9 TECHNISCHE INFORMATION

TECHNICAL INFORMATION

INFORMATIONS TECHNIQUES

INFORMACIONES TÉCNICAS

GENERAL SECTION

PRODUCT-SPECIFIC SECTION

What is glass?

Glass is an inorganic mixture fused at high temperature which solidifies on cooling but does not crystallize. Its basic components, network formers and modifiers, are present in the common glasses in the form of oxides.

Typical glass formers (network formers) are silicon dioxide (SiO_2), boric acid (B_2O_3), phosphoric acid (P_2O_5) and, under certain circumstances, also aluminum oxide (Al_2O_3). These substances are capable of absorbing (dissolving) metal oxides up to a certain proportion without losing their glassy character. This means that the incorporated oxides are not involved in the formation of the glass but modify certain physical properties of the structure of the glass as "network modifiers".

A large number of chemical substances have the property of solidifying from the molten state in the form of glass. The formation of the glass depends on its cooling rate and a necessary prerequisite is the existence of mixed types of bond (covalent bond and ionic bond) between the atoms or groups of atoms. As a result, glass-forming products show a strong tendency while still in the molten state towards three-dimensional crosslinking in a largely random manner.

Crystals are formed when the individual atoms form a regular three-dimensional arrangement in what is known as a "crystal lattice" as soon as the particular substance changes from the liquid to the solid state. Glass, however, forms a largely random three-dimensional "network" when it cools down from the molten state. The components that are mainly involved in the formation of the glass are, therefore, described as "network formers". The glass-forming molecules in this network can incorporate ions that open up the network at certain points, changing its structure and thus the properties of the glass. They are, therefore, called "network modifiers".

What is DURAN®?

The special features of DURAN®

DURAN® is a borosilicate glass type 3.3 as specified in international standard ISO 3585. DURAN® products meet the most important international standards. Maximum chemical resistance, minimum thermal expansion and the resulting high resistance to thermal shock are its principal properties. This optimum physical and chemical performance makes DURAN® the ideal material for use in the laboratory and for large-scale industrial plants in the manufacture of chemical plant.

Moreover, it is widely used on an industrial scale in all other areas of application in which extreme heat resistance, resistance to thermal shock, mechanical strength and exceptional chemical resistance are required.

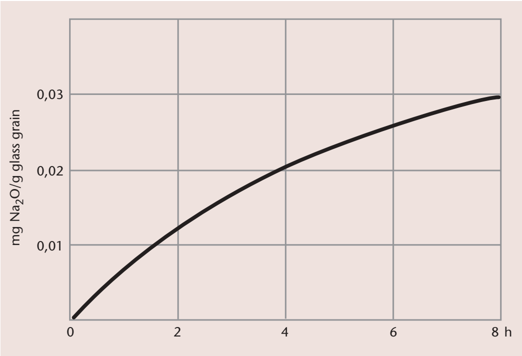
Chemical composition of DURAN®

DURAN®, which is used in laboratories because of its excellent chemical and physical properties, has the following typical composition:

81 %	by weight	SiO_2
13 %	by weight	B_2O_3
4 %	by weight	Na_2O/K_2O
2 %	by weight	Al_2O_3

Chemical properties

The chemical resistance of glass is more extensive than that of all other known materials. DURAN® borosilicate glass is highly resistant to water, acids, saline solutions, organic substances and also halogens such as chlorine and bromine. Its resistance to alkaline solutions is also relatively good. Only hydrofluoric acid, concentrated phosphoric acid and strong alkaline solutions cause appreciable surface removal of the glass at higher temperatures.



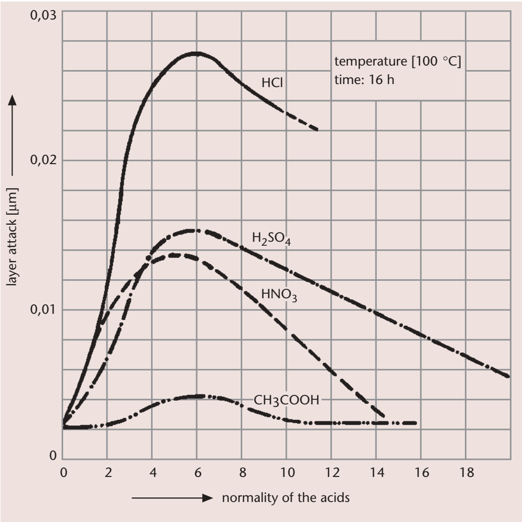
Hydrolytic attack on DURAN® as a function of time (100 °C) approx. to ISO 719.

Hydrolytic resistance

DURAN® corresponds to Class 1 of the glasses divided into a total of 5 hydrolytic resistance classes in accordance with ISO 719 (98 °C).

The amount of Na_2O/g glass grain leached out after 1 hour in water at 98 °C is measured. In the case of DURAN the quantity of Na_2O leached out is less than 31 µg/g of glass grain.

DURAN® also corresponds to Class 1 of the glasses divided into a total of 3 hydrolytic resistance classes in accordance with ISO 720 (121 °C). The quantity of Na_2O leached out after 1 hour in water is less than 62 µg/g of glass grain.

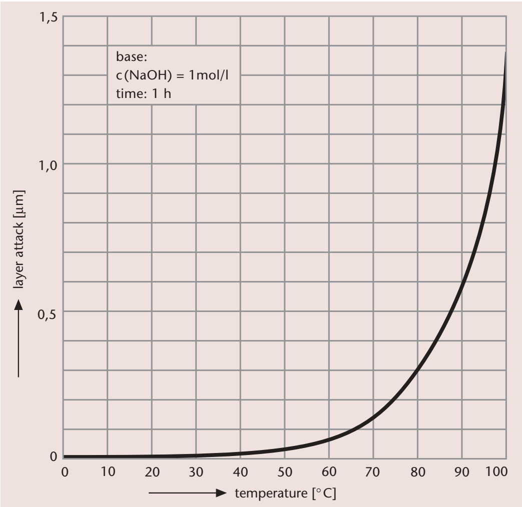


Acid attack on borosilicate glass as a function of acid concentration.

Acid resistance

DURAN® corresponds to Class 1 of the glasses divided into 4 acid classes in accordance with DIN 12116. As the surface removal after boiling for 6 hours in normal HCl is less than 0.7 mg/100 cm², DURAN® is classed as acid-resistant borosilicate glass.

The quantity of alkali metal oxides leached out in accordance with ISO 1776 is less than 100 µg Na_2O/100 cm².



Alkali attack on DURAN® as a function of temperature.

Alkali resistance

DURAN® corresponds to Class 2 of the glasses divided into 3 alkali classes in accordance with ISO 695. The surface removal after boiling for 3 hours in a mixture of equal volumes of sodium hydroxide solution (concentration 1 mol/l) and sodium carbonate solution (concentration 0.5 mol/l) is only approx. 134 mg/100 cm².

