

## 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 ( $\text{SiO}_2$ ), boric acid ( $\text{B}_2\text{O}_3$ ), phosphoric acid ( $\text{P}_2\text{O}_5$ ) and aluminium oxide ( $\text{Al}_2\text{O}_3$ ). 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 that they solidify from the molten state into a glassy state. The formation of glass depends on its cooling rate and a necessary prerequisite is the existence of mixed types of bond (covalent bonds and ionic bonds) between the atoms or groups of atoms.

As a result, glass-forming products show a strong tendency whilst still in the molten state towards amorphous three-dimensional networking through polymerisation. 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 amorphous "network" when it cools down from the molten state. The components 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®

Very high chemical resistance, nearly inert behaviour, a high usage temperature, minimal thermal expansion and the resultant high resistance to thermal shock are its most significant properties. This optimum physical and chemical performance makes DURAN® the ideal material for use in the laboratory and for the manufacture of chemical apparatus used in large-scale industrial plant. It is also widely used on an industrial scale in all other application areas in which extreme heat resistance, resistance to thermal shock, mechanical strength and exceptional chemical resistance are required.

### Chemical composition of DURAN®

DURAN® has the following approximate composition:

81	% by weight	$\text{SiO}_2$
13	% by weight	$\text{B}_2\text{O}_3$
4	% by weight	$\text{Na}_2\text{O}/\text{K}_2\text{O}$
2	% by weight	$\text{Al}_2\text{O}_3$

DURAN® properties are specified in DIN ISO 3585. In contrast to other borosilicate 3.3 glasses, DURAN® is notable for its highly consistent, technically reproducible quality.

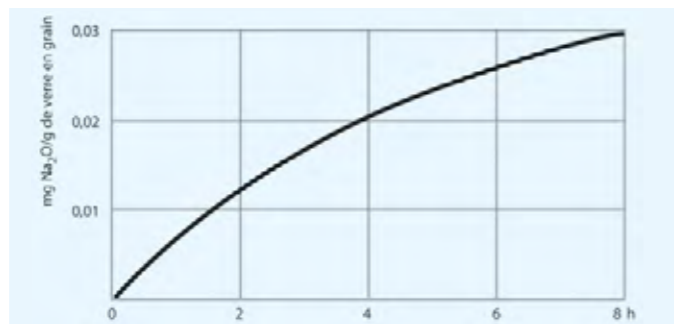


**Chemical properties**

The chemical resistance especially of DURAN® glass is more comprehensive 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 alkali is also relatively good. Only hydrofluoric acid, concentrated phosphoric acid and strong alkalis cause appreciable surface removal of the glass (glass corrosion) at elevated temperatures (>100 °C). Due to the nearly inert behaviour, there are no interactions (e.g. ion exchange) between medium and glass and any spurious influence on experiments is thereby effectively excluded.

**Hydrolytic resistance**

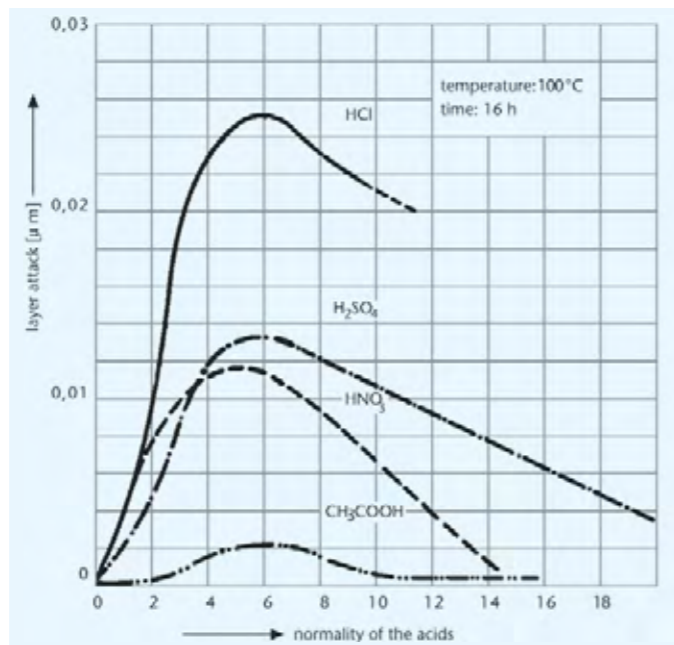
DURAN® corresponds to Class 1 of the glasses that are divided into a total of 5 hydrolytic resistance classes in accordance with ISO 719 (98 °C). The amount of Na<sub>2</sub>O/g glass grain leached out after 1 hour in water at 98 °C is measured. For DURAN® the quantity of Na<sub>2</sub>O leached out 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<sub>2</sub>O leached out after 1 hour in water at 121 °C is less than 62 µg/g of glass grain. Due to its good hydrolytic resistance, DURAN® meets the requirements of the USP, JP and EP for a neutral glass that corresponds to glass type 1. It can therefore be used in an almost unrestricted way in pharmaceutical applications and in contact with foodstuffs.



Hydrolytic attack on DURAN® as a function of time (100 °C)

**Acid resistance**

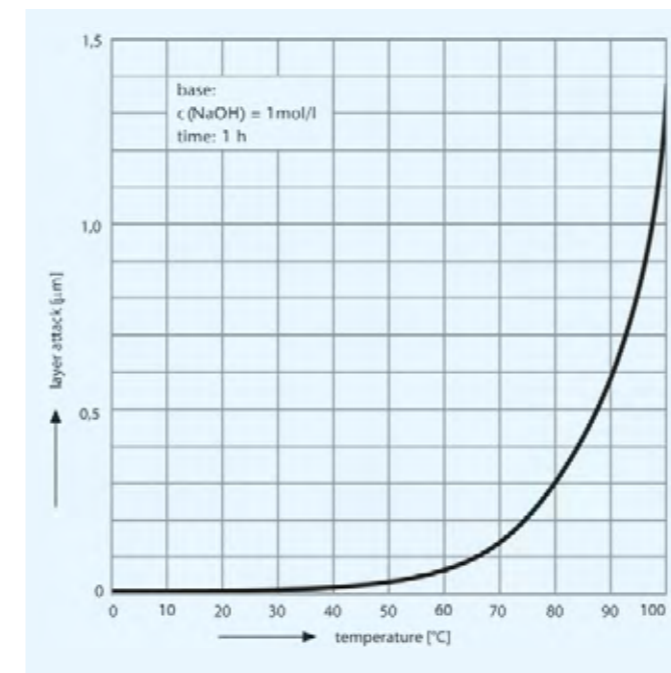
DURAN® corresponds to Class 1 of the glasses divided into 4 acid classes in accordance with DIN 12116. As the surface removal after boiling for 6 hours in normal HCl is less than 0.7 mg/100 cm<sup>2</sup>, DURAN® is classed as acid-resistant borosilicate glass. The quantity of alkaline metal oxides leached out in accordance with ISO 1776 is less than 100 µg Na<sub>2</sub>O/100 cm<sup>2</sup>.



