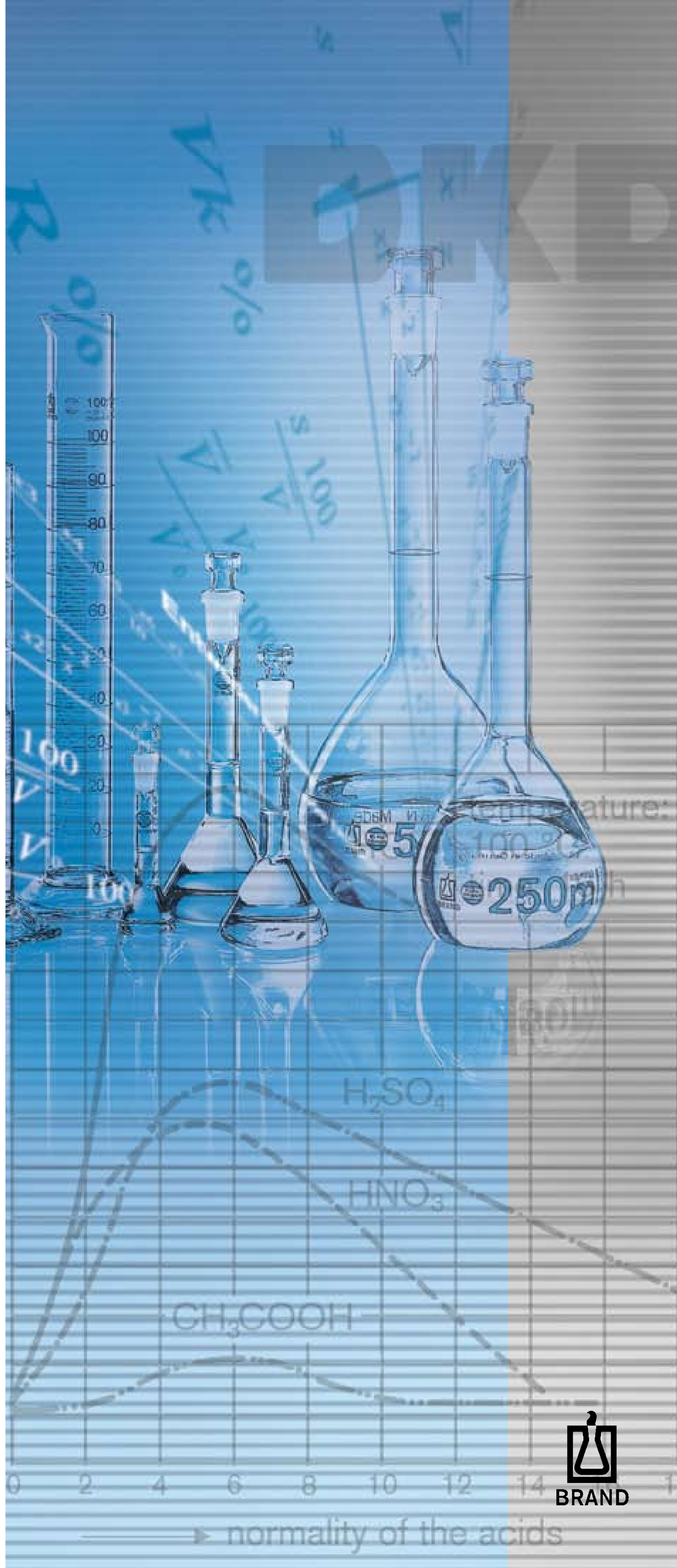
Technical Information



- Quality Management
- Certificates
- Monitoring of Measuring Instruments
- Easy Calibration Technique
- DKD – Calibration Laboratory
- Calibration Service
- IVD Directive and BIO-CERT®
- Thermocycler Compatibility
- Laboratory Glass/Plastics
- Cleaning
- Safety Instructions

Quality definitions, techniques and certifications.

BRAND

Quality Management

Quality management is briefly described for liquid handling instruments and BLAUBRAND® volumetric instruments

Quality management at BRAND begins at product conception and continues through the design process and production. Routine checks throughout the entire manufacturing process result in volumetric instruments with the smallest possible deviation from the true volume (accuracy) and narrow scatter of individual values (coefficient of variation). The final step of this Statistical Process Control is random finished product sampling according to DIN ISO 3951.

The quality management system applied at BRAND and certified to DIN EN ISO 9001 is a combination of process monitoring and random checks. The accepted quality level (AQL) is at the very least 0.4., i.e., the limiting values are met with a statistical certainty of at least 99.6 %.
All measuring instruments used in quality control are regularly checked and are referenced to the national standards of PTB (The German Federal Institute of Physics and Metrology). Quality management according to DIN EN ISO 9001 is the basis for issuing of calibration certificates (e.g., our certificates of performance).

All test results are documented and filed for 7 years. If the batch or serial number is known, each specific test result on the date of production can be traced.
As BRAND manufactures conformity certified volumetric instruments, the quality of products is automatically supervised by the "Eichamt", the German State Office of Weights and Measures. The requirements for monitoring of measuring instruments, traceability to national standards, and staff qualification are fully met.

Conformity Certification

For volumetric instruments which are kept and used for commercial purposes (e.g., medical and pharmaceutical purposes) the German "Eichordnung" dated 12 August 1988 calls for conformity certification instead of official calibration. This also applies for volumetrically relevant accessories (e.g., pipette tips for piston-operated pipettes).

Conformity means: compliance of an instrument with the "Eichordnung", the German Federal Weights and Measures Regulations, Annex 12. The conformity certification procedure is described in DIN 12 600.

The conformity symbol "H" and the manufacturer code designation (for BRAND it is "B") or, on request the "Eichamt" (the German State Office of Weights and Measures, with a separate conformity symbol) certifies the product as complying with the "Eichordnung" for Official Certification and corresponding standards. In general the product itself carries the symbol of conformity or, with disposables, the packaging.

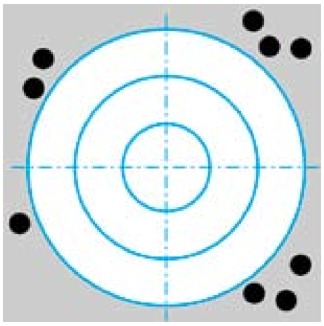
Note:
The conformity certification applies only to volumetric instruments. Therefore, thermometers and density bottles continue to be officially certified.

Precision

What do "Error Limit, Accuracy, Coefficient of Variation and Precision" mean in volumetric measuring?

An illustration of Precision and Accuracy

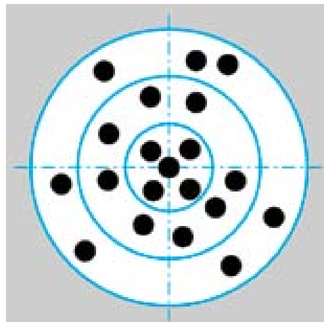
The dart board simulates the volume range around the centered specified value, the black dots simulate the different measured values of a specified volume.



Poor accuracy:
Hits far off center.

Poor reproducibility:
Hits widely scattered.

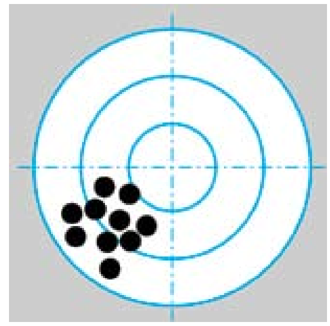
Result:
These volumetric instruments are of inferior quality.



Good accuracy:
On average, hits are evenly distributed around center.

Poor reproducibility:
No gross errors, but hits widely scattered.

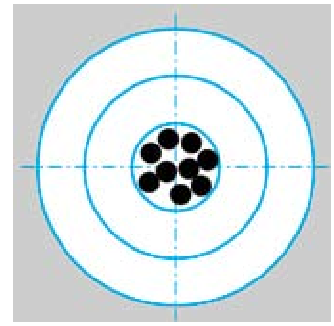
Result:
All deviations are "equally probable".
Instruments exceeding the permissible limit should be removed from service.



Poor accuracy:
Although all hits are close together, the center (true volume) is still missed.

Good reproducibility:
All hits are close together.

Result:
Improperly controlled production, with systematic variation. Instruments exceeding the permissible limit should be removed from service.



Good accuracy:
All hits are near the center, i.e., the specified value.

Good reproducibility:
All hits are close together.

Result:
The volumetric instruments have minute systematic errors, narrow scatter; the permissible limit is not exhausted. These instruments should remain in service.

To describe accuracy, the term “Error limit” is used for glass volumetric devices, while for liquid handling devices the statistical terms “Accuracy [%]” and “Coefficient of Variation [%]” have become established.

■ Error limit

$$EL \geq \left| V_{measured} - V_{spec.} \right|$$

The term "Error limit" (EL) in the corresponding standards defines the maximum permissible deviation from the specified value.

■ Error limit of A and CV

$$EL \geq \frac{|A\%| + 2CV\%}{100\ \%} \cdot V_{nominal}$$

A good estimate for the error limit (EL) of the instrument, e.g., for the nominal volume ($V_{nominal}$), can be calculated using the values for accuracy and coefficient of variation.

■ Accuracy

$$A\,[\%] = \frac{\bar{V} - V_{spec.}}{V_{spec.}} \cdot 100$$

Accuracy (A) indicates the closeness of measured mean volume to the specified value, i.e., systematic measurement variation.

Accuracy is defined as the difference between the measured mean volume ($\bar{V}$) and the specified value ($V_{spec.}$), related to the specified value in percent.

■ Coefficient of Variation

$$CV\,[\%] = \frac{s \cdot 100}{\bar{V}}$$

Coefficient of variation (CV) indicates the closeness of values of repeated measurements, i.e., random measurement variation.

Coefficient of variation is defined as standard deviation in percent, related to the mean volume.

■ Precision (reproducilibity)

It describes the closeness in volume units between the different values in a set of measurements.

■ Partial volumes

$$A_{part.}\,[\%] = \frac{V_{nominal}}{V_{part.}} \cdot A_{nominal}\,\%$$

(analog $CV_{part.}$ %)

Generally A and CV are related to the nominal volume ($V_{nominal}$). These values are in % and have to be converted for partial volumes ($V_{part.}$).

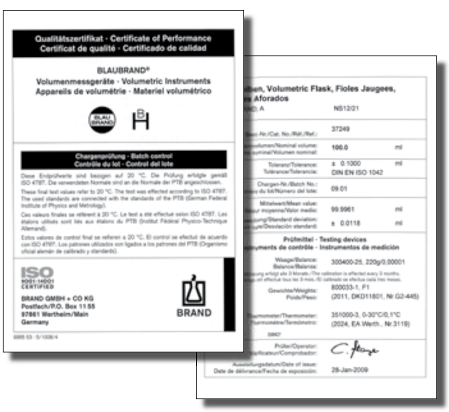
In contrast, there is no conversion for partial volumes, if A and CV are stated in volume units (e.g., ml).

Certificates

BLAUBRAND® Volumetric Instruments

One batch certificate per packing unit!

Reusable BLAUBRAND® volumetric instruments are supplied with one batch certificate per packing unit of the manufacturer. This facilitates not only your initial performance verification, but also the monitoring of measuring equipment, as the data can directly be transferred from the certificate. Batch certificates can also be called up at www.brand.de



Batch number and batch certificate

All reusable BLAUBRAND® volumetric instruments have an easy-to-read digital batch number since 1997. The works certificate records the batch number, the mean value, the standard deviation of the batch and date of issue.

09.02

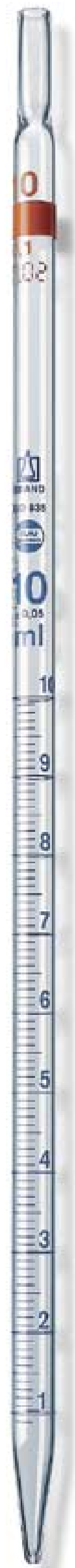
(Batch number: Year of manufacture/batch)

Individual certificate

Both the instrument and the certificate show an individual serial number in addition to the batch number. The works certificate records the measured volume, the uncertainty of measurement and the date of issue.

09.02 0756

(Individual serial number: Year of manufacture/batch/consecutive Instrument Number)



Conformity certified

With the sign, BRAND confirms that the instruments are manufactured according to "Eichordnung", the German Federal Weights and Measures Regulations. This sign of conformity is printed directly on the instruments, according to DIN 12600. All BLAUBRAND® volumetric instruments are conformity certified.

Certificate of performance (Works certificate)

Batch and individual certificates are works certificates. Both are based on the regulations for test and calibration procedures of laboratory instruments according to DIN EN ISO 9001, DIN ISO 10012-1 and ISO 4787. All certificates document the traceability of measuring results to national standards (PTB) which recognize the SI units (International System of Units).