Overview of the chemical properties of technical glasses

Description	Chemical resistance class		
	Hydrolytic resistance ISO 719	Acid resistance DIN 12116	Alkali resistance DIN 52322/ISO 695
DURAN®/BOROFLOAT®	1	1	2
FIOLAX®	1	1	2
AR-GLAS®/Kalk-Soda-Glas	3	1	2
SBW®	1	1	1

Physical properties

Temperature resistance on being heated up and thermal shock resistance: The maximum permissible operating temperature for DURAN® is 500 °C. Above a temperature of 525 °C the glass begins to pass from the solid to the viscous state. As it has a very low linear coefficient of expansion ($\alpha = 3{,}3 \cdot 10^{-6}\ K^{-1}$) a feature of DURAN® is its high thermal shock resistance up to $\Delta T = 100$ K. This means that, for a temperature change of 1K, the glass changes by only $3{,}3 \cdot 10^{-6}$ relative units of length.

Temperature resistance at freezing temperatures: DURAN® can be cooled down to the maximum possible negative temperature and is also suitable for use in liquid air (approx. – 192 °C). In general DURAN products are recommended for use down to – 70 °C. When cooling down and thawing care must be taken to avoid a temperature difference of more than 100 K. When freezing substances in such items as DURAN® bottles or DURAN® test tubes the container should only be filled to a maximum of 3/4 of its capacity and it must be frozen slanted at an angle of 45 ° (to enlarge the surface area) because of the plastic caps at a maximum of – 40 °C.

Use in the microwave: DURAN® laboratory glass is suitable for use in microwaves. This applies also to plastic coated DURAN® products.

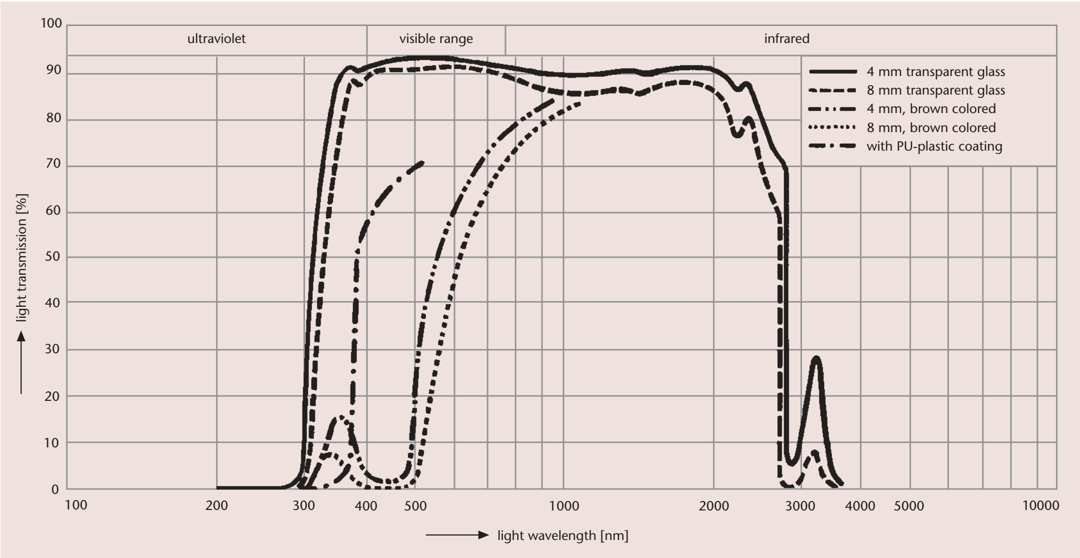
Overview of the physical properties of technical glasses

Description	Melt No.:	Linear expansion coefficient α 20/300 °C $10^{-6}\ K^{-1}$	Transformation temperature °C	Dichte g/cm³
DURAN®/BOROFLOAT®	8 330	3.3	525	2.23
FIOLAX®	8 412	4.9	565	2.34
AR-GLAS®/Kalk-Soda-Glas	8 350	9.1	525	2.50
SBW®	8 326	6.5	555	2.45

Optical properties

In the spectral range from approx. 310 to 2200 nm the absorption of DURAN® is negligibly low. Its appearance is clear and colorless. Fairly large layer thicknesses (axial view through pipes) appear greenish.

For work with light-sensitive substances the surface of the glass can be tinted brown with a diffusion color. This results in strong absorption in the short-wave region up to approx. 500 nm. In photochemical processes the light transmission of DURAN® in the ultraviolet range is of particular importance. The degree of transmission in the UV range shows that photochemical reactions, for example chlorinations and sulfochlorinations, can be carried out. The chlorine molecule absorbs in the range from 280 to 400 nm and thus serves as a carrier of the radiation energy.



Transmission curves for DURAN®.

Conformity with standards

In addition to the international standard ISO 3585, which lays down the type of borosilicate glass 3.3, DURAN® laboratory glassware also conforms to the many standards for glass laboratory items; for example DIN 12 331/ISO 3819 for beakers and DIN 12 347/ISO 1773 for flat bottom flasks.

The particular DIN/ISO standard is indicated on the product pages of this catalog. When changes are made to the DIN, e. g. as a result of adapting to ISO recommendations, our dimensions are modified appropriately in a reasonable time.

DURAN® is a neutral glass with high hydrolytic resistance and is, therefore, classified as glass type 1 in accordance with the German Pharmacopeia (DAB), the European Pharmacopeia (Section 3.2.1) and the United States Pharmacopeia (USP 27) and National Formulary (NF 19).

Plastics and laboratory glass

DURAN® laboratory glass products are complemented by various plastic products such as screw caps, the properties of which can be found in the tables below.

Plastics used with laboratory glass

The indications of temperature resistance given in the table refer to normal autoclaving procedures with steam and a duration of 20 minutes (see page 162, Sterilization)

		Temperature resistance up to °C
EPDM	Ethylene/propylene-diene-rubber	– 45 up to + 150
ETFE[2]	Partially crystalline ethylene/tetrafluoroethylene copolymer	– 100 up to + 180
FEP	Tetra-Fluor-Ethylen/Hexafluor-Propylene	– 200 up to + 200
FKM	Fluorinated rubber	– 20 up to + 200
PBT[2]	Polybutylenteraphthalat	– 45 up to + 180[3]
PE	Polyethylene	– 40 up to + 80
POM	Polyoxymethylene	– 40 up to + 90
PP[2]	Polypropylene	– 40 up to + 140
PTFE[2]	Polytetrafluorethylene	– 200 up to + 260
PU[1]	Polyurethane	– 20 up to + 135
TpCh260	Thermoplastic/Duroplastic	– 196 up to + 260
VMQ[2]	Silicone rubber	– 50 up to + 230

[1] All laboratory glasses coated with PU may only be cleaned while moist in order to avoid any electrostatic charge which may form.
[2] This plastic types are recommended by the BGA (Bundesgesundheitsamt) (Federal Department of Health) in accordance with the specifications applicable in each case.
[3] Changes in colour may occur at temperature stresses above 180 °C.