Acid attack on DURAN® as a function of acid concentration

**Alkali resistance**

DURAN® corresponds to Class 2 of the glasses divided into 3 alkali classes in accordance with DIN ISO 695. The surface erosion after 3 hours boiling in a mixture of equal volume fractions of sodium hydroxide solution (concentration 1 mol/l) and sodium carbonate solution (concentration 0.5 mol/l) is only 134 mg/100 cm<sup>2</sup>.



Alkali attack on DURAN® as a function of temperature

**Overview of the chemical properties of technical glasses**

Description	Chemical resistance class		
	Hydrolytic resistance DIN ISO 719	Acid resistance DIN 12 116	Alkali resistance ISO 695
DURAN®	1	1	2
FIOLAX®	1	1	2
Soda-lime glass	3	1	2
SBW	1	1	1



Physical properties

Temperature resistance when heated and thermal shock resistance

The maximum permissible operating temperature for DURAN® is 500 °C. Above a temperature of 525 °C the glass begins to soften and above a temperature of 860 °C it changes to the liquid state. As it has a very low coefficient of linear expansion ( $\alpha = 3.3 \times 10^{-6} \text{ K}^{-1}$ ), a feature of DURAN® is its high thermal shock resistance up to  $\Delta T = 100 \text{ K}$ . For a temperature change of 1K, the glass changes by only  $3.3 \times 10^{-6}$  relative length units, resulting in low levels of mechanical strain were a thermal gradient exists. The thermal shock resistance is influenced wall thickness and product geometry.

Temperature resistance at low temperatures

DURAN® can be cooled down to the maximum possible negative temperature and is therefore suitable for use with liquid nitrogen (approx. -196°C). During such use/ freezing In general DURAN® products are recommended for use down to -70 °C.

When working at low temperatures, the effect of any expansion of a DURAN® vessel's contents must be borne in mind. During cooling and thawing ensure that the temperature difference does not exceed 100 K. In practice, therefore, stepwise cooling and heating are recommended. 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. Moreover, it should be frozen slanted at an angle of 45 ° (to enlarge the surface area). The minimum service temperature is dependant upon the properties of any screw caps or other components used. For the blue PP screw cap the minimum temperature is -40 °C.

Use in the microwave

DURAN® laboratory glassware is suitable for use in microwaves. This also applies to plastic coated DURAN® products .

Overview of the physical properties of technical glasses

Description	Linear expansion coefficient $\alpha$ (20 °C/300 °C) $[10^{-6} \text{ K}^{-1}]$	Transformation temperature $[^{\circ}\text{C}]$	Density $[\text{g}/\text{cm}^3]$
DURAN®	3.3	525	2.23
FIOLAX®	4.9	565	2.34
Soda-lime glass	9.1	525	2.5
SBW	6.5	555	2.45

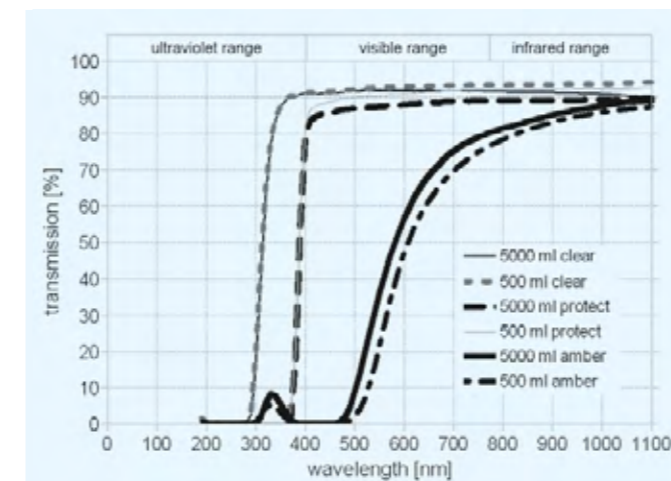
Optical properties

In the spectral range from about 310 to 2200 nm the absorption of DURAN® is negligibly low. It is clear and colourless. Fairly large layer thicknesses (axial view through pipes) appear slightly yellow/greenish. Amber-coloured DURAN® products are suited to use with light-sensitive substances (see amber colouring of DURAN®). 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 light transmission in the UV range indicates the ease with which photochemical reactions can be carried out, for example chlorinations and sulfochlorination. The chlorine molecule absorbs light in the range from 280 to 400 nm and thus serves as a transmitter of the radiation energy.

Amber colouring of DURAN® laboratory glassware

Amber colouring enables storage of light sensitive substances in DURAN® products. Light transmission in the wavelength range between 300 and 500 nm is, in comparison with DURAN® clear glass, < 10%. Accordingly amber DURAN® glass corresponds to USP/EP/JP specifications.

To colour an existing piece of DURAN® glassware, it is sprayed using an innovative process with a special medium-diffusion ink solely on the outside of the clear glass. The piece is heated to a high temperature which mobilises the diffusing ions into the out layer of glass. On cooling, the ambering is very uniform, resistant to chemicals and cleaning in a dishwasher. The proven DURAN® properties within the bottle remain unaffected; there is no contact or interaction between contents and amber coating. The uniformity of the amber colouring process and the resultant quality of the amber colour is ensured by continuous monitoring.