USP Individual certificate

BLAUBRAND® volumetric instruments can be delivered with volume error limits in compliance with United States Pharmacopoeia (USP). Each instrument is individually calibrated and checked. Both the instrument and the certificate show an individual serial number (showing the year of manufacture).

DKD Calibration certificate

1001
DKD-K-20701
09-02

This calibration certificate is issued by the DKD calibration laboratory at BRAND. Due to the extensive international cooperation of the DKD, German Calibration Service, (EA Agreement, ILAC-MRA) the DKD calibration certificate is internationally recognized. Both the instrument and the certificate show the individual serial number and the year and month of issue. More information can be found on page 290.

Ordering information for BLAUBRAND® volumetric instruments can be found on page 129.

Monitoring of Measuring Instruments

GLP, ISO/IEC 17025, ISO 9001

Analytical laboratories have to verify and document the accuracy of all measuring instruments used in order to achieve reliable analysis. This especially applies to laboratories operating according to GLP guidelines, DIN EN ISO/IEC 17025, or certified to DIN EN ISO 9001.
The monitoring of measuring instruments requires that the instrument's performance data be known and documented before being admitted to use and confirmed at appropriate intervals. The frequency of checks depends on the results of previous calibrations. These tests are necessary to ensure continued accuracy of instruments which may have changed due to aggressive chemicals, or method and frequency of cleaning. The test cycle must be specified by the user.
Typical monitoring intervals for liquid handling instruments are every 3-12 months; for glass volumetric instruments, every 1-3 years. Performance certificates issued by BRAND show all instrument data required for monitoring so initial inspection may be eliminated. Also before disposing a measuring instrument, a final test is neccessary (see DIN 32 937).
Performance certificates are supplied as standard for liquid handling instruments and for BLAUBRAND® volumetric instruments (see pages 129, 284).

Testing

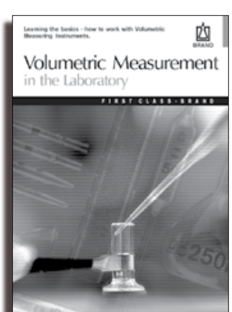
The gravimetric test for liquid handling instruments is performed according to ISO 8655; for glass volumetric instruments, ISO 4787 is applied. Traceability of measuring devices to national standards needs to be ensured.
For instruments calibrated to contain (TC, In) the mass of water contained, and for instruments calibrated to deliver (TD, Ex), the mass of water delivered, will be weighed on a balance. The mass of water measured has to be adjusted to account for parameters like water density and air buoyancy on the balance. The thermal coefficient of expansion of glass volumetric instruments has to be taken into account.

Testing scope

While liquid handling instruments are tested individually, the use of statistical methods to monitor glass volumetric instruments is recommended. The following equation to determine the minimum random quantity (a) out of the total quantity (n) has proven effective in actual use:

$$a = \sqrt{n}$$

Note: Random samples have to be taken from each production batch in use.



Testing instructions (SOPs)

To simplify the monitoring of measuring instruments, BRAND offers specific testing instructions (SOPs) for every type of volumetric instrument at www.brand.de. The testing procedures are outlined step-by-step. At the end of each SOP (Standard Operating Procedure) there is a report to be used for documentation.

EASYCAL™ Software

BRAND has developed the EASYCAL™ software that operates under Windows®, to further simplify the monitoring of measuring instruments.
Upon entry of instrument data and weighing values, the software performs all calculations automatically. In addition, EASYCAL™ generates electronic and printed test records which can be saved for subsequent use. (For more information on EASYCAL™ software, see page 77-80.)

Information for **BRAND Calibration Service** on page 291.

Information on volumetric measurement

BRAND provides a booklet on working with volumetric instruments outlining proper use and possible operating errors.

Literature

Testing Instructions (SOPs), Information on Volumetric Measurement, and a demo-version of EASYCAL™ software can be requested directly from BRAND and are also available at www.brand.de.

Calculations

Monitoring of measuring instruments

Measuring values obtained in the course of a monitoring procedure are to be evaluated as follows:

Example: Transferpette® Digital type, 20-200 µl

Gravimetric testing values at 21.5 °C (Z = 1.0032)	
Tested volume (µl):	200.0000
Specified value (mg):	199.3620
x_1	200.2000
x_2	199.6000
x_3	199.4900
x_4	199.7000
x_5	199.7000
x_6	199.2900
x_7	199.3500
x_8	199.4100
x_9	199.2000
x_{10}	199.1900

1. Calculation of the mean volume

The weighing parameters obtained using the gravimetric test are simply the mass values corresponding to the pipetted volume. In order to obtain the actual volume, a correction must be calculated.
A mean volume ($\bar{x}$) of the weighing values is then calculated by dividing the sum of the weighings by the number of weighings made. This mean mass is then multiplied by a correction factor (Z, units of µl/mg) to give the mean volume ($\bar{V}$) delivered. The factor Z combines density of water, testing temperature and atmospheric pressure. For a typical temperature of 21.5 °C and air pressure of 1013 mbar (hPa), Z=1.0032 µl/mg.

$$\bar{V} = \bar{x} \cdot Z$$

$$\bar{V} = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n} \cdot Z$$

$$\bar{V} = \frac{200.2 + 199.6 + 199.49 + \ldots + 199.19}{10} \cdot 1.0032$$

$$\bar{V} = 199.513 \cdot 1.0032$$

$$\bar{V} = 200.1514$$

2. Calculation of accuracy

$$A\,[\%] = \frac{\bar{V} - V_{spec.}}{V_{spec.}} \cdot 100$$

$$A\,[\%] = \frac{200.1514 - 200}{200} \cdot 100$$

$$A\,[\%] = 0.076$$

Extract from the table "Factor Z for Liquid Handling Instruments"

Temperature °C	Factor Z ml/g
18	1.00245
18.5	1.00255
19	1.00264
19.5	1.00274
20	1.00284
20.5	1.00294
21	1.00305
21.5	1.00316
22	1.00327

Temperature °C	Factor Z ml/g
22.5	1.00338
23	1.00350
23.5	1.00362
24	1.00374
24.5	1.00386
25	1.00399
25.5	1.00412
26	1.00425

3. Calculation of the standard deviation, necessary for the determination of coefficient of variation

$$s = Z \cdot \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + (x_3 - \bar{x})^2 + \ldots + (x_n - \bar{x})^2}{n-1}}$$

$$s = 1.0032 \cdot \sqrt{\frac{(200.2 - 199.51)^2 + (199.6 - 199.51)^2 + (199.49 - 199.51)^2 + \ldots + (199.19 - 199.51)^2}{9}}$$

$$s = 1.0032 \cdot \sqrt{\frac{0.8393}{9}}$$

$$s = 0.306$$

4. Calculation of the coefficient of variation

$$CV\,[\%] = \frac{s \cdot 100}{\bar{V}}$$

$$CV\,[\%] = \frac{0.306 \cdot 100}{200.1514}$$

$$CV\,[\%] = 0.153$$

The result for the calculated example is:

Results of the gravimetric testing:

Tested volume (µl):	200.0000
Mean volume (µl):	200.1514
A [%]	0.076
CV [%]	0.153
A [%] specified*	0.600
CV [%] specified*	0.200

* Error limits specified by the manufacturer of instrument. See your operating manual for specifications.

⇒ This pipette meets specifications.

If the calculated values for Accuracy (A [%]) and Coefficient of Variation (CV [%]) are less than or equal to the factory published specifications, the instrument is calibrated to operate within specifications.

Note:

For checking partial volumes, the values $A_{nominal}$ [%] and $CV_{nominal}$ [%] which are related to the nominal volume $V_{nominal}$ must be converted.

For a partial volume of 20 µl this means:

$$A_{20\,\mu l}[\%] = \frac{V_{nominal}}{V_{20\,\mu l}} \cdot A_{nominal}\,[\%]$$

$$A_{20\,\mu l}[\%] = \frac{200\,\mu l}{20\,\mu l} \cdot 0.5\%$$

$$A_{20\,\mu l}[\%] = 5\%$$

The calculation of $CV_{20\mu l}$ is analog.

What to do if the instrument is not within the factory-specified error limits?

1. Check whether all sections of the SOP are taken into account.
2. Follow the troubleshooting guide in the operating manual for assistance.
3. Adjust the calibration of the instrument in accordance with the operating manual.

If despite these steps the instrument still does not meet the specifications, remove from service and contact BRAND for support.

Easy Calibration Technique

ISO 9001 and GLP guidelines require routine calibration (approx. every 3-12 months) and readjustment of measuring instruments if necessary. This frequently time-consuming task can be finished in seconds with BRAND Liquid Handling instruments.

- No need to send the instruments out for calibration and adjustment.
- Accuracy can be adjusted to meet the needs of your special applications.
- No tools necessary for adjustment. Adjustments can be performed in seconds.

The following BRAND Liquid Handling instruments are equipped with this time-saving adjustment technology:

Dispensette® Easy Calibration
Titrette®
Transferpette®
Transferpette®-8/12
Transferpette® S
Transferpette® S -8/-12
Transferpette® electronic
Transferpette®-8/-12 electronic

Easy Calibration of mechanical instruments

(e.g., bottle-top dispenser Dispensette®)

Example:
Gravimetric testing yields a delivered volume of 9.90 ml with a set volume of 10 ml (e.g., after a longer period of usage or for specific applications). Adjustment is quick and easy in five steps:

1. Open housing by sliding the latch and removing the front.

2. Lift gear lock lever to release.

3. Pull the red knob and set the display to actual delivered volume (e.g., 9.90 ml).

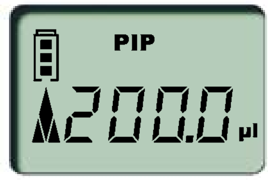
4. Reposition red knob and gear lock lever to the original position.

5. Replace housing – done! Alteration of factory setting is indicated by a red re-calibration flag.

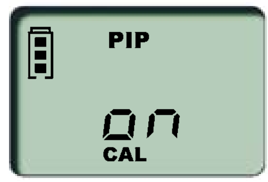
Easy Calibration of electronic instruments

(e.g., Transferpette® electronic microliter pipette)

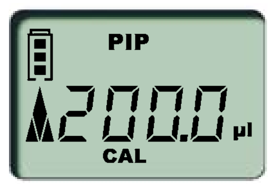
Example:
Gravimetric testing yields a delivered volume of 201.3 µl with a set volume of 200 µl (e.g., after a longer period of usage or for specific applications). Adjustment in just a few steps:



1. Initial display

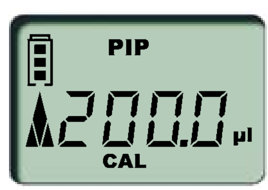


2. Activate calibration mode by pressing the MENU key for 3 seconds, and using the arrow keys to switch calibration mode to "on".



3. When the CAL display is flashing, calibration mode shows the initial volume.

4. Use the arrow keys on the Transferpette® electronic microliter pipette to set the determined volume.



5. After confirming the volume, the values for the tested and corrected volume in the display change. The CAL symbol remains on to confirm that the adjustment was performed. The factory setting can be restored at any time.

EASYCAL™ 4.0

To further facilitate calibration, BRAND has developed EASYCAL™ calibration software. Instrument specific Standard Operating Procedures (SOPs) describe step-by-step testing procedures. All necessary calculations are carried out automatically by the user-friendly software (please see page 77 for more information).
A free demo version of EASYCAL™ and SOPs are available for download from www.brand.de.

BRAND also offers a factory calibration service. (Please see page 291 for more information).

DKD Calibration Laboratory at BRAND

German Calibration Service

The German Calibration Service (DKD) was founded in 1977 as a joint effort of government, industry and national standards authorities (PTB – German Institute of Physics and Metrology), to verify measuring equipment used in industrial and research laboratories and testing institutions. It supplements the existing consumer protection verification system.

DKD Calibration laboratory

The calibration laboratory for volumetric instruments opened by BRAND in 1998 has been accredited by the German Calibration Service (DKD) according to DIN EN ISO/IEC 17 025. Our calibration laboratory is authorized to issue DKD calibration certificates (in several languages) for the volumetric instruments listed on the right.