Chemical resistance of plastics

Classes of substances + 20 °C	PE	PP	PBT	PTFE/ FEP	TpCh 260	ETFE	VMQ	EPDM	PU	FKM	POM
Alcohols, aliphatic	++	++	++	++	++	++	+	+	++	–	+
Aldehydes	+	+	++	++	++	++	+		++		+
Alkaline solutions	++	++	+/–	++	++	++	–	++	++	–	+
Esters	+	+	+	++	++	++	–	++	+	–	–
Ethers	–	–	+	++	++	++	–	–	+	–	+
Hydrocarbons, aliphatic	–	++	++/+	++	++	++	–	++	++	++	+
Hydrocarbons, aromatic	–	+	++/+	++	++	++	–	+	++	++	+
Hydrocarbons, halogenated	–	+		++	++	++	–	+	–	++	+
Ketones	+	+	+/–	++	++	+	–	++	+	–	+
Acids, dilute or weak	++	++	++	++	++	++	–	++	++	++	+
Acids, trated or strong	++	++	+	++	++	++	–	++	+	++	–
Acids, oxidising (oxidising agents)	–	+	–	++	++	+	–	–	+	+	–

++ = very good resistance
+ = good to limited resistance
– = low resistance

Cleaning laboratory glass

Special glass laboratory equipment can be washed by hand in the sink or by machine in a laboratory dishwasher. Laboratory dealers can supply a wide range of cleaners and cleaner-disinfectants for both methods. As contamination during the delivery of our laboratory glassware cannot be totally ruled out, we recommend washing laboratory glassware before it is used for the first time.

To take good care of laboratory glassware it should be washed immediately after use at low temperature, on a short cycle and at low alkalinity.

Laboratory apparatus that has come into contact with infectious substances should first be cleaned and then sterilized with hot air or steam (see section 6 in this connection). This is the only way to prevent impurities from sticking onto the glass and prevent damage of the glasses caused by any adhering chemicals.

Manual cleaning

The normal method is to wipe and rub the glass with a cloth or sponge soaked in cleaning solution. Abrasive cleaners and abrasive sponges should not be used on laboratory glassware as these can damage the surface of the glass.

When soaking glassware it should be left as a rule in the cleaning solution for 20 to 30 minutes at room temperature, then rinsed with tap water followed by distilled water.

The soaking time should only be increased and a higher temperature used for stubborn marks.

Laboratory glassware should not be soaked for long periods in alkaline media at more than 70 °C since this can have an adverse effect on the printing.

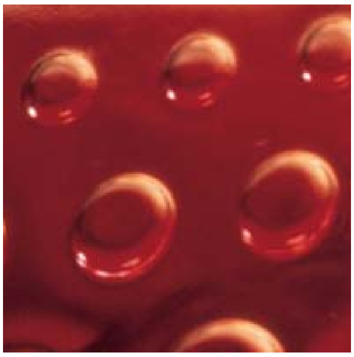
Machine cleaning

Machine cleaning in a laboratory dishwasher is kinder to glassware than soaking it. The glass only comes into contact with the dishwashing liquid for relatively short periods when this is being sprayed onto the surface of the glass by the spray or injector jets.

Chemical cleaning

See page 172, Product-specific part.

Sterilization



Laboratory apparatus that has been in contact with infectious substances should be steam sterilized after washing. In such cases the hints and guideline below should be followed.

Steam sterilization refers to "the destruction or irreversible inactivation of all microorganisms capable of reproduction" (DIN 58 900, Pt. 1, 1986) by means of "saturated steam at a minimum of 120 ° and 2 bar" (DIN 58 946, Pt. 1, 1987). The minimum effective application time (destruction time + safety factor) is indicated in DIN 58 946, Pt. 2 as a duration of 20 minutes at a sterilization temperature of 121 °.

The following should be noted with regard to preparation for sterilization:

– Soiled laboratory glassware must be cleaned first without fail in accordance with the methods described in section 5, since otherwise microorganisms cannot be effectively destroyed and chemicals adhering to the surface of the glassware can damage it as a result of the high temperatures involved.

– To avoid a build-up of pressure, all vessels should always be opened.

– Ensure that saturated steam is used and that this has unhindered access to all contaminated places. This is the only way to achieve effective steam sterilization.

In addition to the standardized procedures described above, individually modified methods, e. g. high temperatures, are also possible for all DURAN® products. Please bear in mind, though, the maximum permissible temperature for the plastics used for fittings, especially in the case of bottles (because of the screw cap), (page 160).

Hints on drying laboratory glass, with special reference to filtration apparatus, can be found on page 171 in the product-specific part.

Working under pressure

When working with glass the limits of this material as regards thermal shock and mechanical loading should be taken into account and strict handling precautions adhered to. For working under pressure more far-reaching rules should be adhered to:

– Glass apparatus that is under pressure or vacuum (e. g. filtering flasks and desiccators) must be handled with special care.

– To avoid stresses in the glass, vessels under vacuum or pressure should not be heated on one side only or with an open flame.

– When working under pressure the maximum figures indicated in the catalog should not be exceeded.

– Before using glass equipment under vacuum or pressure it must always be visually inspected to check that it is in perfect condition (no serious scratches, abrasions, etc.). Damaged glassware should not be used for work with pressure or vacuum.

– Never subject glassware to sudden changes in pressure, e. g. always vent items under vacuum smoothly.

– Laboratory glassware with flat bottoms (e. g. Erlenmeyer and flat bottom flasks) should not be used under pressure or vacuum.

Safety Instructions

The appropriate guidelines applicable for the use of special glass in laboratories in the country in question should always be complied with; in the case of Germany these are the "Richtlinien für Laboratorien" ("Laboratory Guidelines") published by the chemical industry sub-committee of the Hauptverband der gewerblichen Berufsgenossenschaften (the German federation of statutory accident insurance institutions for the industrial sector), Zentralstelle für Unfallverhütung und Arbeitsmedizin, Fachausschuss Chemie, Langwartweg 103, 53129 Bonn, Germany (Verlag Carl Heymanns KG, Gereonstrasse 18–32, 50670 Cologne, Germany).

The following points should, however, be observed in every case:

– Before DURAN® laboratory glassware is used it should be checked to ensure that it is suitable for the intended purpose and that it will operate without problem.

– Defective laboratory glassware can present a hazard (e. g. risk of cuts, burns, infection) which should not be underestimated. If appropriate repairs to any item cannot be carried out or cannot be justified for economic reasons, it must be disposed of in the proper manner.

– Damaged volumetric glassware such as volumetric flasks, measuring cylinders, etc. should never be repaired. The effects of heat can leave stress in the glass (with very high risk of breakage!) and permanent volume changes can occur. It is also dangerous to simply shorten defective measuring cylinders. This results in the distance laid down by DIN between the upper graduation mark and the pouring lip being reduced. The risk of chemicals being spilled if the item is filled too full is consequently increased and safety at work can no longer be ensured.

– Never subject glassware to sudden changes in temperature. This means that hot items should not be taken out of a drying cabinet and placed on a cold or even wet laboratory bench. This applies in particular to thick-walled glassware such as filtering flasks and desiccators.

– When assembling apparatus make sure that it stands firmly and is not subjected to stress by using appropriate support material. To compensate for stress or vibrations PTFE bellows or similar should be used.