Transmission curves for DURAN®

CONFORMITY WITH STANDARDS AND GUIDELINES

Alongside the international standard DIN ISO 3585, in which the properties of borosilicate glass 3.3 are defined, DURAN® laboratory glassware corresponds to the current standards for glass laboratory apparatus. The relevant DIN/ISO standards are given on the product pages of this catalogue. If the standard is changed, e.g. in case of harmonisation to ISO, our dimensions are adjusted accordingly within an appropriate time interval.

DURAN® is a neutral glass of high hydrolytic resistance and thus belongs to glass type 1 in accordance with the European pharmacopeia (EP, chapter 3.2.1), the Japanese pharmacopeia (JP, chapter 7.01) and the United States pharmacopeia (USP, section: 660) and National Formulary.

## LABORATORY GLASSWARE AND PLASTICS

### Plastics used with laboratory glass<sup>1</sup>

To complement DURAN® laboratory glassware products, various plastic products such as screw caps are available. Their properties are listed in the following table.

		Temperature resistance range °C
EPDM	Ethylene/propylene-diene-rubber	-45 to +150
ETFE	Partially crystalline ethylene/tetrafluoroethylene copolymer	-100 to +180
FEP	Tetra-Fluor-Ethylen/Hexafluor-Propylene	-200 to +200
FKM	Fluorinated rubber	-20 to +200
PBT <sup>2</sup>	Polybutylenterephthalat	-45 to +180
PE	Polyethylene	-40 to +80
POM	Polyoxymethylene	-40 to +90
PP	Polypropylene	-40 to +140
PTFE	Polytetrafluoroethylene	-200 to +260
PU <sup>3</sup>	Polyurethane	-30 to +135
TpCh260	Thermoplastic/duroplastic	-196 to +260
VMQ	Silicone rubber	-50 to +200
PSU Compound	Compound polyarylsulfone based	-45 to +180

<sup>1</sup> The details in the table relating to temperature resistance relate to standard autoclaving processes with steam and a duration of 20 minutes (see page 213, sterilisation).

<sup>2</sup> Changes in colour may occur if exposed to temperatures above 180 °C.

<sup>3</sup> All laboratory glasses coated with PU may only be cleaned while moist in order to avoid any electrostatic charge which may form.

### Chemical resistance of plastics

Classes of substances +20 °C	PE	PP	PBT	PTFE/FEP	TpCh260	ETFE	VMQ	EPDM	PU	FKM	POM	PSU Compound
Alcohols, aliphatic	+	+	++	++	++	++	+	+	++	-	+	++
Aldehydes	+	+	+	++	++	++	+	+	++	-	+	+
Alkaline solutions	++	++	+	++	++	++	-	++	++	-	+	++
Esters	+	+	+	++	++	++	-	++	+	-	-	+
Ethers	-	-	+	++	++	++	-	-	+	-	+	+
Hydrocarbons, aliphatic	-	++	+	++	++	++	-	++	++	++	+	+
Hydrocarbons, aromatic	-	+	+	++	++	++	-	+	++	++	+	-
Hydrocarbons, halogenated	-	+		++	++	++	-	+	-	++	+	-
Ketones	+	+	+	++	++	+	-	++	+	-	+	-
Acids, dilute or weak	+	++	++	++	++	++	-	++	++	++	-	++
Acids, conc. or strong	+	+	+	++	++	++	-	++	+	++	-	++
Acids, oxidising	-	+	-	++	++	+	-	-	+	+	-	+

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

## CLEANING LABORATORY GLASSWARE

Special glass laboratory apparatus can be washed by hand in a soaking bath or by machine in a lab washer. Laboratory dealers can supply a wide range of detergents 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 care properly for laboratory glassware, it should be washed immediately after use at low temperature, on a short cycle and with low alkalinity. Laboratory apparatus that has come into contact with infectious substances or microorganisms should be treated in accordance with the current guidelines. Dependent on the substance, autoclaving (e.g. to kill microorganisms) may be necessary prior to cleaning, but it is generally recommended that cleaning or washing of glass products be carried out prior to autoclaving or hot-air sterilisation. This prevents dirt or impurities from adhering to the glassware surfaces and prevent damage caused by any possibly adhering chemicals.

### Manual cleaning

The generally recognized 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. Surface damage can affect the glass properties and limit further use of the product. When soaking glassware it should generally be left in the cleaning solution for 20 to 30 minutes at room temperature, then rinsed with tap water followed by distilled water. To clean the glass as gently as possible, and thus extend its service life, a prolonged soaking time and higher temperature should only be used for stubborn soiling. Laboratory glassware should not be soaked for long periods in strongly alkaline media at more than 70 °C since this can have an adverse effect on the ceramic printing and may cause glass corrosion. Also to be avoided is severe mechanical action, e.g. scraping using a metal spoon.

### Washer-disinfectors for automatic laboratory glassware reprocessing

Washer-disinfectors for automatic laboratory glassware preparation are available in various sizes and performance classes. The product range extends from compact machines of 60 to 90 cm width up to powerful, large capacity machines. The large capacity machines are specially intended for central reprocessing of large quantities of laboratory glassware and are available as both 1-door and 2-door barrier machines for installation in a diaphragm wall.



