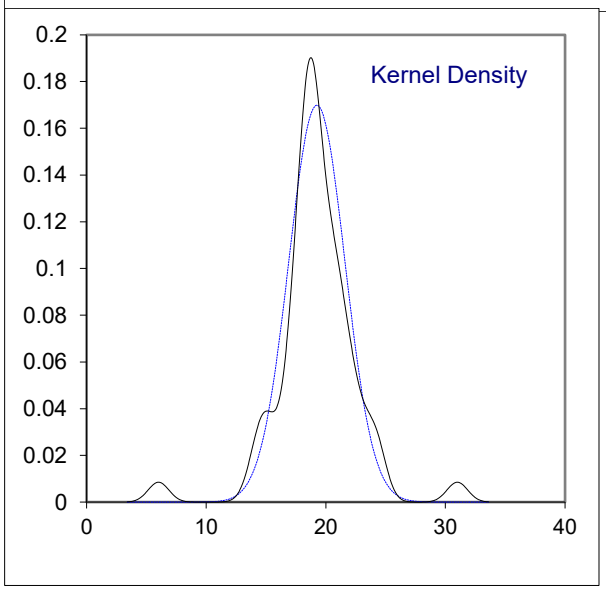

Kernel Density
12
10
8
6
4
2
0
9.5
9.7
9.9
10.1
10.3
10.5

Determination of Water on sample #23240; results in mg/kg

lab	method	value	mark	z(targ)	remarks
173	D6304-C:20	14.5922		-1.98	
179	D1533	22		1.17	
273	IEC60814	31	R(0.01)	5.00	
325	D6304-C:20	<100		-----	
360	EN60814	19.3		0.02	
398	EN60814	21		0.74	
446	EN60814	19		-0.11	
614		-----		-----	
657	IEC60814	18.44		-0.34	
862		-----		-----	
901	D1533	17.6	C	-0.70	First reported 36.9
912	EN60814	17		-0.96	
963	D1533	18		-0.53	
974	D1533	15		-1.81	
1146	D6304-B:20	6	R(0.01)	-5.64	
1178	IEC60814	22.7		1.47	
1262	EN60814	18.2		-0.45	
1264	D1533	22.1		1.21	
1304	In house	15.5		-1.60	
1306	D1533	19		-0.11	
1326	D1533	20.2		0.40	
1381	IEC60814	21.1		0.79	
1435	IEC60814	19.0		-0.11	
1442	IEC60814	20.18		0.40	
1458	IEC60814	20.4		0.49	
1461	EN60814	19.97		0.31	
1478	IEC60814	18.75		-0.21	
1513	IEC60814	18.7		-0.23	
1529	IEC60814	17.5		-0.74	
1560	IEC60814	18		-0.53	
1660	IEC60814	14		-2.23	
1687	EN60814	18.4		-0.36	
1702	IEC60814	19.0		-0.11	
1719	IEC60814	18.8		-0.19	
1743	IEC60814	18		-0.53	
1747	IEC60814	19		-0.11	
1801	IEC60814	18.7		-0.23	
1885	D1533	24.3		2.15	
1890	IEC60814	21.34		0.89	
6000		-----		-----	
6007		-----		-----	
6015		-----		-----	
6053	IEC60814	24		2.02	
6067	IEC60814	20.83333		0.67	
6071	IEC60814	20.7		0.62	
6085	D6304-B:20	23.0		1.60	
6088	D1533	20		0.32	
6141	D1533	17		-0.96	
6167		-----		-----	
6169		-----		-----	
6253		-----		-----	
6275	IEC60814	18.95		-0.13	
6278	D1533	18.59		-0.28	
6280	IEC60814	21.22		0.84	
6283	EN60814	24.15		2.09	
6318	IEC60814	14.924		-1.84	
6361	IEC60814	18.98		-0.11	
6367	IEC60814	18.4		-0.36	
6382	EN60814	16.79		-1.05	
6422	IEC60814	17.35		-0.81	
6428	ISO12937	22.0		1.17	
6446	ISO12937	19		-0.11	
6552	IEC60814	20.3		0.45	

normality	OK
n	52
outliers	2
mean (n)	19.249
st.dev. (n)	2.3494
R(calc.)	6.578
st.dev.(EN60814:97)	2.3504
R(EN60814:97)	6.581


35
30
25
20
15
10
5
0
1146 1660 173 6318 974 1304 6382 912 6141 6422 1529 901 963 1560 1743 1262 1687 6367 657 6278 1513 1801 1478 1719 6275 6361 1435 446 1306 1702 1747 6446 360 1461 6088 1442 1326 6552 1458 6071 6067 398 1381 6280 1890 179 6428 1264 1178 6085 6053 6283 1885 273