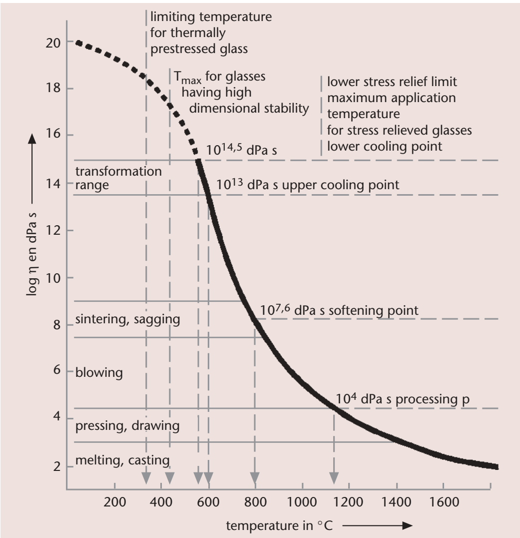
– DURAN® laboratory glass should under no circumstances be disposed in normal bottle banks, since its high melting point can create problems if it is mixed with other glass for recycling. The correct way to dispose of it is, in principle, to include it with general household waste (residual waste) provided, however, that the glass is quite free of any harmful substances.

Further processing

DURAN® items made of proven borosilicate glass 3.3 are suitable for further processing such as the addition of screw thread tubes, olives, tubulature and necks or for adding ground glass joints. The preferred items for further processing are beakers, Erlenmeyer flasks, flat bottom flasks and laboratory bottles.

Certain sections of the viscosity range are of special importance for manipulators. In the transformation range the elastic-brittle behavior of the glass changes with increasing temperature into a markedly viscous one, whereby all its physical and chemical properties change significantly depending on the temperature. The temperature range of the transformation range thus plays an important part in stress relief during heating up and the setting up of stress when the glass is cooled. The position of the transformation range is identified by the transformation temperature "tg" DIN 52 324.

If not indicated otherwise, our products are manufactured from DURAN® borosilicate glass. Items that are made of other glasses are identified specially.



Normal temperature dependence/viscosity curve of, for example, DURAN®; viscosity ranges of important processing techniques, position of fixed points of viscosity and various limiting temperatures.

Bottles

Laboratory bottles

DURAN® laboratory bottles are chemically resistant and stable. When fitted with a plastic pouring ring they can be used without dripping. As there is only one screw thread size for all bottles from 100ml and upwards, the screw caps and pouring rings are fully interchangeable. The bottles, pouring rings and caps are sterilizable.

Properties

Light protection

- brown bottles up to 500 nm
- plastic coated bottles up to 380 nm usable as safe storage for chemicals

Safe closure ensures that such products as

- Dairy products
- Serums are kept sterile.

High resistance to thermal shock

Handling hints

Freezing substances (see also page 158, general section)
Recommendation: When freezing, always place the bottles at an angle (approximately 45 °) and do not fill to more than 3/4 capacity (to increase surface area). Temperature limit: – 40 °C as the plastic caps and pouring rings do not withstand lower temperatures.

Thawing frozen substances
The frozen material can be thawed by immersing the bottle in a liquid bath taking care that the temperature difference does not exceed 100 °C. This will ensure that the frozen material is heated uniformly from every side without damaging the bottle. It can, however, also be thawed slowly from above, so that the surface melts first, allowing the material to expand.

Sterilization
Please note the indications on page 162, general section plus the information below.
Important: When sterilizing, the screw cap should be left loose on the bottle neck (one turn maximum). It should not be closed tight. If the bottle is closed tightly, the pressure cannot be balanced. The consequent difference in pressure can result in breakage of the glass, as the bottle will burst. When loading dish-washing machines, ensure that the glass items – particularly the screw threads – do not come into contact with each other.

Pressure resistance
DURAN® laboratory bottles, with the exception of pressure-resistant bottles 21 810 54, 21 815 54, 21 816 54, are not suitable for use under vacuum or pressure.

Laboratory bottles with plastic coating

DURAN® Protect is a resistant and transparent linked copolymer based plastic coating applied to DURAN® borosilicate glass 3.3. The coating bonds firmly with the glass surface and performs the following functions:

- It protects the glass surface against mechanical damage (scratch protection).
- It holds the fragments together in the event of the glass breaking (splinter protection).
- It minimizes liquid loss in the event of the glass breaking (protection against contents escaping and spray).
- It absorbs UV rays up to a light wavelength of 380 nm (light protection).

Please note: plastic coating does not increase the permissible pressure at which the bottles can be used.

Temperature resistance

Do not expose Protect bottles to open flames or direct heat, e. g. on a laboratory hotplate. The maximum operating temperature is 135 °C. Long-term exposure to temperature (longer than 30 minutes) should be avoided.

DURAN® Protect is suitable for freezing (– 30 °C) and it can be used in microwaves.

Sterilization

In addition to the standard method described on page 162, general section, the following procedure taking into account the temperature is permissible as a maximum:

– Steam sterilization at 134 °C, 2 bar.
– Cycle duration should not exceed 20 minutes.

Important: When sterilizing, the screw cap should be left loose on the bottle neck (cap screwed one turn maximum). It should not be closed tight.

Autoclaving instructions

1. Autoclave in steam at 134 °C for a duration of approx. 20 minutes.
2. Switch off heat.
3. When autoclave has cooled to 100 °C, vent and drain. Do not cool with distilled water or vacuum.
4. When autoclave has cooled to 80 °C, open it.

Important: The bottle must be allowed to cool down before the next autoclaving process.

Pressure or vacuum use

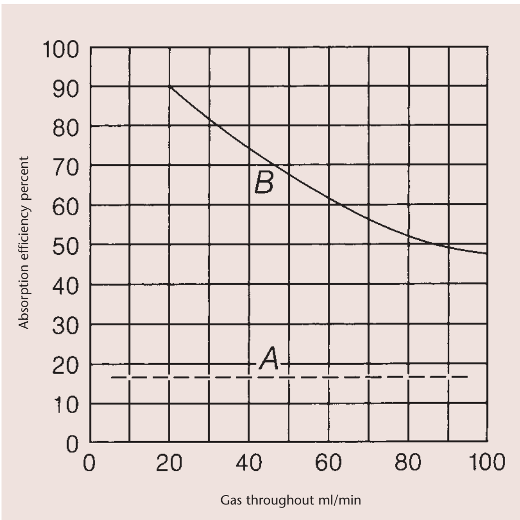
In the event of the glass bottle bursting or imploding, the plastic coating prevents splinters of glass flying about. However, this does not mean on any account that there is no need for any additional protective screening.

Washing

Wash by hand in a sink or mechanically in a dishwasher (see page 161, general section).

Gas washing bottles

Important when working with DURAN® gas washing bottles: The effectiveness of the absorption can be significantly increased by using a filter disk to distribute gases in liquids in gas washing bottles. Gas washing bottles of this type still work reliably even at high flow rates. The graph below illustrates the effectiveness of gas washing bottles with and without glass filter disk.