60 cm wide compact machine  
 Performance/load: e.g. 37 narrow neck glasses, 96 pipettes

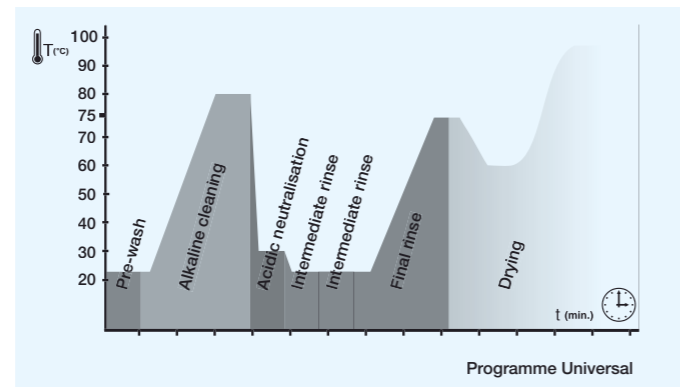


115 cm wide large capacity machine  
 Performance/load: e.g. 232 narrow neck glasses, 232 pipettes

Before purchasing a washer-disinfector, you must first be clear which laboratory glassware, and how much of it, requires reprocessing on a day-to-day basis within the laboratory. Once the machine size is specified, the appropriate accessories can be individually selected. The accessories include trolleys and inserts for secure support of the laboratory glassware. Inserts are primarily for holding wide-necked laboratory glassware. Special injector trolleys are offered to thoroughly clean laboratory glassware with a narrow internal diameter. These couple directly to the water supply of the machine and thus ensure that even internal cleaning of the laboratory glassware is correctly carried out. This system ensures that even difficult-to-access points are cleaned, which would be very difficult, or even impossible, to clean manually.

**Phases of machine-based reprocessing**

Machined-based reprocessing comprises cleaning, rinsing, disinfection (if necessary) and drying of the laboratory apparatus. The following figure shows a typical programme cycle for laboratory glassware reprocessing.



**Example**

Pre-rinse: cold water without process chemicals  
 Cleaning: cold or hot water with alkaline cleaning agent  
 Neutralisation: cold or hot water with acidic neutralisation agent

**Example**

Rinse I: cold water  
 Rinse II: deionised or ultrapure water  
 Flushing: deionised or ultrapure water at 75 °C

**Cleaning**

Cleaning removes dirt from the surfaces. At this stage, process chemicals (e.g. cleaning agents, surfactants, emulsifiers, neutralizers) are used. Cleaning may comprise several programme blocks, such as pre-rinse, cleaning, neutralisation.

**Rinsing**

During rinsing the dissolved dirt and the process chemicals used are rinsed off. Rinsing can comprise a number of individual programme blocks. The choice of water quality (e.g. tap water, deionised water, ultrapure water) depends on the application (e.g. organic/inorganic analysis, microbiology).

**Disinfection**

During disinfection, infectious contamination is killed/inactivated to such a degree that the laboratory glassware no longer represents an infection risk. On the one hand, disinfection serves to protect personnel within laboratories who work with infectious contamination. On the other hand disinfection prevents transfer of germs from samples and preparations in medical laboratories, hygiene institutes, pharmaceutical laboratories and the food and cosmetic industries. Thus hygienic, problem-free working is guaranteed.

**Drying**

The washer-disinfectors have, dependent on model and construction, an active hot-air dryer which permits not only drying of the external surfaces, but also drying of narrow diameter laboratory glassware. Also laboratory glassware of complex shape is reliably dried using hot-air drying. To effectively protect the laboratory glassware against dust particles and microorganisms, the drying air is passed through a HEPA filter.

**Typical programme using a Miele washer-disinfector for reprocessing of laboratory glassware:**

Miele washer-disinfectors for laboratory glassware reprocessing have up to 10 standard programmes. Numerous programme parameters can be adjusted to adapt the standard programmes for particular customer applications. Moreover, customer-specific programmes can be created for special applications.

Inorganic	To remove acid-soluble inorganic residues
Organic	To remove heavy organic residues such as oil, grease, wax, agar
Standard	Simple standard programme for slightly soiled glassware with a low final-rinse requirement
Universal	To remove organic residues (e.g. proteins, oils), for medium-level dirt and a medium final-rinse requirement
Intensive	To remove organic residues (e.g. proteins, cell and tissue cultures, oil), for heavy levels of dirt and a high final-rinse requirement
Plastic	For temperature-sensitive laboratory equipment (e.g. plastic bottles) with a low to medium level of dirt and a medium final-rinse requirement
Vario TD	For cleaning and heat disinfection at 93 °C with 5 minutes temperature-holding time, in accordance with EN ISO 15883-1, disinfection in the last rinse block
Special 93°C-10	For cleaning and heat disinfection at 93 °C with 10 minutes temperature-holding time, disinfection in the first rinse block, used in the case of an outbreak of a notifiable disease.

**Analysis purity through conductivity measurement in the final rinse**

The requirements for analysis purity depend largely on the application of the laboratory glassware. To ensure analysis purity, washer-disinfectors for laboratory glassware reprocessing can optionally be provided with a conductivity measurement module. An integrated conductivity measurement offers the following advantages:

- Detection of undesirable contents in the rinse water (dissolved salts of alkaline or acidic process chemicals)
- Definition of a customer-specific permissible conductivity level

**Process reliability for reproducible results**

Automatic preparation is a validatable preparation process that delivers reproducible results. This is one reason why automatic preparation should be favoured over manual processes.

To guarantee the reproducibility of the results, the machines have the following safety installations:

- Temperature monitoring using two redundant temperature sensors
- Automatic liquid dosing including dosing volume control
- Spray arm rotation speed monitoring

**Process documentation**

In applications which require high standardisation and reproducibility, process documentation contributes significantly to quality control. Process documentation can take place via documentation software or a printer.

### Economy

Nowadays, laboratory glassware preparation must constantly meet ever higher requirements in respect of performance and economy. Machine-based reprocessing is by comparison with manual cleaning, much more efficient: for example, the economy arises from lower time / personnel expenses, shorter process cycles as well as lower power and water consumption. In particular, the short process cycles mean the laboratory glassware is quickly ready for its next use. Minimal handling of contaminated laboratory glassware simultaneously reduces the potential risk to personnel (injury, chemical burns and risk of infection).

### Value retention through gentle preparation

Automatic laboratory glassware preparation is gentler than manual cleaning. The glass surfaces only come into contact with the alkalinity of the detergent for a short, defined time interval, so that glass corrosion is minimized. The accessories include special holders and locks so that the laboratory glassware is securely fastened and protected against breakage.

#### DURAN GROUP recommends Miele

To guarantee thorough, gentle and safe laboratory glassware preparation, DURAN GROUP recommends Miele washer disinfectors.

Miele "Made in Germany" quality is notable for its high reliability and efficiency in day-to-day use in the laboratory. Short operating times and reliable results ensure that high-value laboratory glassware is once again ready for use after only a short period.