DKD Calibration certificate (DKD-K-20701)


DEUTSCHER KALIBRIERDIENST DKD
Kalibrierlaboratorium / Calibration laboratory
Akkreditiert durch die / accredited by the
Akkreditierungsstelle des Deutschen Kalibrierdienstes
DKD-K-20701
BRAND GMBH + CO KG
Fabrik für Laborgeräte
BRAND
Kalibrierschein / Calibration certificate
Kalibrierzeichen / Calibration mark: 1001 DKD-K-20701 2009-02
Gegenstand / Object: Dispenser
Hersteller / Manufacturer: BRAND GMBH + CO KG
Typ / Type: Dispensette III EASY CALIBRATION 1-10ml
Auftraggeber / Customer: Musterfirma, Musterstraße 1
Datum der Kalibrierung / Date of calibration: 2009-02-09

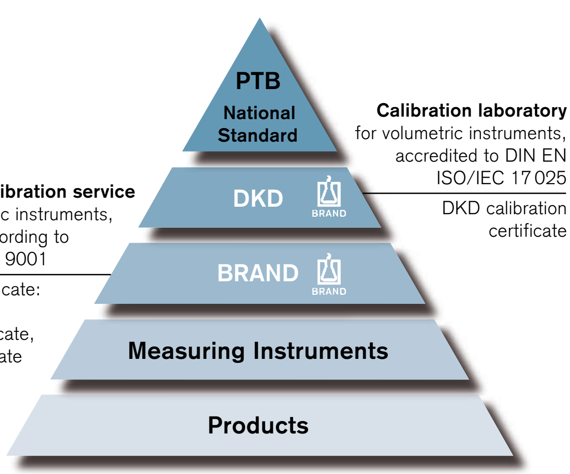
The DKD calibration certificate documents officially the traceability of measuring results to national and international standards as required by the standards DIN EN ISO 9001 and ISO/IEC 17 025 for the monitoring of measuring instruments. A major difference between works calibration services and DKD laboratories is the accurate determination of the respective uncertainty of measurement guaranteed by the accredited laboratory and supervised by the DKD.
DKD calibration certificates are appropriate in uses in which calibrations of an accredited laboratory are requested, where high level calibrations are demanded and for calibration of reference standards and instruments for comparative measurements.

Volumetric instruments for which DKD certificates are available from BRAND

BRAND calibrates the following volumetric instruments (new or used regardless of manufacturer):

- **Piston-operated pipettes,** from 0.1 µl to 10 ml
- **Multichannel piston-operated pipettes,** from 0.1 µl to 300 µl
- **Piston-operated burettes,** from 5 µl to 200 ml
- **Dispensers, dilutors,** from 5 µl to 200 ml
- **Glass volumetric instruments,** adjusted to contain (TC, In) from 1 µl to 10 l
- **Glass volumetric instruments,** adjusted to deliver (TD, Ex) from 100 µl to 100 ml
- **Plastic volumetric instruments,** adjusted to contain (TC, In) from 1 ml to 2000 ml
- **Plastic volumetric instruments,** adjusted to deliver (TD, Ex) from 1 ml to 100 ml
- **Glass density bottles,** from 1 cm^3 to 100 cm^3

For ordering volumetric instruments with DKD calibration certificate, add "DKD" as a prefix to the catalog number.
To obtain a DKD calibration certificate for volumetric instruments already in use (regardless of their make), send the instruments to BRAND marked with the note "DKD Calibration".



Traceability of measuring results to national standards

Internationally recognized

The DKD is a member of the European Cooperation for Accreditation (EA). A multilateral agreement assures obligatory recognition of the DKD calibration certificate in a variety of countries. In addition, since November 2000, over 50 accreditation bodies in over 40 countries – including the DKD – have signed the first international convention for reciprocal recognition, the "Mutual Recognition Arrangement" (MRA) of the International Laboratory Accreditation Corporation (ILAC). Under this convention, the subscribing bodies agree to reciprocal recognition and to promote acceptance of calibration certificates and test reports from the laboratories accredited by the signatories. (The complete text of this convention can be read on the Internet at www.ilac.org.)

Calibration Service from BRAND

Instruments used for control, inspection, measuring and testing require written protocols for routine testing and calibration. A testing schedule and inspection and testing procedure must be defined. Documentation is required of the Accuracy and Coefficient of Variation testing that is performed. Frequent confirmation can become time consuming and expensive. Measuring instruments must be taken out of service and may have to be adjusted or repaired. Maintaining an in-house calibration lab with specially trained personnel can be very costly.

BRAND offers full calibration service including instrument adjustment and repair. This reduces service downtime, saves money and provides an independent review organization for the calibration of the instruments.

BRAND calibration service is available for:

- Piston-operated pipettes (single and multichannel)
- Bottle-top dispensers
- Digital bottle-top burettes
- Repetitive pipettes (Stepper)

Testing according to DIN EN ISO 8655

At BRAND, a team of qualified personnel in temperature and humidity controlled rooms using the most modern balances and calibration software, calibrate liquid handling instruments, regardless of their make, according to DIN EN ISO 8655.

Instruments with adjustable volumes such as Transferpette® microliter pipette or the Dispensette® bottle-top dispenser are tested at nominal volume, 50 % and 10 % or 20 % of the nominal volume.

Results of the calibration are documented with a detailed calibration certificate, which meets the requirements of many different testing procedures.

BRAND Calibration Service

- Calibration and adjustment of liquid handling instruments regardless of their make (BRAND instruments can be maintained and repaired if necessary).
- Cost-efficient handling
- Detailed calibration certificate
- Upon request, we will issue an additional certificate that documents the metrological status of the instruments you send in for adjustment/maintenance/repair.

  Calibration order forms and declarations on the absence of health hazards are available for download from the Internet at www.brand.de.

IVD Directive

IVD Directive of EU

On December 7th, 1998, the EU directive for "In-vitro-Diagnostic Medical Devices" (IVD Directive) was published in the Official Journal of the European Communities and became effective since June 7th, 2000.

How to define In-Vitro-Diagnostic Medical Devices (IVD)?

An "In-Vitro-Diagnostic Medical Device" is any medical device used in-vitro for the examination of specimens, including blood- and tissue donations, derived from the human body.
IVD can be a reagent, calibrator, control material, kit, instrument, apparatus, equipment, system, or specimen receptacles, intended by the manufacturer to be specifically used for in-vitro diagnostic examination. IVD are mainly used to of provide information

- concerning a physiological or pathological state
- concerning a congenital abnormality
- to monitor therapeutic measures.

What is a Medical Device?

The definition of a "Medical Device" includes any instrument, apparatus, appliance, material or other article, including the software necessary for its proper application, intended by the manufacturer to be used for human beings for the purpose of:

- diagnosis, prevention, monitoring, treatment or alleviation of disease, injury or handicap
- investigation, replacement or modification of the anatomy or of a physiological process
- control of conception.

Excluded are pharmacological or immunological means, which are regulated by appropriate drug laws.

CE Marking

The CE mark is the official marking required by the European Community. It shows the user, that this product fulfills all essential safety and environmental requirements as defined in the so-called European Directives. The manufacturer marks the instrument and produces a declaration of conformity describing the instruments' fulfillment with the guidelines and technical requirements.

BRAND medical products are all included in the class of in-vitro diagnostic (IVD) devices. This includes, for example:

– blood counting chambers
– haemacytometer cover glasses
– disposable capillary pipettes
– micro haematocrit capillaries
– haematocrit sealing compound
– sample cups for analyzers
– urine beaker
– feces container
– cryogenic tubes
– pipette tips
– PD-Tips
– Transferpette® microliter pipettes
– HandyStep® repetitive pipettes

BIO-CERT®

Sterile / Free of endotoxins, DNA, RNase, ATP

Sensitive applications like PCR*, DNA/RNA purification, or DNA sequencing require the highest quality disposable plastic labware. BIO-CERT® products are produced at the highest purity level to meet the most demanding requirements.

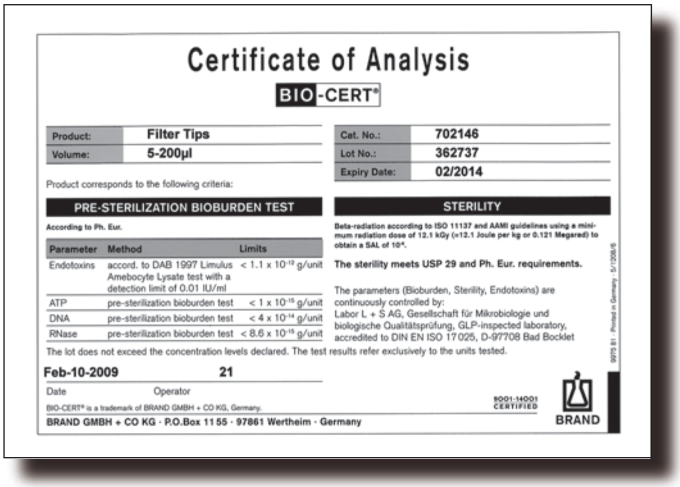
PLASTIBRAND® BIO-CERT® products are certified to be:

Sterile:
BIO-CERT® products are sterilized according to ISO 11137 and AAMI guidelines with β-radiation, using a minimum radiation dose of 12.1 kGy. This gives a SAL (sterility assurance level) of 10^{-6}. The sterility meets USP 29 and Ph. Eur. requirements for sterility.

Free of endotoxins:
The endotoxin concentration in BIO-CERT® products is tested by a gel-clotting **L**imulus **A**moebocyte **L**ysate test. The detection limit is 0.01 EU/ml providing documented endotoxin level of less than 1×10^{-12} g/item.

Free of DNA and RNase:
BIO-CERT® products are DNA-free ($< 4 \times 10^{-12}$ g/item) to prevent false positive signals during PCR* applications. These products are free of RNases ($< 8.6 \times 10^{-15}$ g/item) to prevent degradation of RNA during purification processes.

Free of ATP:
All products are supplied with a Certificate of Analysis which guarantees an ATP concentration less than1 x 10^{-15} g/item. Therefore, BIO-CERT® products are suitable for ATP detection using bioluminescence-systems.



Certificate of Analysis

BIO-CERT®

Product:	Filter Tips
Volume:	5-200µl

Cat. No.:	702146
Lot No.:	362737
Expiry Date:	02/2014

Product corresponds to the following criteria:

PRE-STERILIZATION BIOBURDEN TEST

According to Ph. Eur.

Parameter	Method	Limits
Endotoxins	accord. to DAB 1997 Limulus Amebocyte Lysate test with a detection limit of 0.01 IU/ml	$< 1.1 \times 10^{-12}$ g/unit
ATP	pre-sterilization bioburden test	$< 1 \times 10^{-15}$ g/unit
DNA	pre-sterilization bioburden test	$< 4 \times 10^{-14}$ g/unit
RNase	pre-sterilization bioburden test	$< 8.6 \times 10^{-15}$ g/unit

STERILITY

Beta-radiation according to ISO 11137 and AAMI guidelines using a minimum radiation dose of 12.1 kGy (=12.1 Joule per kg or 0.121 Megarad) to obtain a SAL of 10^{-6}.

The sterility meets USP 29 and Ph. Eur. requirements.

The parameters (Bioburden, Sterility, Endotoxins) are continuously controlled by:
Labor L + S AG, Gesellschaft für Mikrobiologie und biologische Qualitätsprüfung, GLP-inspected laboratory, accredited to DIN EN ISO 17025, D-97708 Bad Bocklet

The lot does not exceed the concentration levels declared. The test results refer exclusively to the units tested.

Feb-10-2009 — 21
Date — Operator

BIO-CERT® is a trademark of BRAND GMBH + CO KG, Germany.
BRAND GMBH + CO KG · P.O.Box 11 55 · 97861 Wertheim · Germany

9001-14001 CERTIFIED

BRAND

9975 81 · Printed in Germany · 5/1208/5

- BIO-CERT® products are made from dye-free materials.
- All lots are tested for sterility and pyrogens (endotoxins) and monitored for DNA-, RNase- and ATP-concentration.
- All products are supplied with a Certificate of Analysis.

The following plastic disposables are available in BIO-CERT® quality:

- pipette tips (see page 87-89)
- filter tips (see page 87-89)
- PD-Tips (see page 91, 92)
- microcentrifuge tubes, 1.5 ml (see page 94-97)

* The Polymerase Chain Reaction („PCR") is covered by patents owned by Hoffmann-La Roche

Thermal Cycler Compatibility

One glance at the table will tell you which BRAND PCR plates are compatible with your thermal cycler. We are continuously updating the table with information from manufacturers and feedback from our customers. Ask for a free sample of our PCR plates to check compatibility with your thermal cycler (www.brand.de), with no obligation. A brief message from you about your results will help us to complete the table.