Absorption efficiency of two gas wash bottles:
A without gas filter and B with gas filter plate

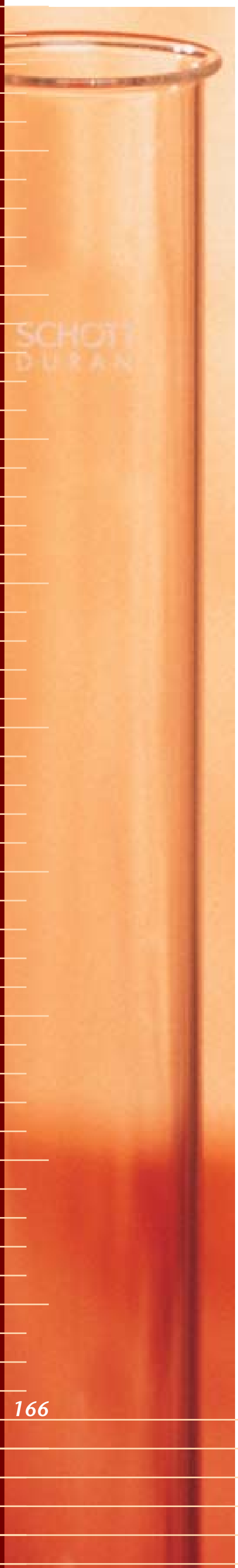
Filtering bottles with side-arm socket

The use of filtering flasks with side-arm socket has considerably simplified work in preparative and analytical laboratories and at the same time it has significantly reduced the risk of accidents. Please note that these filtering flasks are suitable for use under vacuum to DIN 12 476, ISO 6556 (see also page 162, general section).

These filtering bottles have a 17.5/26 ground socket for 15 to 18 mm OD vacuum tubing (e. g. 6 · 5 mm or 8 · 5 mm, DIN 12 865).

Desiccators

DURAN® desiccators are used to dry substances containing moisture and also to store products sensitive to moisture. They comprise a laboratory vessel suitable for use under vacuum with a ground lid made from the tried and tested DURAN® borosilicate glass 3.3 with its many outstanding physical and chemical properties (see pages 157 and 158). Due to the particularly precise manufacture of the various individual parts and accessories such as the lids, stopcocks, bases, etc. the components are compatible with each other and are fully interchangeable. The overview on page 50 shows you what individual parts you need to assemble the desiccator you require to your individual specification. A particularly decisive point for working with vacuum: DURAN® desiccators are notable for their special safety. For working with vacuum, see page 162, general section.



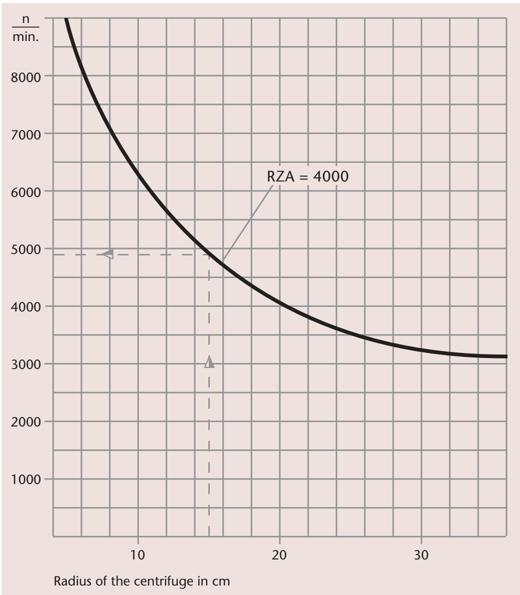
Centrifuge tubes and culture tubes

Centrifuge tubes

These centrifuge tubes are approved to DIN 58 970 (Part 2) for a maximum relative centrifugal acceleration of 4000 and filling in line with their capacity with contents having a maximum density of 1.2 g/ml.

Calculation: $RZA = 1.118 \cdot 10^{-5} \cdot r \cdot n^2$

$$n = \sqrt{\frac{4000}{1.118 \cdot 10^{-5} \cdot r}}$$



Example: r = 15 cm
see example in the diagram number of revolutions (n) = 4,900 min^{-1}

Culture tubes

In addition to DURAN® culture tubes our product range also includes AR-GLAS® culture tubes. This is a clear glass of the third hydrolytic class and it is a soda-lime glass with a high alkali and alkaline earth oxide content.

AR-GLAS® is notable for its wide-ranging fields of application which include such areas as pharmaceuticals, medicine, cosmetics and the foodstuffs industry.

The following information with regard to AR-GLAS® should also be noted:

Physical data

Mean linear coefficient of expansion $\alpha_{20/300}$ to DIN 52 328:	$9.1 \cdot 10^{-6}$ K^{-1}
Transformation temperature T_g:	525 °C
Temperature fixed points at viscosity h in dPa · s:	
10^{13} upper annealing temperature	530 °C
$10^{7.6}$ softening temperature	720 °C
10^4 working temperature	1040 °C
Density r:	2.50 g/cm^3

Chemical data

Hydrolytic class	(ISO 719)	3
Acid class	(DIN 12 116)	1
Alkali class	(ISO 695)	2

Chemical composition
(main components in approx. weight %)

SiO_2	B_2O_3	K_2O	Al_2O_3	Na_2O	BaO	CaO	MgO
69	1	3	4	13	2	5	3

Flat flange range

For many years laboratories of all types have valued the wide range of possible applications for DURAN® flat flange reaction vessels. SCHOTT supplies an extensive range of blanks and finished items which can provide the optimum solution for each individual application, irrespective of whether it be reaction, distillation, evaporation or desiccation.

SCHOTT's flat flange and reaction vessels are notable for the following benefits:
– Very robust design of the glass flange (optimum flange angle of 45°)
– The stainless steel quick release clamp with 3 flexible segment ensures easy and safe handling
– The flat flange reaction vessel body and lid have the same nominal diameter, making them interchangeable with each other
– Proven flange design – flat ground – with or without groove, suitable for any seal required
– Beaded lid design for safe handling; bodies can be changed without dismantling the apparatus.

Important: All components are suitable for use under vacuum and approved for positive operating pressure as indicated.

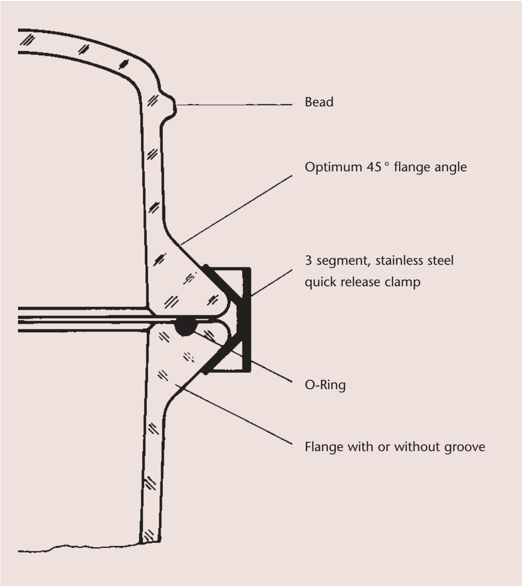
Round bottom jacketed vessels

SCHOTT supplies round bottom cylinders for the manufacture of jacketed vessels. The matching inner and outer vessels have a standard length of 400 mm in various diameters. They can be cracked off at the appropriate length so that reaction vessels can be manufactured with capacities ranging from 250 ml to 10 l.

Benefits:
– The use of the proven borosilicate glass 3.3 ensures good compatibility in welding components together
– Safe to operate under positive pressure or vacuum due to the specific design of the glass vessel (permissible operating data as indicated)
– Optimum flow distribution of the heating fluid as a result of careful matching of the outer jacket and the inner vessel.