In addition, the gentle preparation also ensures a long service life for DURAN® laboratory glassware.



### STERILISATION

When preparing laboratory glass for sterile applications or as part of the cleaning process, sterilisation is a well-established process. DURAN® laboratory glassware is suitable both for autoclaving as well as for hot air and plasma sterilisation ( $H_2O_2$ ). Laboratory apparatus that has come into contact with infectious substances or microorganisms must be cleaned in accordance with the appropriate guidelines for handling these materials. As the case may be, this may include sterilisation.

When carrying out sterilisation, especially of laboratory glassware, the following instructions should be observed: To avoid overpressure, all vessels should always be kept open. When sterilising media, the use of a membrane cap is recommended. Such a cap permits pressure equalisation through a PTFE membrane and hence the cap can be tightly closed. Consequently, the risk of contamination is greatly reduced.

Alongside the standardised procedures described above, individually modified methods are also applicable to all DURAN® products, for example using higher temperatures. However, you must ensure, especially with bottles (due to the screw caps) that the permissible highest temperatures for the plastic used in the accessories is not exceeded (see page 208).

### WORKING UNDER PRESSURE

Only products whose design includes the appropriate geometry and wall thickness, and which are explicitly designated as such, are suitable for working under pressure and / or vacuum (e.g. filtering flasks, desiccators or flat flange vessels).

When used under positive or negative pressure, and especially when also working with differential temperatures, additional care measures must be taken. Glass apparatus that is under pressure or vacuum should only be subject to further stress (e.g. significant temperature change) with extreme caution, as the individual resulting strains are additive and could readily result in failure.

To guarantee optimum user safety, the following points should be borne in mind:

- To avoid stresses in the glass, evacuated vessels or vessels under pressure should not be heated on one side or heated with an open flame.
- When working under pressure the maximum figures indicated in the catalogue 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, micro-cracks, abrasions, etc.). Damaged glassware should not be used for work under pressure or vacuum for safety reasons.
- Never subject glassware to sudden pressure changes, e.g. always re-pressurise evacuated glass apparatus slowly.
- Laboratory glassware with a flat bottom (e.g. Erlenmeyer and flat bottom flasks) should not be used under pressure or vacuum.
- The plastic coating of laboratory bottles (DURAN® protect) has no influence on pressure resistance. These products are not designed for use under pressure. For pressure applications using laboratory bottles, the DURAN® pressure plus bottle should be used. The DURAN® pressure plus bottle is pressure resistant from -1 to 1.5 bar due to a modified geometry and increased wall thickness.





### SAFETY INSTRUCTIONS

When used according to our specifications, DURAN® glassware is very safe to use. The appropriate guidelines applicable for the use of special glass in laboratories in the country in question should always be complied with.

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

- For safety reasons, before DURAN® laboratory glassware is used it should be checked to ensure that it is suitable for the intended purpose and that it can be used without problem.
- Defective laboratory glassware represents a risk (e. g. risk of cuts, burns, infection) that 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.
- Repairs must only be carried out by competent, specialist, glassworkers. Poorly, repaired glassware can fail without warning and represents a significant hazard.
- Only subject DURAN® glassware to sudden temperature changes within the recommended limit for thermal shock resistance ( $\Delta T = 100K$ ). This means that hot laboratory glassware 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 filtration flasks and desiccators.
- When assembling apparatus make sure that it stands firmly and is not subjected to stress by using appropriate stands.

### DISPOSAL

DURAN® laboratory glass should under no circumstances be disposed of in the domestic glass recycling stream (e. g. bottle banks), since its high melting point and different chemistry make it incompatible with other glass cullet (soda-lime glass) for recycling. The correct way to dispose of it is, in principle, to include it with general household waste (residual waste) in accordance with the relevant guidelines, provided that the glass is quite free of any harmful contamination (Waste code no: 17 02 99 D1).

### DURAN® LABORATORY GLASS IS ECO-FRIENDLY

DURAN® laboratory glass is made from natural, mineral raw materials. Unlike other materials, laboratory glass, when used properly, will give years of service and this means that it is vastly superior to other materials from an ecological viewpoint too. Depending on its use, DURAN® can be disposed of as household waste and does not need to be dealt with as special waste which may be environmentally harmful. Toxic substances cannot leach out because of the raw materials used.

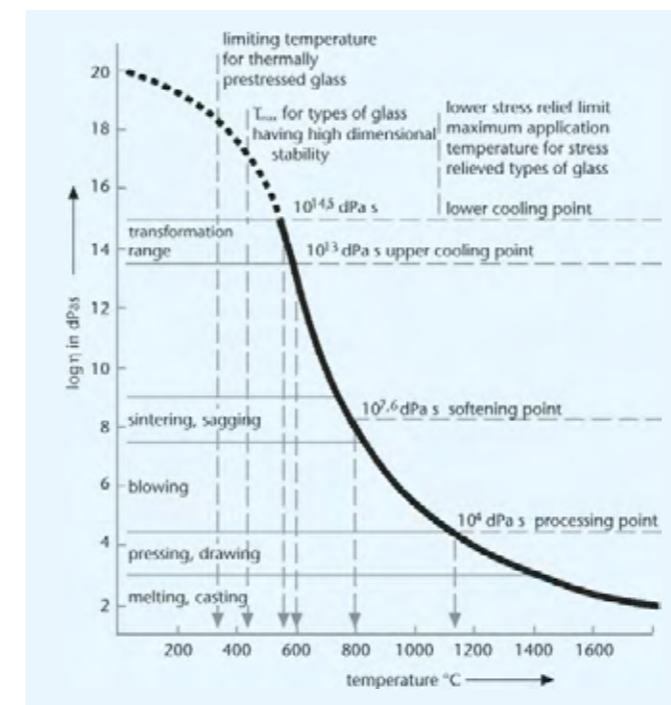
Production processes in our factories have been consistently optimized over recent years to ensure that they are environmentally friendly during the actual manufacturing stage through the minimum usage of valuable resources. Electrical heating and advanced technology in our melting units ensure that no pollutants are released during manufacture in our ultramodern factories which could harm our workers or people living nearby. In addition energy demand is kept as low as possible. The latest waste gas purification equipment is used to avoid emissions which could pollute the environment. A significant investment has been made in an enclosed cooling water recirculation system to cut the amount of fresh water required to a minimum thus helping to conserve vital water resources. We use packaging made from environmentally harmless, recycled paper which can be returned after use to the resource cycle.