	24-, 48-, 96-well, no skirt **7814 11, 7814 15, 7813 50**	**96-well,** elevated skirt **7813 52**	**96-well,** full skirt **7813 53**	**96-well,** half skirt **7814 00**	**384-well,** full skirt **7813 45**	**384-well,** full skirt **7813 47**	**384-well,** full skirt., rigid **7813 48**
Applied Biosystems							
2700	●	●		●	●	●	●
3100	●	●				●	●
3130	–	–				●	●
3700	●	●			●	●	●
3730/3730x	●	●				●	●
qPCR 5700		● (RT)					
qPCR 7000	● (RT)	● (RT)					
qPCR 7300	● (RT)	● (RT)					
qPCR 7500	● (RT)	● (RT)					
qPCR 7700	● (RT)	● (RT)					
qPCR 7900 HT		● (RT)				● (RT)	
9600	●	●		●			
9700	●	●		●	●	●	●
Amersham Biosciences							
MegaBACE 500			●				
MegaBACE 1000			●				
MegaBACE 4000					●	●	●
Biometra							
Uno	●	●	●	●			
Uno II	●	●		●	●	●	●
T1 Thermal Cycler	●	●	●	●	●	●	●
T3 Thermal Cycler	–			–			
Tgradient	●	●	●	●			
Trobot	●		●	●	●	●	●
BioRad							
iCycler	●	●	●				
MyCycler	●						
qPCR MyiQ	● (RT)		● (RT)				
qPCR iQ5	● (RT)		● (RT)				
Corbett Research							
PalmCycler 96			●				
PalmCycler 384						●	●
Eppendorf							
Mastercycler Gradient	●	●	●	●			
Mastercycler ep	●	●	●				
Mastercycler M 384					●	●	●
Mastercycler ep Realplex qPCR			● (RT)				

	24-, 48-, 96-well, no skirt **7814 11, 7814 15, 7813 50**	**96-well,** elevated skirt **7813 52**	**96-well,** full skirt **7813 53**	**96-well,** half skirt **7814 00**	**384-well,** full skirt **7813 45**	**384-well,** full skirt **7813 47**	**384-well,** full skirt., rigid **7813 48**
Ericomp							
Single Block	●	●					
Twin Block	●	●					
Delta Cycler	●	●					
Hybaid							
Multiblock System MBS	●		●		●	●	●
Omnigene	●	●	●	●	●	●	●
Omn-E	●	●	●	●			
PCR Express	●	●	●	●	●	●	●
PCR Sprint	–		●	–			
pxe	●		●		●	●	●
px2	●		●		●	●	●
Touchdown	●	●	●	●	●	●	●
MJ Research							
BaseStation			●				
qPCR Chromo 4			● (RT)				
Dyad/Disciple	●		●			●	●
qPCR Opticon			● (RT)				
qPCR Opticon 2			● (RT)				
PTC-100	●	●	●	●		●	●
PTC-200	●	●	●	●	●	●	●
PTC-225 Tetrad	●	●	●	●	●	●	●
MWG							
Primus 96	●	●	●	●			
Primus 384					●	●	●
Stratagene							
qPCR Mx4000	● (RT)	● (RT)					
qPCR Mx3000	● (RT)		● (RT)				
Robocycler	●	●	●	–	●	●	●
TaKaRa							
TP240			●				
TP3000	●		●				
Techne							
TC-412/Flexigene	●	–	●	●	●	●	●
Genius	●	–	●	●	●	●	●
TC-512/Touchgene Gradient	●	–	●	●	●	●	●
TC-3000X	●*	–	–	–	–	–	–
Transgenomic							
Wave System			●				

● (RT) = Real Time PCR compatible ● = compatible

– = not compatible (empty) = no info

qPCR = Devices that can carry out a quantitative real-time PCR

* compatible with 7814 11 and 7814 15

As of Dec. 2008

Laboratory Glass

There is no universal material to meet every single laboratory requirement. The decision to use glass or plastic depends on the application and design of the instrument, taking into account the specific properties of the materials, and cost considerations.

General Properties

Glass has very good chemical resistance against water, saline solutions, acids, alkalis and organic solvents and in this respect surpasses the majority of plastics. It is only attacked by hydrofluoric acid, and – at elevated temperatures – by strong alkalis and concentrated phosphoric acid. Further advantages of glass are its dimensional stability, even at elevated temperatures, and its high transparency.

Specific properties of individual glasses

For the laboratory, various glasses with different technical properties are available.

Soda-lime glass

Soda-lime glass (e.g., AR-Glas®) has good chemical and physical properties. It is suitable for products which are usually subjected to short-term chemical exposure, and to limited thermal stress (e.g., pipettes, culture tubes).

Borosilicate glass (BORO 3.3, BORO 5.4)

Borosilicate glass has very good chemical and physical properties.
DURAN® is a borosilicate glass type 3.3 as specified in international standard DIN ISO 3585, for applications requiring very good chemical and thermal resistance (including resistance to thermal shock), and high mechanical stability. Typical applications are components for chemical apparatus, round-bottom flasks, and beakers.

Working with glass

When working with glass, it is essential to consider its limitations regarding resistance to thermal shock and to mechanical stress. Strict safety measures must be observed:

- Do not heat volumetric instruments, measuring cylinders and flasks on hot plates.
- Exothermic reactions such as diluting sulfuric acid or dissolving solid alkaline hydroxides must always be carried out while stirring and cooling the reagents, and in suitable vessels such as Erlenmeyer flasks – never in graduated cylinders or volumetric flasks!
- Glass instruments must never be exposed to sudden temperature changes. When taking them out of a drying cabinet while hot, never place on a cold or wet lab bench.
- For compressive loads, only glass instruments intended for this purpose may be used. For example, filtering flasks and desiccators may be evacuated only after confirming that they are in perfect condition. BRAND does not offer instruments for pressure applications.

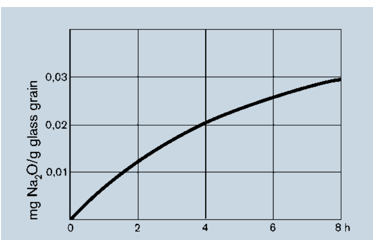
Chemical Resistance

Chemical interaction of glass with water and acids

The chemical interaction of water and acids with glass surfaces is negligibly small; only very small amounts, primarily monovalent ions, are dissolved from the glass. This forms a very thin, almost non-porous layer of silica gel on the glass surface, inhibiting further attack. Exceptions are hydrofluoric acid and hot phosphoric acid which prevent the formation of the inert layer.

Chemical interaction of glass with alkalis

Alkalis attack glass surfaces as concentration and temperatures increase. Borosilicate glass 3.3 limits surface erosion to the µm range; however, after prolonged exposure, volume changes and/or graduation destruction may occur.

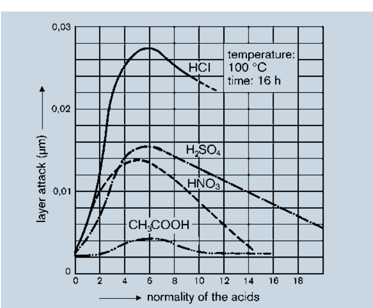


Hydrolytic attack on DURAN®
as a function of time

Hydrolytic resistance of glass grains

DURAN® meets hydrolytic resistance class 1 of DIN ISO 719 (98 °C), which is divided into 5 hydrolytical resistance classes. This means that when glass grain with a granulation rate of 300-500 µm is exposed to water at 98 °C for 1 hour, less than 31 µg Na_2O per gram of glass grain will be removed.

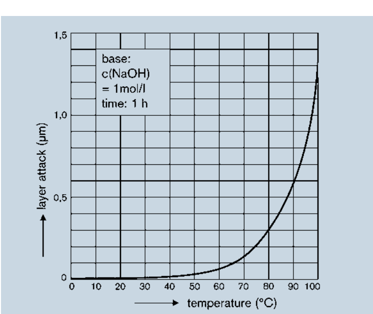
In addition, DURAN® also meets class 1 of DIN ISO 720 (121 °C), which is divided into 3 hydrolytical resistance classes. This means that when glass grain is exposed to water at 121 °C for 1 hour, less than 62 µg Na_2O per gram of glass grain will be removed.



Acid attack on DURAN®
as a function of acid concentration

Acid resistance

DURAN® meets class 1 of DIN 12 116, which is divided into 4 acid resistance classes. DURAN® is also called acid-resistant borosilicate glass, as the surface erosion after 6 hours of boiling in 6 N HCl is less than 0.7 mg/100 cm². Removal of alkali oxide according to DIN ISO 1776 is less than 100 µg Na_2O/100 cm².



Alkali attack on DURAN®
as a function of temperature

Alkali resistance

DURAN® meets class 2 of DIN ISO 695, which is divided in 3 alkali resistance classes. Surface erosion after 3 hours of boiling in a mixture with equal volumes of sodium hydroxide solution (1 mol/l) and sodium carbonate solution (0.5 mol/l) is approximately 134 mg/100 cm².

Chemical resistance to	Water DIN ISO 719 (HGB Class 1-5)	Acids DIN 12 116 (Class 1-4)	Alkalis DIN ISO 695 (Class 1-3)
Soda-lime glass (AR-Glas®)	3	1	2
Borosilicate glass 3.3 (DURAN®)	1	1	2

Mechanical Resistance

Thermal stresses

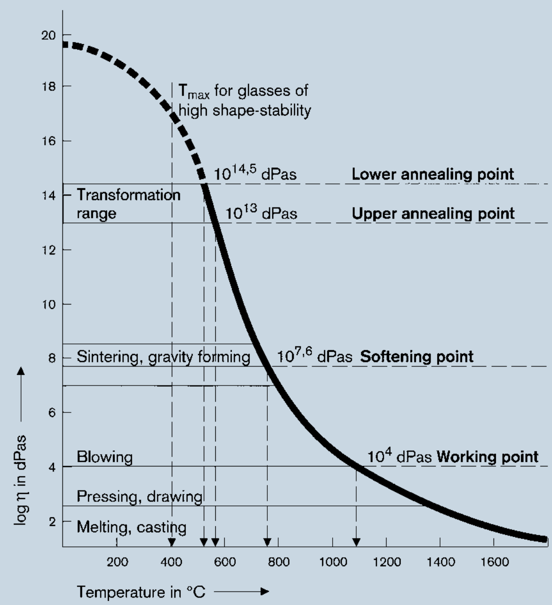
During the production and processing of glass, hazardous thermal stresses may be introduced. During the cooling of molten glass, the transition from the plastic state to the brittle state takes place in the range between the upper and lower annealing points. At this stage, existing thermal stress must be eliminated through a carefully controlled annealing process. Once the lower annealing point is reached, the glass may be cooled more rapidly, without introducing any major new stress.
Glass responds in a similar way when heated, e.g., through direct exposure to a Bunsen flame, to a temperature higher than the lower annealing point. Uncontrolled cooling may result in the "freezing in" of thermal stress which would considerably reduce resistance to breakage and mechanical stability.
To eliminate inherent stress, glass must be heated up to a temperature between the upper and lower annealing point, be kept at this temperature for approx. 30 minutes and be cooled by observing the prescribed cooling rates.

Resistance to temperature changes

When glass is heated to a temperature below the lower annealing point, thermal expansion and the poor thermal conductivity result in tensile and compressive stress. If, due to improper heating or cooling rates, the permissible mechanical strength is exceeded, breakage occurs. Apart from the coefficient of expansion α, which varies with each kind of glass, the wall thickness, the geometry of the glass body, and any existing scratches must be taken into account. Therefore, it is difficult to state specific numerical values for thermal shock resistance. However, a comparison of the α values shows that DURAN® is much more resistant to thermal changes than, e.g., AR-Glas®.

Mechanical stresses

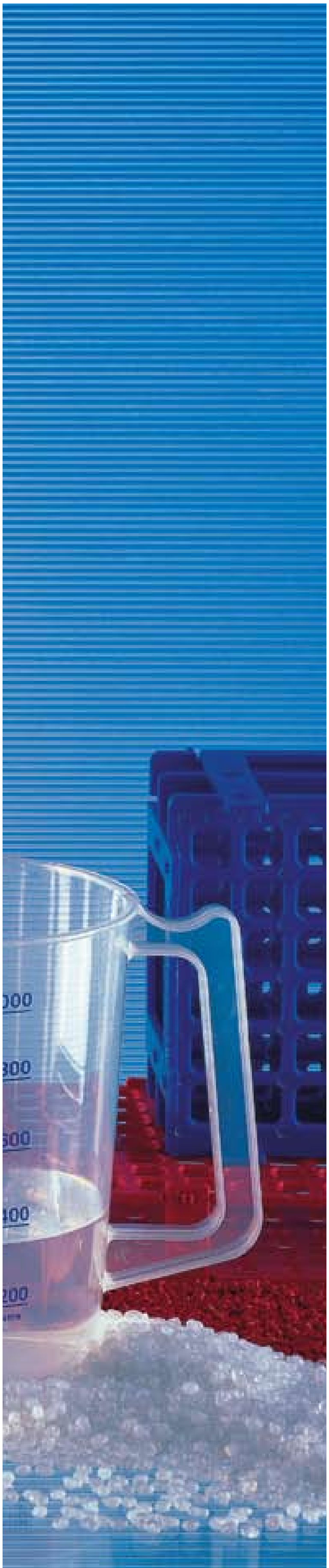
From a technical viewpoint, glasses behave in an ideally elastic way. This means that, after exceeding the limits of elasticity, tensile and compressive stress does not result in plastic deformation, but breakage occurs. The tensile strength is relatively low and may be further diminished by scratches or cracks. For safety reasons, the tensile strength of DURAN® in apparatus and plant design is calculated at 6 N/mm^2. The compressive strength, however, is approximately ten times as high.