Important information for the further processing of jacketed vessels, flat flange reaction vessels and lid blanks. (see also page 163, general section): The figures given in the operating pressure tables in the catalog are only valid for the original vessel blanks, on condition that no subsequent reduction in wall thickness occurs as a result of welding.

For glass articles which differ from the original shape after further processing, the permissible operating data must be determined in accordance with the technical rules and regulations.



Beaded lid for safer handling of the reaction vessel

Accessories

Two types of seal can be supplied for flat flange reaction vessels:

a) O rings (see below) for operation under positive pressure and vacuum up to 200°C
  – Easy to open
  – The lid does not stick, even after operation for long periods under vacuum and at relatively high temperatures
  – No need to grease contact surfaces
b) Grease for operation under positive pressure and vacuum above 200°C
  – The groove acts in this case as an ideal grease groove
  – No contamination of the substance.

The stainless steel quick release closures with three holding segments are optimally designed to provide even distribution of the contact pressure. The chromium-nickel-steel support comprising two tensioning rods is designed for incorporating the reaction vessels or the lids in support panels, for example. If there is a need to change the lid or the vessel, this can be done without dismantling the entire apparatus.

Shape-retentive O-rings

FEP – seamlessly coated elastomer O-rings – with silicone core

These O-rings consist of a rubber-elastic core and an FEP coating which encloses the rings seamlessly. The combination of these high-quality materials ensures that the elasticity of a conventional O-ring is retained. The chemical resistance of FEP (tetrafluoroethylene-hexafluor-propylene/copolymer FEP) is equal to that of PTFE. The material is thus resistant to almost all chemicals and is suitable for temperature from – 50 °C to + 200 °C.

Benefits of the O-rings
- Excellent recovery through elastomer core and thus reusable
- good chemical resistance, compatible with most liquids and chemicals.
- Temperature resistant
- Solvent-resistant
- Physiologically harmless

Filters and filtration apparatus

Screwfilters with interchangeable filter disks

With 3 filter sizes, each having 4 filter disks of varying porosity, you have 12 different filter rates available to you. DURAN® screwfilters have a range of benefits compared with conventional filter apparatus:

- Interchangeable filter disks
- Safe and simple removal of the filtered material
- Disks have longer service life, as no damage is caused by scraping off the filtered material
- Filter disks are easy to clean from both sides
- Slit sieve (Cat. Ref. 21 340 31) can be used in the medium sized screwfilter to support membrane and paper filters
- Space saving
- Cost-effective; filter disks and apparatus can be ordered individually, as required.

Important: The filter disk should be located between 2 FKM gaskets.

Ultrafine filtration

For ultrafine filtration filter apparatus with porosity 5 glass filter disks are used. Here the nominal value of the maximum pore size is between 1.0 and 1.6 mm. Experiments with bacterium prodigiosum, the most commonly used for test purposes in this field, have shown that a bacterium-free filtrate is obtained with a nominal maximum pore size of 2 mm, even when filtering very dense suspensions. A strain of virtually spherical bacteria was used. Experiments with spore-producing bacillus mesentericus led to the same result.

It is interesting to note in this connection that diluted suspensions of these bacteria (15,000 to 90,000 per milliliter) could still be filtered sterile through porosity 3 filters. A bacterium-free filtrate could not be obtained however when filtering dense suspensions through them. The pores are already so narrow that all bacteria in dilute suspensions adhere to the pore walls.

Once the pore walls become saturated, bacteria can still pass through in the case of dense suspensions. Direct straining is only effected with a maximum pore size of 2 mm and below; i. e. it is only here that the pores are smaller than the bacteria to be filtered out.

Ultrafine filtration is one of the most important methods for the treatment of biological solutions without using fairly high temperatures which in many cases would lead to a change in, or decomposition of, the active ingredients in the solution.

For liquid filtration, sintered glass filter funnels of standard design are used. For bacterium-free filtration of gases, e.g. in ventilation of fungal and bacterial cultures, pipeline filters are used. Here, porosity 3 is adequate, providing the space in front of the dry filter disk, on the air inlet side, is stuffed evenly and loosely with cotton wool.

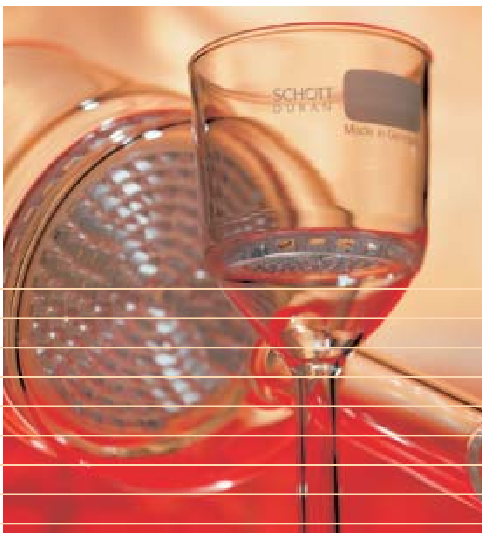
Porosity

Glass filters are divided according to the pore size into porosity classes from 0 to 5. Table 1 shows the porosity ranges and their main fields of application. The pore sizes indicated always refer to the disk's largest pore. This figure also indicates the diameter of the particles which are held back in the course of filtration. The porosity is measured using the Bechhold bubble pressure method which is widely described in the literature.* In the interests of rapid filtration every effort is made to produce filter disks with as many open pores as possible without blockages or closed cavities. This is one of the areas where SCHOTT glass filtration apparatus distinguishes itself. The benefits of using it result from the proven properties of DURAN® borosilicate glass and the special production methods used to sinter the granulated glass which is the starting material for the filter disks.

An essential condition for successfully working with glass filters is the selection of the correct porosity. Table 1 contains details of six porosity ranges with indications of their main areas of application. A point to be borne in mind is that the filtration equipment should ideally be selected to ensure that the nominal size of the largest pore is somewhat smaller than the smallest particles to be filtered out; this will make it more difficult for them to block the pores. This will result in the highest possible throughput speed and cleaning will not be made unnecessarily difficult. This is particularly important when filtering out fine grained insoluble solid particles such as silicates and graphite.

For quantitative analysis applications porosity 3 or porosity 4 glass filtration apparatus is used almost exclusively. Different working instructions often contain different porosity indications here for the same materials. This is explained by the fact that the type of work cycle in the production of precipitations for gravimetric analysis often results in differing grain sizes. In case of doubt it is preferable to use porosity 4; this will ensure quantitative separation of the precipitate in any case. On the other hand, for materials such as silver chloride or nickel dimethyl glyoxime porosity 3 has proved to be perfectly adequate in any case.