### FURTHER PROCESSING

DURAN® items made of borosilicate glass 3.3 are suitable for further processing such as the addition of screw thread tubes, olives, tubulatures, necks and ground glass joints. Preferred for further processing are round, flat bottom and Erlenmeyer flasks. Certain sections of the temperature / viscosity range are of particular importance for glassworking. In the transformation range the elastic-brittle behaviour of the glass changes with increasing temperature into a markedly viscous one, so that consequently all its physical and chemical properties change significantly with temperature. The transformation temperature range thus plays an important part in stress relief during heating up and the introduction of stress when the glass is cooled. The position of the transformation range is identified by the transformation temperature "Tg" DIN 52 324.

**Note:**

DURAN GROUP cannot accept any product liability where items are subjected to further processing. In this case the entire responsibility for quality lies with the glassworker. The latter is therefore responsible for ensuring that the further processed item conforms to current directives and safety requirements.



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. The extensive range of original accessories includes screw caps for the widest possible range of applications. Alongside the standard PP screw cap for everyday laboratory use, further caps made from various plastics and having special properties are available. DURAN® laboratory bottles are completed by suitable pouring rings from different plastics, which enable drip-free working. As almost all GL 45 bottles of 100 ml capacity and above use the same thread size, screw caps and pouring rings are fully interchangeable. The bottles, pouring rings and caps are autoclavable/sterilisable.

#### Properties

##### Light protection

- amber bottles are opaque up to 500 nm
- plastic coated bottles are opaque up to 380 nm
- Application: storage of light sensitive substances

##### High thermal shock resistance

Due to their temperature properties, the bottles are suitable for autoclaving and sterilising (see page 213, general section). Because of the bottom geometry and the wall thickness, direct heating with an unshielded flame is not recommended. When using an electronic heating plate or water bath laboratory bottles should be heated gradually.

##### Notes on use:

##### Pressure resistance

DURAN® laboratory bottles are, with the exception of the pressure-resistant DURAN® pressure plus bottles, in general not suitable for use under pressure or in a vacuum. DURAN® pressure plus bottles are pressure resistant from -1 to +1.5 bar (overpressure) due to a modified geometry and increased wall thickness.

##### Sterilisation

When sterilising or autoclaving contents, the screw cap must only be loosely fitted (max. one turn). The contents may expand or boil causing a large pressure difference in a closed vessel, which may well result in explosive failure. Alternatively, a DURAN® membrane cap may be used. Pressure equalisation takes place through the PTFE membrane, while at the same time the membrane cap can remain tightly closed, greatly reducing the risk of contamination. See also page 213, general part.

##### Cleaning

Cleaning should be carried out manually in a soaking bath or automatically in a dishwasher (see page 209, general part). When cleaning in a dishwasher, load so that there is no glass-to-glass contact (especially the threads) to avoid chips or abrasions.

##### Freezing substances

Recommendation: The bottle should be frozen slanted at an angle of 45°, filled to a maximum 3/4 (to enlarge the surface area) and dependent on the properties of any screw caps or other components used. For the blue PP screw cap the minimum temperature is -40 °C. Alternatively the Premium screw cap can be used (min. working temperature: -196 °C). See also page 206, general part.

##### Thawing frozen substances

Frozen contents can be thawed by immersing the bottle in a liquid bath while taking care that the

temperature difference between the contents and the bath does not exceed  $\Delta T = 100\text{K}$ . This will ensure that the frozen material is warmed uniformly from every side without damaging the bottle. The contents can, however, also be thawed slowly from above, so that the surface melts first, allowing the material to expand.

### Laboratory bottles with plastic coating

The coating of DURAN® Protect bottles is a resistant and transparent plastic coating based on a cross-linked copolymer.

The coating adheres securely to the glass surface and fulfils the following functions:

- Protects the glass surface against mechanical damage (scratch protection).
- Holds the fragments together in the event of the glass breaking (splinter protection).
- Minimises liquid loss if the glass breaks (protects against contents escaping and splash).
- Absorbs UV rays up to a light wavelength of 380 nm (light protection).

##### Usage tips:

- The plastic coating does not increase the pressure resistance. These bottles are designed for pressure or vacuum applications.
- If the plastic coated bottle breaks during use, the contents and the plastic coating are likely to come into contact. A test for any interaction between plastic and contents should be carried out to ensure that the contents remain unchanged and can be further used.

##### Temperature resistance

Do not expose DURAN® protect bottles to open flames or direct heat, e.g. on a laboratory hotplate. The maximum operating temperature is +135 °C and thus the bottle is suitable for use in an autoclave. Long-term exposure to temperature (> 30 minutes) should be avoided. DURAN® protect bottles can be used for freezing to -30 °C and used in microwaves. Thermal and chemical stresses can result in coating discolouration.

##### Autoclaving:

The following procedure, bearing in mind the maximum temperature resistance, is recommended:

- Steam sterilisation at +121 °C or +134 °C.
- The cycle duration should not exceed 20 minutes.

(See also page 213, general section)

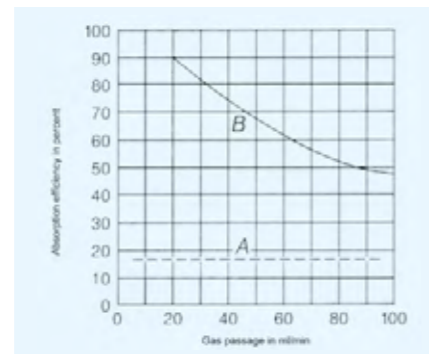
When sterilising, the screw cap should only be loosely applied (max. one turn - do not tighten), or use a membrane cap that allows pressure equalisation.