Kernel Density
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40

APPENDIX 2 Other reported test results on sample #23240

2,6-Ditertiary-butyl phenol (DBP) in %M/M, 2,6-Ditertiary-butyl paracresol (DBPC) in %M/M, Dibenzyl disulfide (DBDS) in mg/kg, Benzotriazole (BTA) in mg/kg and Irgamet 39 in mg/kg

lab	DBP	DBPC	DBDS	BTA	Irgamet 39	remarks
173	-----	-----	-----	-----	-----	
179	-----	-----	-----	-----	-----	
273	-----	-----	-----	-----	-----	
325	-----	-----	-----	-----	-----	
360	-----	< 0.01	-----	-----	-----	
398	-----	-----	-----	-----	-----	
446	-----	-----	-----	-----	-----	
614	-----	-----	-----	-----	-----	
657	0.15828	***0.14219***	-----	-----	-----	
862	<0.02	<0.01	-----	<5	-----	
901	-----	<0.01	-----	-----	-----	
912	-----	-----	-----	-----	-----	
963	<0.02	<0.02	<5	<1	<1	
974	-----	-----	-----	-----	-----	
1146	-----	-----	-----	-----	-----	
1178	-----	0.0001	-----	-----	-----	
1262	-----	0.0	-----	-----	-----	
1264	0	0	0	0	0	
1304	-----	0.000	-----	-----	-----	
1306	-----	0	0	-----	13.29	
1326	-----	-----	-----	-----	-----	
1381	-----	-----	-----	-----	-----	
1435	-----	<0.024	<3.0	-----	<5.0	
1442	0	0	<5	<0,04	<5	
1458	-----	<0.02	-----	-----	-----	
1461	-----	-----	-----	-----	-----	
1478	-----	0.00	-----	-----	-----	
1513	-----	<0,01	<5	-----	<5	
1529	0.000	0.001	-----	-----	-----	
1560	-----	Not Detected	-----	-----	-----	
1660	< 0.01	< 0.01	< 5	< 1	< 5	
1687	-----	-----	-----	-----	-----	
1702	-----	Not Detected	<5	-----	<1	
1719	-----	-----	-----	-----	-----	
1743	-----	<0.05	<3	-----	-----	
1747	-----	-----	-----	-----	-----	
1801	-----	0.015	n.c.	-----	n.c.	
1885	0	-----	-----	-----	-----	
1890	-----	-----	-----	-----	-----	
6000	-----	-----	-----	-----	-----	
6007	-----	-----	-----	-----	-----	
6015	-----	-----	-----	-----	-----	
6053	-----	-----	-----	-----	-----	
6067	-----	-----	-----	-----	-----	
6071	-----	-----	-----	-----	-----	
6085	-----	0	-----	-----	-----	
6088	-----	0.047	-----	-----	-----	
6141	-----	0	0	0	0	
6167	-----	-----	-----	-----	-----	
6169	-----	-----	-----	-----	-----	
6253	-----	-----	-----	-----	-----	
6275	-----	0	0	0	-----	
6278	-----	-----	-----	-----	-----	
6280	-----	-----	-----	-----	-----	
6283	<0,01	<0,01	<5	<10	<10	
6318	-----	-----	-----	-----	-----	
6361	-----	-----	-----	-----	-----	
6367	-----	-----	-----	-----	-----	
6382	-----	-----	-----	-----	-----	
6422	-----	-----	-----	-----	-----	
6428	-----	-----	-----	-----	-----	
6446	<0,1	<0,1	-----	-----	-----	
6552	-----	<0.02	ND	-----	-----	

APPENDIX 3

Number of participants per country

4 labs in	AUSTRALIA
3 labs in	BELGIUM
4 labs in	BULGARIA
3 labs in	CHINA, People's Republic
1 lab in	CROATIA
1 lab in	ESTONIA
1 lab in	FRANCE
7 labs in	GERMANY
1 lab in	GREECE
1 lab in	HONG KONG
1 lab in	INDIA
1 lab in	INDONESIA
3 labs in	ITALY
1 lab in	KUWAIT
1 lab in	MALAYSIA
2 labs in	MOROCCO
2 labs in	NETHERLANDS
1 lab in	NEW ZEALAND
1 lab in	NORWAY
2 labs in	PAKISTAN
1 lab in	PHILIPPINES
1 lab in	POLAND
1 lab in	PORTUGAL
1 lab in	QATAR
3 labs in	SAUDI ARABIA
3 labs in	SINGAPORE
1 lab in	SLOVENIA
2 labs in	SOUTH AFRICA
2 labs in	SPAIN
2 labs in	TURKIYE
2 labs in	UNITED ARAB EMIRATES
1 lab in	UNITED KINGDOM
2 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)/D5	= 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)

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Website: www.iisnl.com