* Frank, W.: GIT 11 (1967) H. 7, 683–688



Porosity	New identification mark ISO 4793	Nominal max. pore size µm	Areas of application, examples
0	P 250	160–250	**Gas distribution:** Gas distribution in liquids with low gas pressure. Filtration of coarsest precipitates.
1	P 160	100–160	**Coarse filtration, Filtration of coarsest precipitates.** **Gas distribution in liquids:** Liquid distribution, coarse glass filters, extraction apparatus for coarse-grained material. Substrates for loose filter layers against gelatinous precipitates.
2	P 100	40–100	**Preparative fine filtration:** Preparative work with crystalline precipitates. Mercury filtration.
3	P 40	16–40	**Analytical filtration:** Analytical work with medium fine precipitates. Preparative work with fine precipitates. Filtration in cellulose chemistry, fine glass filters. Extraction apparatus for fine grained material.
4	P 16	10–16	**Analytical fine filtration:** Analytical work with very fine precipitates (e. g. $BaSO_4$, Cu_2O). Preparative work with correspondingly fine precipitates. Non-return valves and check valves for mercury.
5	P 1,6	1,0–1,6	**Ultrafine filtration**

Table 1

Flow Rates

To determine possible application of glass filter disks and filtration apparatus, it is necessary to know not only the porosity, but also the flow rates of liquids and gases. These are shown for water and air in figures 1 and 2. The data applies to 30 mm diameter filter disks. The flow rates for other disk diameters can be calculated by multiplying the value read off by the conversion factor given in table 2.

Filter disk diam. mm	10	20	30	40	60	90	120	150	175
Conversion factor	0.13	0.55	1	1.5	2.5	4.3	6.8	9.7	15

Table 2

Example:

Suction filtration of an aqueous solution using a filter funnel with a 60 mm disk diameter, porosity 4, under water-jet vacuum. Figure 1 gives a flow rate of 200 ml/min for a difference in pressure of about 900 mbar. Table 2 gives a flow volume of 200 · 2.5 = 500 ml/min for 60 mm disk diameter.

As the flow rate is heavily dependent on the pore diameter (pore radius to the power of 4), deviations from the values indicated can occur. Flow can also be obstructed by the formation of filter cakes on the filter disk. Further changes in flow volume occur when working with liquids whose viscosity differs from that of water. In these cases the flow volume is inversely proportional to the viscosity.

Deviations for gases occur with filter disks that are covered by a layer of water or other liquid (gas flow in washing processes). More detailed information on this subject can be found in the literature.*

* Frank, W.: GIT (1967) H. 7 S. 683-688

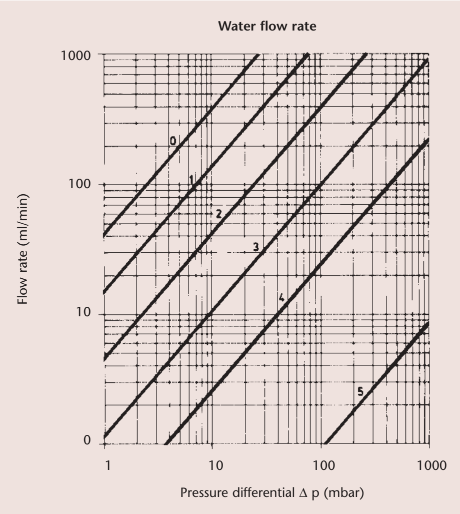


Fig. 1: Water flow rate through filter discs of various porosities as a function of pressure differential. For disc diameter 30 mm.

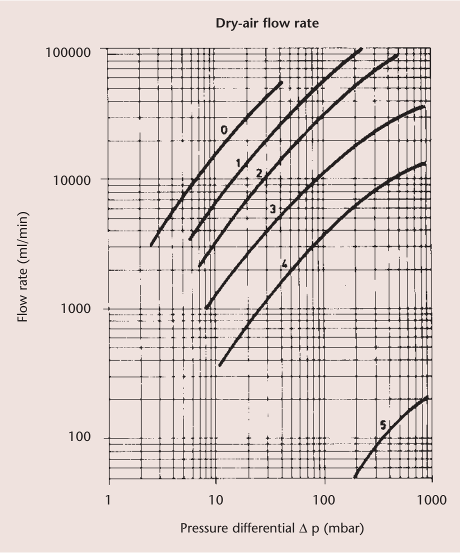


Fig. 2: Air flow rate through filter discs of various porosities as a function of pressure differential. For disc diameter 30 mm.

Care and cleaning of filtration apparatus

In addition to the information in the general section on page 161, please also note the following guidelines which apply specifically to filtration apparatus.

Thermal shock, drying and sterilization

Please note the following care guidelines. This will ensure that no internal stress is set up between the jacketed vessel and the filter disk, which could result in the filter breaking.

1. Sudden changes in temperature and uneven heating should be avoided. Glass filter funnels, pipeline filters and other glass filtration apparatus with disk diameters exceeding 20 mm, which are to be dried or sterilized, should be placed in a cold oven or sterilizer.
2. The heating and cooling rate should not exceed 8 °C/minute.
3. Before filtering hot substances place the filtration apparatus in a drying cabinet and bring it up to the required temperature slowly.
4. Wet filtration apparatus should be heated slowly up to 80 °C and dried for one hour before increasing the temperature further.

Whenever possible, filtration apparatus should stand on its rim (stem upwards) in ovens or sterilizers. It is of benefit in such cases to stand the apparatus on a perforated support which will allow air convection between the inside of the vessel and the body of the oven. If placing the filtration apparatus in the oven at an angle cannot be avoided (as in the case of pipeline filters), any support point close to the position of the filter weld must be protected against heating up prematurely by putting heat-insulating material under it.

After cooling down the glass filtration apparatus should be left in the drying cabinet or sterilizer. Due to the heat inertia of this type of heating appliance, the cooling time is adequate.

Cleaning new glass filtration apparatus

Before using glass filtration apparatus for the first time, hot hydrochloric acid followed by several rinses of distilled water should be drawn through the filter disc under a good vacuum to remove any dust and particles of glass powder that may be adhering to it. It is important not to start any of the successive water rinses until the preceding one has been completely flushed through. Forced filtration of this type must only be used to clean filters. It should never be adopted for preparative or analytical filtration.

Mechanical cleaning

Important: – Glass filters should always be cleaned immediately after use.
– Do not use sharp objects to remove filtrate.

If no precipitate has got into the pores, it is sufficient in many cases to rinse the surface under a tap or with a spray bottle. Brushes or rubber wipers can be used to clean the surface of the filter disk.

If some precipitate has got into the pores, it will be necessary to backflush the disk. In the case of porosities 0 to 2 this can be done simply with water from tap, for example by connecting it with rubber tubing to the stem of the funnel with the water flowing back through the filter disk. The pressure of the water should not exceed 1 bar. For porosities 3, 4 and 5 the precipitate should be sprayed or rinsed off the disk and water sucked through in the opposite direction to filtration. Filters clogged by dust and dirt during gas filtration can be restored by treatment with a warm detergent solution followed by blowing clean air through from the clean side of the filter. The foam will bring the dirt particles to the surface and they can then be removed by rising with water.

Chemical cleaning

If some of the pores on the filter disk still remain clogged after mechanical cleaning or if it is desirable to make sure that no residue from previous work remains before filtering a new substance, then thorough chemical cleaning is necessary. The choice of solvent obviously depends on the nature of the contamination. For example:

Barium sulfate	Hot conc. sulfuric acid
Silver chloride	Hot ammonia liquor
Red copper oxide	Hot hydrochloric acid and potassium chlorate
Mercury residue	Hot conc. nitric acid
Mercury sulfide	Hot aqua regia
Albumen	Hot ammonia liquor or hydrochloric acid
Grease, oil	Carbon tetrachloride
Other organic substances	Hot conc. sulfuric acid with an addition of nitric acid, sodium nitrate or potassium dichromate
Animal charcoal	Careful heating with a mixture of 5 parts by volume of conc. sulfuric acid + 1 part by volume of conc. nitric acid to about 200 °C

This should of course be followed by thorough rinsing with water.