Gas washing bottles

By distributing the gas through the liquid by use of a filter disk, the gas surface is significantly increased and the interchange between gas and medium is improved. DURAN® gas washing bottles also work reliably at high flow velocities. The graph illustrates the effectiveness of gas washing bottles with and without a gas filter disk.



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

Filtering flasks with side-arm socket or plastic hose connection

DURAN® filtering flasks are vacuum tight in accordance with DIN 12 476, ISO 6556. Alongside the filtering flasks with glass hose connections, versions are also available with a side-arm socket or plastic hose connection. The ground side-arm socket with dimensions 17.5/26 is suitable for vacuum hoses from 15 to 18 mm OD (e.g. 6 x 5 mm or 8 x 5 mm, DIN 12 865). The plastic hose connections are suitable for hoses of approx. 9 mm internal diameter. The versions with side-arm socket or plastic hose connection offer improved safety for the user.

DESICCATORS

DURAN® desiccators are used for drying moist substances or as storage vessels for moisture-sensitive products. To accelerate the drying process, the desiccators can be used under vacuum. Due to the high wall-thickness of the vessels and the exact machining of the vacuum-tight ground joints on the lid and base, storage under vacuum is possible - even over extremely long periods.

All individual parts and a wide range of accessories such as lids, stopcocks, bases, etc. are compatible and can be interchanged as required. Always ensure the individual parts have the same DN (nominal diameter in millimetres).

For desiccators, the DN is based on the diameter of the sieve plate; this, or the lip it rests upon in the desiccator base, can be measured directly. For lids, measure the outside diameter of the flange and cross-reference with the tables on the product pages. An overview on page 80 indicates which individual parts are required to assemble the desired desiccator.

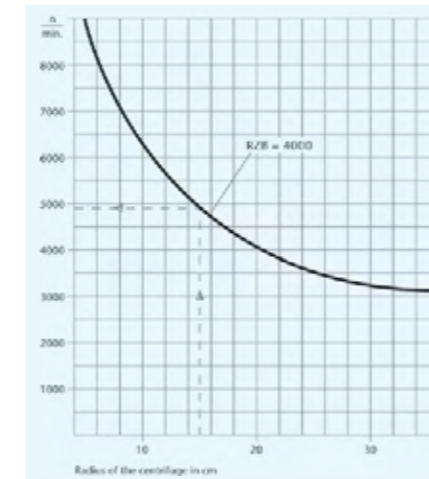
Usage tips:

- Designed for use under full vacuum (-1 bar)
- Due to the high wall thickness and the reduced thermal shock resistance under pressure loading, the desiccators must not be heated on one side only or heated using a naked flame.
- Before evacuation, it is recommended that the glass surfaces of the desiccator be checked for damage such as scratches, cracks or nicks. Damaged desiccators must not be used for safety reasons.
- Never expose desiccators to abrupt pressure changes (do not suddenly ventilate evacuated vessels).

CENTRIFUGE TUBES AND CULTURE TUBES

Centrifuge tubes

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



Calculation:  
 $RZA = 1,118 \times 10^{-5} \times r \times n^2$   
 $n = \sqrt{\frac{4000}{1,118 \times 10^{-5} \times r}}$

Example:  $r = 15 \text{ cm}$   
 Example in the diagram:  
 number of revolutions (n)  
 = 4900 min<sup>-1</sup>

Culture tubes

In addition to DURAN® culture tubes, our product range also includes soda-lime culture tubes. This is a glass belonging to the third water resistance class and is one of the soda-lime glasses with a high fraction of alkaline and alkaline earth oxides.

Properties of soda-lime glass:

Physical data		Chemical data							
Linear expansion coefficient		Hydrolytic class		(ISO 719)				3	
$\alpha_{20/300}$ to DIN 52328:	$9,1 \times 10^{-6} \text{ K}^{-1}$	Acid class		(DIN 12 116)				1	
Transformation temperature T <sub>g</sub> :	525 °C	Alkali class		(ISO 695)				2	
Temperature fixed points at viscosity $\eta$ n dPa x s:		Chemical composition							
10 <sup>13</sup> upper annealing temperature	530 °C	(main components in approx. weight %)							
10 <sup>7.6</sup> softening temperature	720 °C	SiO <sub>2</sub>	B <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O	Al <sub>2</sub> O <sub>3</sub>	Na <sub>2</sub> O	BaO	CaO	MgO
10 <sup>4</sup> working temperature	1040 °C	69	1	3	4	13	2	5	3
Density $\rho$ :	2,50 g/cm <sup>3</sup>								

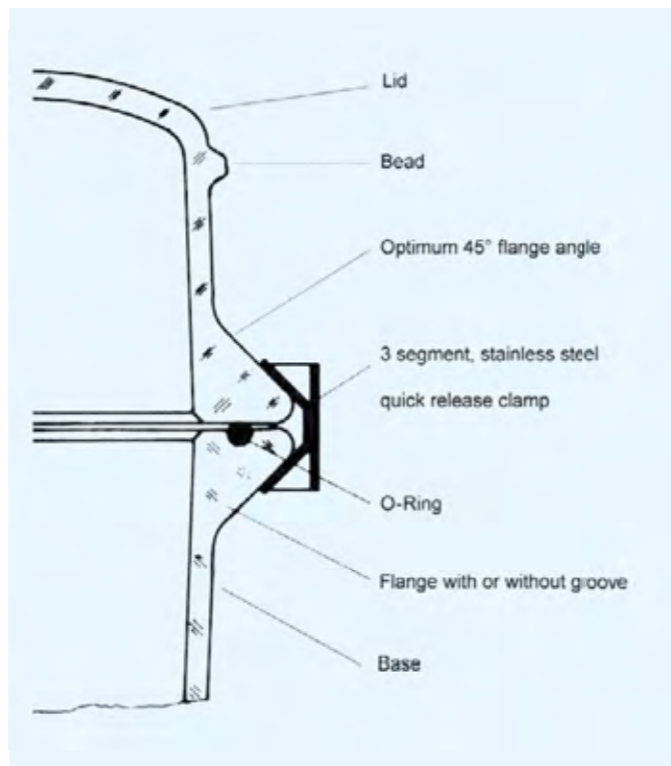
## FLAT FLANGE RANGE

The DURAN® flat flange reaction vessels are valued for their universal suitability for use in the laboratories of a wide range of specialisations. Whether for reaction, distillation, evaporation or desiccation, DURAN Group offers a wide range of unfinished and finished parts which always provide the optimum solution for the particular application. Due to the pure glass-glass connections, reactions with highly corrosive or highly chemically reactive substances can be carried out without problem.