Glass Viscosity Curve

Typical viscosity temperature curve using a borosilicate glass as an example; viscosity ranges for important forming techniques, fixed viscosity points, and various temperature limits.

	Upper annealing point (viscosity 10^{13} dPas)	Lower annealing point (viscosity $10^{14.5}$ dPas)	Linear expansion coefficient $\alpha_{20/300}$ 10^{-6} K^{-1}	Density g/cm^3
Soda-lime glass (AR®-Glas)	530	495	9.1	2.52
Borosilicate glass 3.3 (DURAN®)	560	510	3.3	2.23



Plastics

Besides glass, plastics play a very important role in laboratories. In general, plastics can be divided into the three groups:

■ Elastomers

Polymers with loosely cross-linked molecules, exhibiting rubber-like elasticity at room temperature. Heating causes irreversible curing (vulcanization). The most popular elastomers are natural rubber and silicone rubber.

■ Thermosets

Polymers with tightly cross-linked molecules are very hard and brittle at room temperature; heating causes irreversible curing. These plastics are rarely used for plastic labware. The best known thermosets are the melamine resins. Melamine resin is produced by polycondensation of melamine with formaldehyde.

■ Thermoplastics

Polymers with a linear molecular structure with or without side branches are transformed into objects during molding operations without changing their thermoplastic properties. Thermoplastics are the materials commonly used in plastic labware production. Hence we provide here a brief description of some individual plastics explaining their structural, mechanical, chemical and physical properties. The most popular thermoplastics are polyolefins like polyethylene and polypropylene.

PS **Polystyrene**

Polystyrene is glass-clear, hard, brittle, and dimensionally stable due to its amorphous structure. PS has good chemical resistance to aqueous solutions but limited resistance to solvents. Disadvantages include low thermal stability and its tendency to suffer from stress-cracks.

SAN **Styrene-acrylonitrile copolymer**

This is a glass-clear material with good resistance to stress-cracking. It has slightly better chemical resistance than PS.

PMMA **Polymethyl methacrylate**

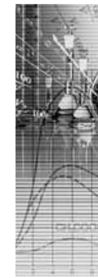
Rigid, glass-clear ("organic glass"). Resistant to atmospheric agents. Replaces glass in many applications where temperatures are below 90 °C and low chemical resistance is required. PMMA has excellent UV radiation stability.

PC **Polycarbonate**

These are thermoplastic linear carboxylic acid polyesters combining many of the properties of metals, glass and plastics. The materials are transparent and have good thermal properties between -130 to +130 °C. Note: PC may be weakened by autoclaving or exposure to alkaline detergents.

PA **Polyamide**

Polyamides are linear polymers with repeating amide chain linkages. With their favorable strength characteristics and high durability, polyamides can often be used as structural materials and for surface coating metals. They have good chemical resistance against organic solvents, but are easily attacked by acids and oxidizing agents.



PVC Vinyl chloride polymers

The vinyl chloride polymers are mainly amorphous thermoplastics with very good chemical resistance.
Their combination with plasticizers opens up many useful applications, ranging from artificial leather to injection molding components. PVC has good chemical resistance, especially with oils.

POM Polyoxymethylene

POM has superior properties with regard to hardness, rigidity, strength, durability, chemical resistance and favorable slip and abrasion characteristics. It can replace metals in many applications. POM can withstand temperatures up to 130 °C.

PUR Polyurethane

Polyurethane is a very versatile plastic, and is therefore used in a wide variety of applications.The molecules are formed by a polyaddition reaction of dialcohols with polyisocyanate.
As a material for the coating of BLAUBRAND® graduated flasks, a high-quality, scratch-resistant, transparent PUR type with a high modulus of elasticity is used. The working temperature can range from -30 to +80 °C. Brief exposure to higher temperatures of up to 135 °C are permissible, but over time this will lead to a reduction in elasticity.

PE-LD Low Density Polyethylene

The polymerization of ethylene under high-pressure results in a certain number of branches in the chain. The result is a less compact molecular structure than PE-HD, with very good flexibility and good chemical resistance, but less chemical resistance to organic solvents than PE-HD. Use is limited to temperatures below 80 °C.

PE-HD High Density Polyethylene

If the polymerization of ethylene is controlled by a catalytic process, a very small number of branches in the chain are obtained. The result is a more rigid and compact structure with enhanced chemical resistance and usability up to 105 °C.

PP Polypropylene

PP has a similar structure to Polyethylene, but with methyl groups at every second carbon atom of the chain. The major advantage, compared with PE, is its higher temperature resistance. It can be repeatedly autoclaved at 121 °C. Like the above mentioned polyolefins, PP has good mechanical properties and good chemical resistance but is sligthly more susceptible to be attacked by strong oxidizing agents than PE-HD.

PMP Polymethylpentene

PMP is similar to PP but has isobutyl groups instead of the methyl groups. Chemical resistance is comparable to PP but tends to suffer from tension cracks when exposed to ketones or chlorinated solvents. The most important qualities of PMP are its excellent transparency and good mechanical properties at temperatures up to 150 °C.

ETFE
Ethylene-Tetrafluoroethylene copolymer

ETFE is a copolymer of ethylene with chlorotrifluoroethylene and/or with tetrafluoroethylene. This plastic is remarkable for its excellent chemical resistance, but its temperature stability is lower in comparison with PTFE (at most 150 °C).

PTFE Polytetrafluoroethylene

PTFE is a fluorinated hydrocarbon with a macromolecular, partly crystalline structure. PTFE is resistant to virtually all chemicals. It offers the widest working temperature range, from -200 to +260 °C. Its surface is adhesion resistant. The slip properties and electrical insulation capacity of the material are better than those of FEP and PFA. The only disadvantage is that it can only be molded by sintering processes. PTFE is opaque. It is suitable for use in microwave ovens.

FEP
Tetrafluorethylene-perfluorpropylene copolymer

A fluorinated hydrocarbon with a macromolecular, partly crystalline structure. The surface is non-adhesive. The mechanical and chemical properties are comparable with PTFE, but the working temperature is limited to the range from -100 to +200 °C. Water absorption is extremely low. FEP is translucent.

PFA Perfluoroalkoxy copolymer

Fluorinated hydrocarbon with a high-molecular, partly crystalline structure. Its surface is adhesion-resistant. Mechanical properties and chemical inertness are comparable with those of PTFE.
The working temperature can range from -100 to +260 °C. The water absorption of PFA is extremely low. PFA is translucent.
PFA is manufactured without the addition of catalysts or plasticizers, and can be molded to produce an extremely smooth, readily cleanable surface, and is therefore particularly well suited for trace analysis.

General Properties

Resistance to breakage and low weight are important advantages of plastics. The application determines which plastic to select.

A variety of parameters should be considered: exposure time and concentration of chemicals, thermal stress (e.g., autoclaving), exertion of force, exposure to UV radiation, and aging, which may be caused by the action of detergents, or other environmental factors.

The recommendations listed below are based on technical literature and information provided by the manufacturers of raw materials. They were prepared carefully and are intended as general guidance. However, they cannot replace suitability testing perfomed by the user under actual working conditions.

Physical Properties

	Max. operating temperature (°C)	Brittle temperature (°C)	Micro wave suitability*	Density (g/cm³)	Elasticity	Transparency
PS	70	-20	no	1.05	rigid	transparent
SAN	70	-40	no	1.03	rigid	transparent
PMMA	65 to 95	-50	no	1.18	rigid	transparent
PC	125	-130	yes	1.20	rigid	transparent
PVC	80	-20	no	1.35	rigid	transparent
POM	130	-40	no	1.42	good	opaque
PE-LD	80 to 90	-50	yes	0.92	very good	translucent
PE-HD	105	-50	yes	0.95	good	translucent
PP	125	0	yes	0.90	moderate	translucent
PMP	150	0	yes	0.83	moderate	transparent
ETFE	150	-100	yes	1.70	moderate	translucent
PTFE	260	-200	yes	2.17	very good	opaque
FEP	205	-100	yes	2.15	moderate	translucent
PFA	250	-200	yes	2.17	moderate	translucent
PUR	80	-30	yes	1,20	very good	transparent
FKM	220	-30	–	–	very good	–
EPDM	130	-40	–	–	very good	–
NR	80	-40	no	1.20	very good	opaque
SI	180	-60	no	1.10	very good	translucent

* Observe chemical and temperature resistance

Sterilization

	Autoclaving* at 121 °C (2 bar), acc. DIN EN 285	β/γ-radiation 25 kGy	Gas (ethylene oxide)	Chemical (formalin, ethanol)
PS	no	yes	no	yes
SAN	no	no	yes	yes
PMMA	no	yes	no	yes
PC	yes1)	yes	yes	yes
PVC	no2)	no	yes	yes
POM	yes1)	yes (restricted)	yes	yes
PE-LD	no	yes	yes	yes
PE-HD	no	yes	yes	yes
PP	yes	yes (restricted)	yes	yes
PMP	yes	yes	yes	yes
ETFE	yes	no	yes	yes
PTFE	yes	no	yes	yes
FEP/PFA	yes	no	yes	yes
PUR	yes3)	–	yes	yes
FKM	yes	–	yes	yes
EPDM	yes	–	yes	yes
NR	no	no	yes	yes
SI	yes	no	yes	yes

* Before autoclaving, labware must be carefully cleaned and rinsed with distilled water. Always remove covers from containers!
1) Frequent autoclaving reduces mechanical stability.
2) With the exception of PVC tubing, which is autoclavable up to 121 °C.
3) Frequent autoclaving reduces elasticity.

Biological Properties

The following plastics are generally non-toxic to cell cultures:

PS, PC, PE-LD, PE-HD, PP, PMP, PTFE, FEP, PFA.

Chemical Properties

With regard to chemical resistance, plastics are classified as follows:

+ = Excellent chemical resistance

Continuous exposure to the substance does not cause damage within 30 days. The plastic may remain resistant for years.

o = Good to limited chemical resistance

Continuous exposure to the substance causes minor damage, some of which is reversible, within 7-30 days (e.g., swelling, softening, decrease of mechanical strength, discoloration).

– = Poor chemical resistance

Not suitable for continuous exposure to the substance. Immediate(!) damage may occur (loss of mechanical strength, deformation, discoloration, cracking, dissolution).