For biochemical work, cleaning with dichromate sulfuric acid should be avoided, since trivalent chromium compounds, present or newly formed by reduction, are absorbed on the surface of the filter disk. When they are released during subsequent use, biological substances can be seriously damaged. The danger of this happening can be avoided by using sulfuric acid with nitrate or perchlorate added. Only easily soluble reduction products are formed and these can be completely removed by rinsing again with water. As hot, concentrated phosphoric acid and hot alkaline solutions attack the surface of the glass, they are not suitable as cleaning agents.
If they have to be filtered, enlargement of the pore diameter and thus reduced life of the apparatus is unavoidable.

Volumetric products

Volumetric flasks

Volumetric flasks for the accurate measurement of specific quantities of liquid are, like virtually all volumetric glassware, quantitative analysis aids. Chemists use them principally for the preparation and storage of normal solutions. DURAN® volumetric flasks are made of Schott's chemically resistant borosilicate glass 3.3. They are calibrated to contain ("In") for a reference temperature of 20 °C. The volume content tolerances for Class "A" volumetric flasks meet the accuracy limits of the German weights and measures regulations and the ISO and DIN recommendations.

Measuring and mixing cylinders

Measuring cylinders are used as receptacles for and at the same time to measure various quantities of liquid. Mixing cylinders can be used for diluting solutions and mixing several components in a given quantity ratio. DURAN® measuring and mixing cylinders are made of borosilicate glass 3.3 and are very resistant to mechanical and thermal loads.

The large hexagonal base with 3 nipples on its bottom increases stability and prevents the cylinder rolling away.

The cylinders have the same wall thickness over the whole measuring range, which avoids the risk of errors due to wedging. They are calibrated to contain ("In") for a reference temperature of 20 °C. Accuracy limits for measuring and mixing cylinders are laid down in DIN 12 680, DIN 12 685 and ISO 4788.

Burettes

Burettes are used exclusively for titration measurement purposes. The quantity of liquid required for the titration, which however is not known in advance, can be read off accurately upon completion of the reaction. DURAN® burettes are made of Schott's chemically resistant borosilicate glass 3.3. They are calibrated to deliver ("Ex") for a reference temperature of 20 °C. The volume content tolerances for burettes meet the accuracy limits specified by ISO and DIN. The accuracy limits of the Schott Class "B" version are about 1.5 times the accuracy limits of Class AS. They are, therefore, better than required by DIN.

By specifying a Class "AS" the German weights and measures regulations within the framework of the 15th Amending Regulations have taken into account that the great majority of volumetric measurements, especially in clinical laboratories, are carried out with water or dilute aqueous solutions; thus apparatus with considerably shorter run-off times than previously required but with the same accuracy limits is now admitted for calibration.

Capacity	Accuracy limits class AS suitable for official calibration DIN 12 700	Accuracy limits class B	
		ISO 385 DIN 12 700	SCHOTT
ml	± ml	± ml	± ml
1	0.01	–	–
2	0.01	–	–
5	0.01	–	–
10	0.02	0.05	0.03
25	0.03	0.05	0.04
50	0.05	0.1	0.08
100 [1]	0.08	0.2	0.15

[1] Non-DIN size

Pipettes

Pipettes are used for accurate measurement and recharging of liquids. With bulb pipettes it is only possible to charge specific quantities. With graduated pipettes different quantities of liquid can be taken up and they can then be discharged in part or whole. Graduated and bulb pipettes are AR-GLAS® products.

They are calibrated to deliver ("Ex") for a reference temperature of 20 °C. The volume content tolerances for pipettes meet the accuracy limits specified by ISO and DIN. The accuracy limits of the Schott Class B version are about 1.5 times the accuracy limits of Class AS. They are, therefore, better than required by DIN.

By specifying a Class "AS" the German weights and measures regulations within the framework of the 15th Amending Regulations have taken into account that the great majority of volumetric measurements, especially in clinical laboratories, are carried out with water or dilute aqueous solutions; thus apparatus with considerably shorter run-off times than previously required but with the same accuracy limits is now admitted for calibration.

Capacity	Accuracy limits class AS suitable for official calibration DIN 12 700	Accuracy limits class B	
		ISO 385 DIN 12 700	SCHOTT
ml	± ml	± ml	± ml
0.1 [1]	–	–	0.003
0.2 [1]	–	–	0.004
0.5	–	0.01	0.008
1	0.006	0.01	0.008
2	0.010	0.02	0.015
5	0.03	0.05	0.040
10	0.050	0.10	0.080
25	0.100	0.20	0.150

[1] Non-DIN, non-ISO size, graduated pipettes 0.1 and 0.2 ml are calibrated to contain ("in")

Glass-ceramic laboratory protection plates

Glass-ceramic protection plates solve a problem in the laboratory which could not be avoided previously when using conventional asbestos mats. When heated they do not give off any substances which are harmful to health. In addition to this main benefit of glass-ceramic laboratory protection plates compared with asbestos, the use of which is now restricted or prohibited in some countries, there are further convincing reasons for replacing asbestos wire mesh in all laboratories with glass-ceramic protection plates.

Savings in energy and time

The good permeability of glass-ceramic protection plates for infrared radiation results in the heating energy being transferred to the material to be heated with little loss. This can save you 20% or more time and energy. In addition, there is room for several items on the plate's flat square surface.

Chemically resistant

When working in the laboratory it is impossible in practice to avoid aggressive media boiling over or spilling. Even highly aggressive media can do no damage to glass-ceramic laboratory protection plates.

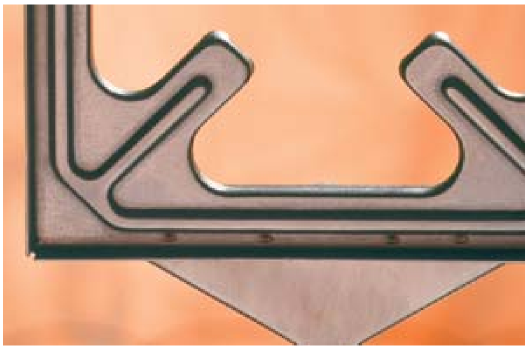
Problem-free cleaning

The smooth non-porous surface of the glass-ceramic protection plate can be cleaned by hand or by machine without any problem. In fact in the same machine where your laboratory glassware is washed: in the glass washer.

High temperature resistance

Range of use from – 200 °C to + 700 °C. A particular benefit of glass-ceramic laboratory protection plates is the fact that they can be used at continuous high temperature.

Durability at	700 °C –	6000 hours
	750 °C –	750 hours



Even when a hot plate is quenched with cold water, there is no risk of breakage, since its resistance to thermal shock is greater than 650 °C. To avoid overheating, care must be taken not to exceed the above-mentioned limits when working with a Bunsen burner. Our glass-ceramic laboratory protection plates retain their shape and flatness and do not age.