Chemical resistance of plastics to categories of substances

Classes of substances at 20 °C	PS	SAN	PMMA	PC	PVC	POM	PE-LD	PE-HD	PP	PMP	ETFE	PTFE FEP PFA	PUR	FKM	EPDM	NR	SI
Acids, weak or diluted	o	o	–	o	+	–	+	+	+	+	+	+	o	+	+	o	o
Acids, strong or concentrated	o	–	–	–	+	–	+	+	+	+	+	+	o	o	+	–	–
Oxidizing acids, oxidizing agents	–	–	–	–	–	–	–	–	–	–	+	+	o	o	o	–	–
Alkalis	+	+	+	–	+	+	+	+	+	+	+	+	-	o	+	+	o
Alcohols, aliphatic	+	+	–	+	+	+	+	+	+	+	+	+	o	–	+	+	+
Ketones	–	–	–	–	–	+	o	o	o	o	o	+	-	–	o	–	–
Aldehydes	–	–	o	o	–	o	o	+	+	o	+	+	o	+	+	o	o
Esters	–	–	o	–	–	–	o	o	o	o	+	+	-	–	o	o	o
Hydrocarbons, aliphatic	–	–	+	o	+	+	o	+	+	o	+	+	o	o	–	–	–
Hydrocarbons, aromatic	–	–	–	–	–	+	o	+	o	–	+	+	-	o	–	–	–
Hydrocarbons, halogenated	–	–	–	–	–	+	o	o	o	–	+	+	-	o	–	–	–
Ether	–	–	–	–	–	+	o	o	o	–	+	+	o	–	–	–	–

Abbreviations of the described plastics (to DIN 7728)

PS	Polystyrene
SAN	Styrene-acrylonitrile copolymer
PMMA	Polymethyl methacrylate
PC	Polycarbonate
PVC	Polyvinyl chloride
POM	Polyoxymethylene
PE-LD	Low-density polyethylene
PE-HD	High-density polyethylene
PP	Polypropylene
PMP	Polymethylpentene
ETFE	Ethylene-tetrafluoroethylene copolymer
PTFE	Polytetrafluoroethylene
FEP	Perfluoroethylene-propylene copolymer
PFA	Perfluoroalkoxy copolymer
PUR:	Polyurethane
FKM	Fluoro elastomer
EPDM	Ethylene-propylene-diene-rubber
NR	Natural rubber
SI	Silicone rubber

Chemical Resistance (Status as of: 0310)

	PS		SAN		PMMA		PC		PVC		POM		PE-LD		PE-HD	
	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C
Acetaldehyde	-	-	-	-	-	-	0	-	-	-	+	+	+	-	+	0
Acetic acid (glacial) 100%	-	-					-	-			-	-	+	0	+	+
Acetic acid 50%	0	0	+	0	-	-	+	0	+	0	0	-	+	+	+	+
Acetic anhydride	-	-					-	-	-	-	-	-	-	-	0	0
Acetone	-	-	-	-	-	-	-	-	-	-	+	+	+	0	+	+
Acetonitrile	-	-	-	-	-	-	-	-	-	-	+		+	0	+	0
Acetophenone	-	-	-	-	-	-	-	-	-	-	+		-	-	0	0
Acetyl chloride	-	-	-	-	-	-	-	-	-	-			+		+	
Acetylacetone	-	-	-	-	-	-	-	-	-	-	+		+		+	
Acrylic acid	-	-	-	-	-	-	-	-	-	-	-	-	+		+	
Acrylonitrile	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
Adipic acid	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+
Allyl alcohol (2-Propene-1-ol)	0	0	0	-	-	-	0	0	0	-	+	+	+	+	+	+
Aluminium chloride	+	+	+	+	+	+	-	-	+	0	+	0	+	+	+	+
Aluminium hydroxide	0	0	0	0	0	0	0	-	+	+	+	+	+	+	+	+
Amino acids	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium chloride	+	+	+	+	0	0	0	0	+	0	+	+	+	+	+	+
Ammonium fluoride	+	+	+	+	0	0	0	0	+	0	+	+	+	+	+	+
Ammonium hydroxide 30% (Ammonia)	0	-	+	0	+	+	-	-	+	0	0	0	+	+	+	+
Ammonium sulfate	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
n-Amyl acetate	-	-	-	-	+	+	-	-	-	-	+	+	0	-	+	0
n-Amyl alcohol (Pentanol)	0	0	+	+			+	+	0	0	+	+	+	+	+	+
Amyl chloride (Chloropentane)	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Aniline	-	-	-	-	-	-	0	-	-	-	0	0	+	0	+	+
Aqua regia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Benzaldehyde	-	-	-	-	-	-	0	-	-	-	+	+	+	+	+	+
Benzene	-	-	-	-	-	-	-	-	-	-	+	0	0	-	+	+
Benzine (gasoline)	-	-	-	-	+		0	-	0	-	+	+	0	-	+	+
Benzoyl chloride	-	-	-	-	-	-	-	-	-	-	+	0	0	-	+	+
Benzyl alcohol	-	-	-	-	-	-	0	0	0	0	+	+	0	-	0	-
Benzylamine	-	-	-	-	-	-	-	-	-	-	+		0	-	0	
Benzylchloride	-	-									+					
Boric acid, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bromine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromobenzene	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Bromoform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromonaphthalene	-	-	-	-												
Butanediol	-	-	-	-							+	+	+	+	+	+
1-Butanol (Butyl alcohol)	0	-	+	0	0	-	0	0	0	0	+	+	+	+	+	+
n-Butyl acetate	-	-	-	-	-	-	-	-	-	-	+	0	0	0	+	+
Butyl methyl ether	-	-	-	-	-	-	-	-	-	-	+	+	0	-	0	-
Butylamine	-	-	-	-							+	+				
Butyric acid	-	-	-	-			0	-					-	-	0	-
Calcium carbonate	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calcium chloride	+	+	+	+	+	+	+	+	0	-	+	+	+	+	+	+
Calcium hydroxide	+	0	+	0	+	+	-	-	+	+	+	+	+	+	+	+
Calcium hypochlorite	+	+	+	+	0	0	0	-	0	-	+	+	+	+	+	+
Carbon disulfide	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Carbon tetrachloride	-	-	-	-	0	-	-	-	-	-	0	0	0	-	0	-
Chloro naphthalene											-	-				
Chloroacetaldehyd	-	-	-	-	-	-										
Chloroacetic acid	0	-	-	-	0	-	0	-	+	0	-	-	+	+	+	+
Chloroacetone	-	-	-	-	-	-										
Chlorobenzene	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Chlorobutane	-	-	-	-	-	-					-	-	0	-	0	-
Chloroform	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-
Chlorosulfonic acid											-	-				
Chromic acid 10%	-	-	-	-	0	-	+	0	+	0	0	0	+	+	+	+
Chromic acid 50%	-	-	0	0	-	-	0	-	+	-	-	-	+	0	+	0
Chromosulfuric acid	0	0	0	0	-	-	-	-	+	0	-	-	-	-	-	-
Copper sulfate	+	+	+	0	+	+	+	+	+	0	+	+	+	+	+	+
Cresol	-	-					-	-	-	-			-	-	0	-
Cumene (Isopropyl benzene)	-	-	-	-	-	-	-	-	-	-	+	-	0	-	+	0
Cyclohexane	-	-					-	-	-	-	+	+	0	-	0	-
Cyclohexanone	-	-					-	-	-	-			-	-	0	-
Cyclopentane	-	-					-	-	-	-			-	-	0	-
Decane							0		0		+				0	-
Decanol	0		0				0		+		+				+	
Dibenzyl ether	-	-	-	-	-	-					+				+	
Dibromoethane																
Dibutyl phthalate	-	-	-	-	-	-	-	-	-	-	+	+	0	-	0	-
Dichlorbenzene	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-
Dichlormethane (Methylene chloride)	-	-					-	-	-	-			0	-	0	-
Dichloroacetic acid	0	-					0	-	0	-			0	-	0	0
Dichloroethane											-	-	0	-	0	-
Diesel oil (Heating oil)	-	-	-	-	0	-	-	-	0		+	+	0	-	+	0
Diethanolamine	-	-	-	-	-	-	-	-							0	
Diethyl ether	-	-	-	-	-	-	-	-	-	-	+	+	-	-	0	-
Diethylamine	0	0					-	-	-	-			-	-	0	-
Diethylbenzene	-	-					0	-	-	-			-	-	0	-
Diethylene glycol	0	-	+	+	-	-	0	0	-	-	+	0	+	+	+	+
Dimethyl sulfoxide (DMSO)	-	-	-	-	-	-	-	-	-	-			+	+	+	+
Dimethylaniline	-	-	-	-	-	-	-	-								
Dimethylformamide (DMF)	-	-	-	-	-	-	-	-	0	-	+	+	+	+	+	+
1.4 Dioxane	-	-	-	-	-	-	0	0	-	-	0	0	+	0	+	+
Diphenyl ether	-	-	-	-	-	-					0					
Ethanol (Ethyl alcohol)	0	-	0	-	-	-	+	0	+	0	+	+	+	+	+	+
Ethanolamine																
Ethyl acetate	-	-					-	-	-	-			+	+	+	+
Ethyl methyl ketone	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Ethylene chloride	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-

The data for the chemical resistance of salts also apply to their aqueous solutions.

	PP		PMP		ETFE		PTFE		FEP/PFA		FKM	EPDM	NR	SI
	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	20°C	20°C	20°C
Acetaldehyde	+	-	0	-	+	0	+	+	+	+	-	0	-	-
Acetic acid (glacial) 100%	+	0	+	0	+	+	+	+	+	+	-	0	0	0
Acetic acid 50%	+	+	+	+	+	+	+	+	+	+	-	-	-	-
Acetic anhydride	0	0	+	0	+	+	+	+	+	+	-	0	0	0
Acetone	+	+	+	+	+	0	+	+	+	+	-	+	0	-
Acetonitrile	+	0	0	-	+	+	+	+	+	+	-	-	-	-
Acetophenone	0	0	0	-	+	+	+	+	+	+	-	+	-	-
Acetyl chloride	+				+	+	+	+	+	+	+	-	-	-
Acetylacetone	+		+		+	+	+	+	+	+	-	+	-	-
Acrylic acid	+		+		+	+	+	+	+	+	-	-	-	-
Acrylonitrile	0	-	-	-	+	+	+	+	+	+	-	-	-	-
Adipic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Allyl alcohol (2-Propene-1-ol)	+	+	+	0	+	+	+	+	+	+	+	+	0	-
Aluminium chloride	+	+	+	+	+	+	+	+	+	+	+	+	0	0
Aluminium hydroxide	+	+	+	0	+	+	+	+	+	+	+	+	+	+
Amino acids	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium fluoride	+	+	+	+	+	+	+	+	+	+	0	+	-	+
Ammonium hydroxide 30% (Ammonia)	+	+	+	+	+	+	+	+	+	+	-	+	+	0
Ammonium sulfate	+	+	+	+			+	+			-	+	0	0
n-Amyl acetate	0	-	+	0	+	+	+	+	+	+	-	0	0	-
n-Amyl alcohol (Pentanol)	+	+	+	+	+	+	+	+	+	+	0	0	0	-
Amyl chloride (Chloropentane)	-	-	-	-	+	+	+	+	+	+	+	-	-	-
Aniline	+	+	+	0	+	0	+	+	+	+	-	-	-	-
Aqua regia	-	-	-	-	+	+	+	+	+	+	-	-	-	-
Barium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Benzaldehyde	+	+	+	+	+	0	+	+	+	0	-	0	-	-
Benzene	+	0	0	0	+	+	+	+	+	+	0	-	-	-
Benzine (gasoline)	0	0	0	0	+	+	+	+	+	+	+	-	-	-
Benzoyl chloride	+	0	0	0	+	+	+	+			+	-	-	-
Benzyl alcohol	0	-	0	-	+	+	+	+	+	+	+	0	-	0
Benzylamine	0		0		+	+	+	+	+	+	+	0	-	0
Benzylchloride					+	+	+	+			+	-	-	-
Boric acid, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bromine	-	-	-	-	+	+	+	+	+	+	0	-	-	-
Bromobenzene	-	-	-	-	0	-	+	+	+	+	+	-	-	-
Bromoform	-	-	-	-	+	+	+	+	+	+			-	-
Bromonaphthalene					+	+	+	+	+	+				
Butanediol	+	+	+	+	+	+	+	+	+	+	-	+	0	-
1-Butanol (Butyl alcohol)	+	+	+	0	+	+	+	+	+	+	+	0	+	0
n-Butyl acetate	0	0	+	0	+	+	+	+	+	+	-	0	-	-
Butyl methyl ether	+	0	+	-	+	0	+	+	+	+	-	-	-	-
Butylamine					+	+	+	+			-	-	-	0
Butyric acid	-	-			+	+	+	+	+	+	0	-	-	-
Calcium carbonate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calcium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calcium hydroxide	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Calcium hypochlorite	+	+	+	0	+	+	+	+	+	+	+	+	-	0
Carbon disulfide	-	-	-	-	+	0	+	+	+	+	+	-	-	-
Carbon tetrachloride	-	-	-	-	+	+	+	+	+	+	+	-	-	-
Chloro naphthalene					+	+	+	+			+	-	-	-
Chloroacetaldehyd					+	+	+	+						
Chloroacetic acid	+	0	+	0	+	+	+	+	+	+	0	0	-	-
Chloroacetone					+	+	+	+			-	+	0	-
Chlorobenzene	-	-	-	-	+	0	+	+	+	+	0	-	-	-
Chlorobutane	0	-	0	-	+	+	+	+	+	+	0	-	-	-
Chloroform	-	-	0	-	+	0	+	+	+	0	0	-	-	-
Chlorosulfonic acid					0	-	+	+	+	+	-	-	-	-
Chromic acid 10%	+	+	+	+	+	+	+	+	+	+	+	-	-	0
Chromic acid 50%	0	0	0	0	+	+	+	+	+	+	+	-	-	-
Chromosulfuric acid	-	-	0	-	+	+	+	+	+	+	+	-	-	-
Copper sulfate	+	+	+	+	+	+	+	+	+	+	+	+	0	+
Cresol	0	0	-	-	+	0	+	+	+	+	+	-	-	-
Cumene (Isopropyl benzene)	0	-	-	-	+	+	+	+	+	+	+	-	-	-
Cyclohexane	0	-	-	-	+	0	+	+	+	+	+	-	-	-
Cyclohexanone	0	-	0	0	+	+	+	+	+	+	-	-	-	-
Cyclopentane	0	-	0	-	+	+	+	+	+	+	+	-	-	-
Decane	0		0		+	+	+	+	+	+	+	-	-	0
Decanol	+		+		+	+	+	+	+	+	+	+	0	0
Dibenzyl ether	+		0		+	+	+	+	+	+	-	0	-	-
Dibromoethane					0		+	+	+					
Dibutyl phthalate	+	0	+	0	+	+	+	+	+	+	0	0	-	0
Dichlorbenzene	0	-	-	-	+	0	+	+	+	+	+	-	-	-
Dichlormethane (Methylene chloride)	0	-	0	-	0	0	+	+	+	+	0	-	-	-
Dichloroacetic acid	0	-	+	+	+	0	+	+	+	+	-	-	-	-
Dichloroethane	0	-	0	-	+	+	+	+	+	+	0	-	-	-
Diesel oil (Heating oil)	+	0	0	-	+	+	+	+	+	+	+	-	-	-
Diethanolamine	0						+	+				0		
Diethyl ether	0	-	-	-	+	+	+	+	+	+	-	-	-	-
Diethylamine	0	-	0	0	+	0	+	+	+	+	-	0	0	
Diethylbenzene	-	-	-	-	+	0	+	+	+	+	+	-	-	-
Diethylene glycol	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Dimethyl sulfoxide (DMSO)	+	+	+	+	+	+	+	+	+	+				+
Dimethylaniline					+	+	+	+	+	+	0	0	-	0
Dimethylformamide (DMF)	+	+	+	+	+	+	+	+	+	+	-	0	0	0
1.4 Dioxane	+	0	0	0	+	0	+	+	+	+	-	0	-	-
Diphenyl ether							+	+			0	-	-	-
Ethanol (Ethyl alcohol)	+	+	+	0	+	+	+	+	+	+	0	+	0	0
Ethanolamine	+				+	+	+	+	+	+	-	+	-	-
Ethyl acetate	+	0	0	-	+	+	+	+	+	+	-	0	-	
Ethyl methyl ketone	+	0	-	-	0	0	+	+	+	+	-	0	-	
Ethylbenzene	-	-	-	-	0	0	+	+	+	+	0	-	-	-
Ethylene chloride	0	-	-	-	+	+	+	+	+	+	0	-	-	-

Continued list of "Chemical Resistance"

	PS		SAN		PMMA		PC		PVC		POM		PE-LD		PE-HD	
	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C
Ethylene glycol (Glycol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ethylene oxide	-	-	0	-	-	-	0	-	0	-	+	+	0	0	0	0
Fluoroacetic acid	-	-	-	-	-	-	-	-	-	-	-	-				
Formaldehyde 40%	-	-	+	+	-	-	+	0	0	-	+	+	+	+	+	+
Formamide											-	-	+	+	+	+
Formic acid 98-100 %	+	0	0	0	-	-	+	0	-	-	-	-	+	+	+	+
Glycerol	+	+	+	+	+	+	+	+	+	+	0	0	+	+	+	+
Glycolic acid 70 %													+	+	+	+
Heating oil (Diesel oil)	-	-	-	-	0	-	-	-	0	-	+	+	0	-	+	0
Heptane	-	-			0	-	+	0	-	-			0	-	0	0
Hexane	-	-	+	+	0	0	-	-	0	-	+	+	0	-	+	0
Hexanoic acid					+											
Hexanol					+								+	+	+	+
Hydriodic acid													+	+	+	+
Hydrobromic acid	0	-					+	+			-	-	+	+	+	+
Hydrochloric acid 10%	+	+	0	-	0	-	-	-	+		-	-	+	+	+	+
Hydrochloric acid 20%	+	+	0	-	0	-	0	0	0		-	-	+	+	+	+
Hydrochloric acid 37 %	0	0	0	-	0	-	-	-	0	-	-	-	+	+	+	+
Hydrofluoric acid 40 %	+	+	+	0	-	-	-	-	0	-	-	-	+	+	+	+
Hydrofluoric acid 70 %	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	0
Hydrogen peroxide 35%	+	+	+	+	-	-	+	+	+	0	+	-	+	+	+	+
Iodine-potassium iodide solution	0	-	0	-	-	-	0	-	-	-	0	0	-	-	-	-
Isoamyl alcohol											+	+	+	+	+	+
Isobutanol (Isobutyl alcohol)	0	0	0	-	0	-	+	+	+	0	+	+	+	+	+	+
Isooctane	0	-	0	-			0									
Isopropanol (2-Propanol)	0	0	+	-	0	-	+	+	+	0	+	+	+	+	+	+
Isopropyl ether	-	-					-	-	-	-			-	-	-	-
Lactic acid	+	+	+	+	0	-	+	+	0	0	+	-	+	+	+	+
Mercury	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mercury chloride	+	0	+	+	+	+	+	+	-	-	0	0	+	+	+	+
Methanol	0	-	0	-	-	-	+	0	+	0	+	+	+	0	+	+
Methoxybenzene	-	-	-	-	-	-	-	-			0					
Methyl butyl ether	-	-	-	-	-	-	-	-	-	-	0		-	-	0	-
Methyl formate (Methyl methanoate)	-	-	-	-	-	-	-	-			+					
Methyl propyl ketone	-	-	-	-	-	-	-	-	-	-	+	+	+	0	+	+
Methylene chloride (Dichloro methane)	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-
Mineral oil (Engine oil)	+		+		+	+	+		+	+	+	+	+	0	+	+
Nitric acid 10%	-	-	+	0	+	0	+	0	+	0	-	-	+	+	+	+
Nitric acid 30%	-	-	0	-	0	0	+	0	0	-	-	-	0	0	0	-
Nitric acid 70%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrobenzene	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-
Oleic acid	-	-	-	-	-	-										
Oxalic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ozone	0	0	0	0	+	0	-	-	+	0	-	-	0	-	0	-
n-Pentane																
Peracetic acid							-	-			-	-				
Perchloric acid	-	-	-	-	-	-	-	-	0	-	-	-	+	-	+	-
Perchloroethylene	-	-	0	0	0	-	-	-	-	-	+	0	-	-	-	-
Petroleum	-	-			+		0	0	+	-	+	+	0	-	0	-
Petroleum ether	-	-			+				0	-	+	+	0			
Phenol	-	-	-	-	-	-	-	-	-	-	-	-	+	0	+	+
Phenylethanol															0	
Phenylhydrazine															0	
Phosphoric acid 85%	+	0	+	+	-	-	+	+	+	0	+	-	+	+	+	+
Piperidine															+	
Potassium chloride	0	0	0	0	+	+	+	+	+	0	+	+	+	+	+	+
Potassium dichromate																
Potassium hydroxide	0	0	0	0	+	+	-	-	0	0	+	+	+	+	+	+
Potassium permanganate	+	+	+	0	+	+	+	+	+	+	0	0	+	+	+	+
Propanediol (Propylene glycol)	+	+	-	-	0	0	+	0	0	-	+	+	+	+	+	+
Propanol	0		+	+	0		0		+	+	+	+	+	+	+	+
Propionic acid	0	-					-	-	0	-	-	-	0	-	+	0
Pyridine	-	-	-	-	-	-	-	-	0	-	+	0	+	0	+	0
Salicylaldehyde	-	-	-	-			0	0	-	-			+	+	+	+
Salicylic acid	+	+	+	+					0	-	-	-	+	+	+	+
Silver acetate	0	0	0	0	0	0	+	+	0	0	0	0	+	+	+	+
Silver nitrate	0	0	+	+	+	+	+	+	0	0	0	0	+	+	+	+
Sodium acetate	+	+	+	+	-	-	+	+	0	0	+	0	+	+	+	+
Sodium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium dichromate	+	0	+	0	+	0	+	-	+	+	+	+	+	+	+	+
Sodium fluoride	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium hydroxide	+	+	+	+			-	-	+	+	+	+	+	+	+	+
Sulfuric acid 60 %	-	-	+	0	-	-	0	0	0	-	-	-	+	+	+	+
Sulfuric acid 98%	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-
Tartaric acid	+	+	+	+	0	0	+	+	+	+	+	+	+	+	+	+
Tetrachloroethylene																
Tetrahydrofuran (THF)	-	-	-	-	-	-	-	-	-	-	0	0	0	-	0	-
Tetramethylammonium hydroxide							-	-			-	-				
Toluene	-	-	-	-	-	-	-	-	-	-	+	+	0	-	0	0
Trichloroacetic acid	0	-					0	-	0	-			0	-	0	0
Trichlorobenzene	-	-					-	-	-	-			-	-	-	-
Trichloroethane	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-
Trichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
Trichlorotrifluoro ethane	-	-	-	-												
Triethanolamine	-	-	-	-												
Triethylene glycol	+	+	+	+	0	0	+	0	0	-	+	0	+	+	+	+
Trifluoro ethane	-	-	-	-												
Trifluoroacetic acid (TFA)	-	-	-	-							-	-				
Tripropylene glycol	+	+	+	+	0	0	+	0	0	-	+	0	+	+	+	+
Turpentine	-	-	0	0	+	+	-	-	+	+	+	+	0	-	0	-
Urea	+	+	+	+	+	+	-	-	0	-	+	+	+	+	+	+
Xylene	-	-	-	-	-	-	-	-	-	-	+	+	0	-	0	-
Zinc chloride	+	+	+	+	-	-	+	+	+	0	+	0	+	+	+	+
Zinc sulfate	+	+	+	+	0	0	+	+	+	0	0	-	+	+	+	+

The data for the chemical resistance of salts also apply to their aqueous solutions.

	PP		PMP		ETFE		PTFE		FEP/PFA		FKM	EPDM	NR	SI
	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	50°C	20°C	20°C	20°C	20°C
Ethylene glycol (Glycol)	+	+	+	+	+	+	+	+	+	+	0	+	0	+
Ethylene oxide	0	-	0	-	+	+	+	+	+	+	-	-	-	-
Fluoroacetic acid							+				-	-	-	-
Formaldehyde 40%	+	+	+	+	+	+	+	+	+	+	0	+	0	0
Formamide	+	+	+	+	+	+	+	+	+	+	0	0	+	
Formic acid 98-100 %	+	+	+	0	+	+	+	+	+	+	-	0	0	-
Glycerol	+	+	+	+	+	+	+	+	+	+	0	+	0	+
Glycolic acid 70 %	+	+	+	+	+	+	+	+	+	+	0	+	+	+
Heating oil (Diesel oil)	+	0	0	-	+	+	+	+	+	+	+	-	-	-
Heptane	0	0	0	0	+	+	+	+	+	+	+	-	-	0
Hexane	+	0	0	-	+	+	+	+	+	+	+	-	-	0
Hexanoic acid							+	+						
Hexanol	+	+	+	+	+	+	+	+	+	+	+	-	0	0
Hydriodic acid	+	+	+	+	+	+	+	+	+	+	+	+		
Hydrobromic acid	+	+	+	+	+	+	+	+	+	+	+	0	0	-
Hydrochloric acid 10%	+	+	+	+	+	+	+	+	+	+	+	+	0	0
Hydrochloric acid 20%	+	+	+	+	+	+	+	+	+	+	+	+	0	-
Hydrochloric acid 37 %	+	+	+	+	+	+	+	+	+	+	0	+	0	-
Hydrofluoric acid 40 %	+	+	+	+	+	+	+	+	+	+	0	0	-	-
Hydrofluoric acid 70 %	+	0	+	0	+	+	+	0	+	+	-	-	-	-
Hydrogen peroxide 35%	+	+	+	+	+	+	+	+	+	+	+	0	-	0
Iodine-potassium iodide solution	+	+	+	0	+	+	+	+	+	+	+	+	+	-
Isoamyl alcohol	+	+	+	+	+	+	+	+	+	+	0	0	0	0
Isobutanol (Isobutyl alcohol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Isooctane					+	+	+	+	+	+	+	-	-	-
Isopropanol (2-Propanol)	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Isopropyl ether	-	-	-	-	+	0	+	+	+	+	-	-	-	-
Lactic acid	+	+	+	+	+	+	+	+	+	+	+	0	0	0
Mercury	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mercury chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Methanol	+	+	+	+	+	+	+	+	+	+	-	+	0	+
Methoxybenzene					+	+	+	+	+	+	-	-	-	-
Methyl butyl ether	+	+	+	0	+	0	+	+	+	+	-	-	-	-
Methyl formate (Methyl methanoate)					+	+	+	+	+	+		0	-	0
Methyl propyl ketone	+	0	0	0	+	+	+	+	+	+	-	0	-	-
Methylene chloride (Dichloro methane)	0	-	-	-	+	+	+	+	+	+	0	-	-	-
Mineral oil (Engine oil)	+	+	+	+	+	+	+	+	+	+	+	-	-	0
Nitric acid 10%	+	+	+	+	+	+	+	+	+	+	0	0	-	-
Nitric acid 30%	0	-	0	-	+	+	+	+	+	+	0	-	-	-
Nitric acid 70%	-	-	-	-	+	+	+	+	+	+	-	-	-	-
Nitrobenzene	-	-	-	-	+	+	+	+	+	+	-	-	-	-
Oleic acid					+	+	+	+	+	+	0	-	-	-
Oxalic acid	+	+	+	+	+	+	+	+	+	+	+	+	0	0
Ozone	0	-	+	+	+	+	+	+	+	+	+	+	-	+
n-Pentane					+	+	+	+	+	+	+	-	-	-
Peracetic acid					+	+	+	+	+	+				-
Perchloric acid	+	-	0	-	+	+	+	+	+	0	+	0	-	-
Perchloroethylene	-	-	-	-	+	+	+	+	+	+	0	-	-	-
Petroleum	0	-	0	0	+	+	+	+	+	+	+	-	-	0
Petroleum ether					+	+	+	+	+	+	+	-	-	-
Phenol	+	+	0	0	+	+	+	+	+	+	0	-	-	-
Phenylethanol	0				+	+	+	+	+	+				
Phenylhydrazine	0				+	+	+	+	+	+	0	-	0	-
Phosphoric acid 85%	+	+	+	+	+	+	+	+	+	+	+	0	-	-
Piperidine	+				+	+	+	+	+	+	-	-	-	-
Potassium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Potassium dichromate							+	+			0	+	0	0
Potassium hydroxide	+	+	+	+	+	+	+	+	+	+	-	+	0	-
Potassium permanganate	+	+	+	+	+	+	+	+	+	+	+	+	0	-
Propanediol (Propylene glycol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Propanol	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Propionic acid	+	0	+	0	+	0	+	+	+	+	+	0	-	-
Pyridine	0	0	+	0	-	-	+	+	+	+	-	-	-	-
Salicylaldehyde	+	+	+	+	+	-	+	+	+	+				
Salicylic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Silver acetate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Silver nitrate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium acetate	+	+	+	+	+	+	+	+	+	+	-	+	+	0
Sodium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium dichromate	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Sodium fluoride	+	+	+	+	+	+	+	+	+	+	+	+	0	0
Sodium hydroxide	+	+	+	+	+	+	+	+	+	+	0	+	0	0
Sulfuric acid 60 %	+	+	+	+	+	+	+	+	+	+	+	-	-	-
Sulfuric acid 98%	-	-	+	+	+	+	+	+	+	+	+	-	-	-
Tartaric acid	+	+	+	+	+	+	+	+	+	+	+	0	+	+
Tetrachloroethylene					0		+	+	+		0	-	-	-
Tetrahydrofuran (THF)	0	-	0	-	+	0	+	+	0	0	-	-	-	-
Tetramethylammonium hydroxide					+	+	+	+	+	+	-	+		
Toluene	0	-	0	-	+	+	+	+	+	+	0	-	-	-
Trichloroacetic acid	0	-	+	+	+	0	+	+	+	+	-	0	0	0
Trichlorobenzene	-	-	0	0	+	0	+	+	+	+				
Trichloroethane	-	-	-	-	+	+	+	+	+	+	+	-	-	-
Trichloroethylene	-	-	-	-	+	+	+	+	+	+	0	-	-	-
Trichlorotrifluoro ethane					0	-	+	+	+	+				
Triethanolamine							+	+	+	+	-	0	0	-
Triethylene glycol	+	+	+	+	+	+	+	+	+	+	+	+	0	+
Trifluoro ethane							+	+	+	0	+	-	-	-
Trifluoroacetic acid (TFA)							+	0	+	-	-			
Tripropylene glycol	+	+	+	+	+	+	+	+	+	+			+	+
Turpentine	-	-	0	0	+	+	+	+	+	+	+	-	-	-
Urea	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Xylene	-	-	0	-	+	+	+	+	+	+	0	-	-	-
Zinc chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Zinc sulfate	+	+	+	+	+	+	+	+	+	+	+	+	0	+

Cleaning

Manual and Machine Cleaning

Glass and plastic labware can be cleaned manually, in an immersion bath, or in a laboratory washing machine.
Labware should be cleaned immediately after use – at low temperatures, with brief soaking times, and low alkaline detergents. Labware which has come into contact with infectious substances should first be cleaned and afterwards, if necessary, autoclaved.

This is the only way to prevent baking-on the substance, and subsequent damage to the labware by any adhering chemical residues.

Note:
Carefully disinfect labware before cleaning when there is a risk of injury during cleaning procedure.

Wiping and scrubbring method

The generally accepted wiping and scrubbing method with a cloth or sponge soaked in cleaning solution is the most popular cleaning method. Labware must never be treated with abrasive scouring agents or pads which might damage the surface.

Immersion method

For the immersion method, labware is soaked in the cleaning solution for 20 to 30 minutes at room temperature, then rinsed with tap water, and finally with distilled water. Only for stubborn residues should the soaking time be extended and the temperature increased.

Ultrasonic bath

Both glass and plastic labware may be cleaned in an ultrasonic bath. However, direct contact with the sonic membranes must be avoided.

Machine cleaning

Machine cleaning with a laboratory washing machine is more gentle to labware than cleaning in an immersion bath. The labware is only exposed to the cleaning solution for the relatively short flushing periods when sprayed by the jet or ejector nozzles.

- Lightweight objects will not be tossed and damaged by the jet if they are secured in washing nets.
- Labware is protected against scratching when the wire baskets in the washing machine are plastic coated.

Glass labware

With glass labware, prolonged immersion times in alkaline media above 70 °C should be avoided. Such treatment, particularly with volumetric instruments, might cause volume changes through glass corrosion, and destruction of graduations.

Plastic labware

Plastic items generally have smooth, non-wetting surfaces and can usually be cleaned effortlessly under low alkalinity conditions. Polystyrene or polycarbonate labware, e.g., centrifuge tubes, must only be cleaned manually with neutral detergents. Prolonged exposure even to low alkaline detergents will impair their strength. The chemical resistance of these plastics should be verified in each case.

Cleaning in trace analysis

To minimize metallic traces, laboratory equipment is placed into 1N HCl or 1N HNO_3 at room temperature for not more than 6 hours. (Glass laboratory equipment is often boiled for 1 hour in 1N HNO_3.)

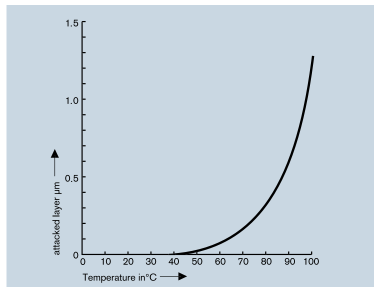
It is then rinsed with distilled water. To minimize organic contamination, laboratory equipment can first be cleaned with alkalis, or a solvent such as alcohol.

Gentle Cleaning

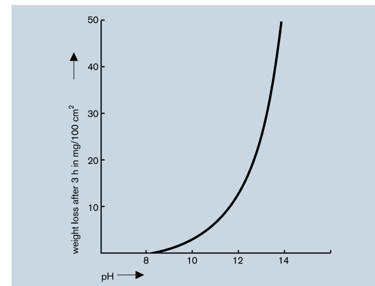
For gentle treatment of labware, clean immediately after use – at low temperatures, with brief soaking times, and at low alkalinity. Glass volumetric instruments should not be exposed to prolonged immersion times in alkaline media above 70 °C, as such treatment might cause volume changes through glass corrosion, and destruction of graduations.

Information

At 70 °C, a 1N sodium hydroxide solution will corrode a layer of approx. 0.14 µm off the surface of DURAN® (borosilicate glass 3.3) within 1 hour. However, at 100 °C, a layer of 1.4 µm, or tenfold more, will be removed. Therefore, cleaning temperatures above 70 °C should be avoided and low alkaline cleaning agents are preferrable.



Alkali attack on DURAN® in relation to temperature, calculated from weight loss. c (NaOH) = 1 mol/l. Exposure time: 1 hour.



Alkali attack on DURAN® in relation to pH value, at 100 °C. Exposure time: 3 hours.

(Graphs are from the brochure "Technische Gläser" by SCHOTT Glaswerke, Mainz.)

Disinfection and Sterilization

Disinfection

Laboratory instruments that have come into contact with infectious material or genetically modified organisms must be disinfected prior to reuse/disposal; i.e., they must be brought to a condition in which they no longer pose a risk.
Therefor laboratory instruments can be treated with disinfecting detergents for example. If necessary and suitable, the items may subsequently be sterilized (autoclaved).

Steam sterilization

Steam sterilization (autoclaving) is defined as the destruction or irreversible inactivation of all reproducible microorganisms under exposure to saturated steam at 121 °C (2 bar), according to DIN EN 285. For correct sterilization procedure, including biological security, please contact your sterilization officer.

The following points must be observed:

- Efficient steam sterilization is assured only if the steam is saturated and has unrestricted access to all contaminated areas.
- To prevent pressure build-up, containers or vessels must always be open.
- Contaminated reusable labware must be cleaned thoroughly before steam sterilization. Otherwise, residue will bake on during sterilization and microorganisms may not be effectively destroyed if they are protected by the residue. Furthermore, any adhering chemical residues may damage the surfaces due to the high temperatures.
- Not all plastics are resistant to steam sterilization. Polycarbonate, e.g., will lose its strength. Polycarbonate centrifuge tubes cannot be steam sterilized.
- During sterilization (autoclaving), plastic labware in particular should not be mechanically stressed (e.g., do not stack). Thus, to avoid shape deformation, beakers, flasks, and graduated cylinders should be autoclaved in an upright position.

Thermal resistance

All reusable BLAUBRAND® and SILBERBRAND volumetric instruments can be heated up to 250 °C in a drying cabinet or a sterilizer, without any subsequent volume deviations. However, as with all glass instruments, irregular heating or sudden temperature changes produce thermal stresses which may result in breakage. Therefore:

- Always place glass instruments into a cold drying cabinet or sterilizer; then heat slowly.
- At the end of the drying or sterilizing period, allow instruments to cool off slowly inside the switched-off oven.
- Do not heat up volumetric instruments on a hot plate.
- Pay special attention to the maximum operating temperatures of plastic instruments.

Safety Information

Handling of Hazardous Substances

The handling of hazardous chemicals, infectious, toxic or radioactive substances and genetically modified organisms, calls for a high degree of responsibility on the part of everyone involved, to ensure personal and environmental protection. The relevant regulations must be scrupulously observed including laboratory, professional association, environmental, radiation, waste disposal and generally accepted technical standards and guidelines (e.g., DIN or ISO).

Important information on safety

- Before use, laboratory instruments must be examined by the user for suitability and functionality.
- In the course of repeated use, laboratory instruments should be examined for eventual damage, especially instruments subjected to pressure or vacuum (e.g., desiccators, filter flasks, etc.).
- The hazards of working with defective labware should never be under-estimated (e.g., cuts, burns, risk of infection). If a professional repair is not practical, properly dispose of such items.
- Always hold pipettes near the suction end, and carefully insert the pipette into the adapter of the pipette controller until it is securely and firmly seated. Do not use force. Broken glass can cause injury!
- Instruments to be repaired must be cleansed of all residues and be sterilized, as necessary. Radioactively contaminated items must be decontaminated as prescribed by the radiation protection authorities. Volumetric glass instruments (e.g., volumetric flasks, graduated cylinders, etc.) should not be repaired when damaged. Exposure to heat may result in residual stress within the glass (greatly increasing the probability of breakage), or an uncontrolled cooling process may lead to permanent volume alterations.

  Cutting down damaged graduated cylinders shortens the distance between the upper graduation mark and the spout, as defined by DIN, resulting in an increased danger of chemicals being spilled.
- Waste must be disposed of according to local laws and regulations. This applies also to disposable articles. It must not pose a hazard to human beings or the environment.
- Please properly dispose of laboratory glassware, being sure to remove any potential contaminants. Please note that laboratory glassware is not recyclable.

Please see page 295 for other **safety information** that apply to glass instruments.