The vessels are notable due to a robust glass flange design with an optimum flange angle of 45°. The proven flange design (flat ground) is available with groove, consequently O-Rings can be used. The corresponding stainless-steel quick release clamps with three flexible retaining clips ensure easy and safe handling. All individual parts and a wide range of accessories such as lids, O-Rings and quick-release clamps etc. are compatible and can be interchanged as required. In so doing however, you must always ensure the same DN (nominal diameter) of the individual parts applies.

### Usage tips:

- All components are suitable for use under full vacuum (-1 bar). Many are rated for positive pressure operation (see product descriptions for details)
- Before use, it is recommended that the glass surfaces be checked for damage such as scratches, cracks or nicks.
- Damaged glassware should not be used for safety reasons.
- Due to the high wall thickness and reduced thermal shock resistance under pressure loading, the flat flange vessels should be heated uniformly and gradually.



Beaded lid for safer handling of the reaction vessel

## Accessories

Flat flange reaction vessels can be sealed by:

- a) O-rings (see below) for use at positive and negative pressures up to max. 230 °C (O-ring dependent)

- b) Grease for use at positive and negative pressures above 230 °C

### Advantages:

- Easy to open
- The lid does not stick, even after operation for long periods under vacuum and at high temperatures
- Reduced need to grease contact surfaces

### Advantages:

- Flange groove acts as an ideal grease groove
- No substance contamination

The stainless steel quick release clamps with three holding segments are optimally designed to provide even distribution of contact pressure. The chromium nickel steel support comprising two clamping rods is designed for secure fitting of the reaction vessels or the lids in support bar. 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

Comprising an elastic, silicone core with a seamless FEP coating that encloses the ring. The combination of these high-quality materials ensures good elasticity in conjunction with outstanding chemical resistance. The chemical resistance of FEP (tetrafluoroethylene hexafluor-propylene copolymer) is equal to that of PTFE. Hence the material is resistant to almost all chemicals and is suitable for temperature from -200 °C to +200 °C.

### Silicone (VMQ) O-rings

These O-rings are made solely from silicone (VMQ) and therefore are highly elastic. Their chemical resistance, however, is reduced in comparison with FEP coated O-rings. Temperature resistance extends from -50 °C to +230 °C.

	Elasticity/recovery	Temperature resistance	Chemical resistance	Solvent resistance	Physiologically harmless
O-Rings, red FEP coated	+	++	++	++	++
O-Rings, transparent made of silicone (VMQ)	++	++	+	+	++

++ = very good resistance  
+ = good resistance

## FILTERS AND FILTRATION APPARATUS

### Porosity

DURAN® filters and the corresponding filter plates are precision manufactured from DURAN® borosilicate glass 3.3 with its high chemical and thermal-shock resistance. They are entirely inorganic and inert in most circumstances. There are therefore no leachable organic or ionic species present that could otherwise contaminate the filtrates. They are ideal for separations, e.g. with strong acids or alkalis and can likewise be readily cleaned and reused. DURAN® filter products have a maximum operating temperature of +450 °C.

DURAN® filtration vessels are specially optimised to the matching filtration apparatus (eg funnels with guko adapters) and are vacuum-tight due to their special geometry and high wall thickness. Their designs have been approved by the TÜV accreditation body and marked with the "GS" indication were appropriate; see specific products for details.

Porosity measurement is by the Bechhold bubble pressure method, which is widely described in the literature<sup>1</sup>. 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 DURAN® glass filters stand out.

Prerequisite for the successful use of glass filters is selection of the correct porosity. In this respect, the following table lists 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 prevent infiltration of particles into of the pores.

For quantitative analysis applications, porosity 3 or porosity 4 glass filtration apparatus is used almost exclusively. Different working methods often contain different porosity indications here for the same materials. This is because different processes used in the production of precipitations for gravimetric analysis often result in different grain sizes.

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

### Flow rate

To determine the possible applications 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 given in Figures 9 and 10 for water and air. The data applies to 30 mm diameter filter disks.

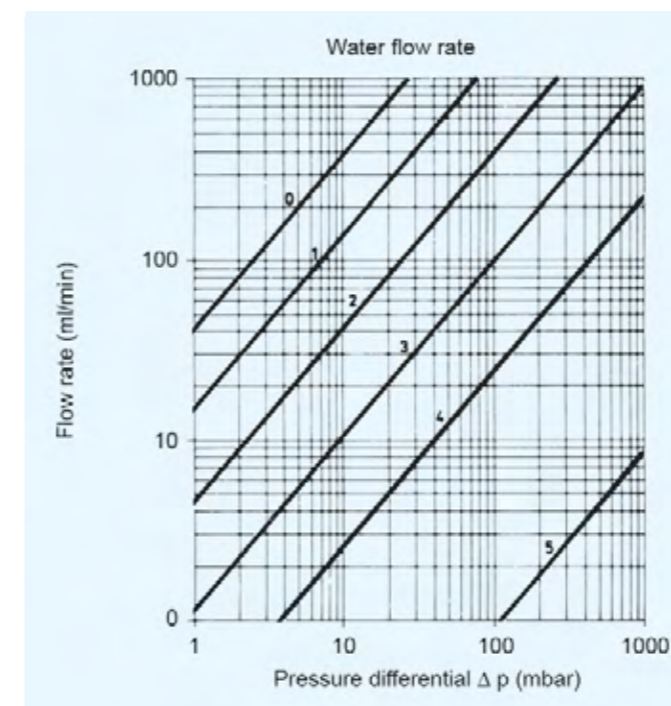
The flow rates for other disk diameters can be calculated by multiplying the value read off by the conversion factor given in Table the following table:

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

### Example:

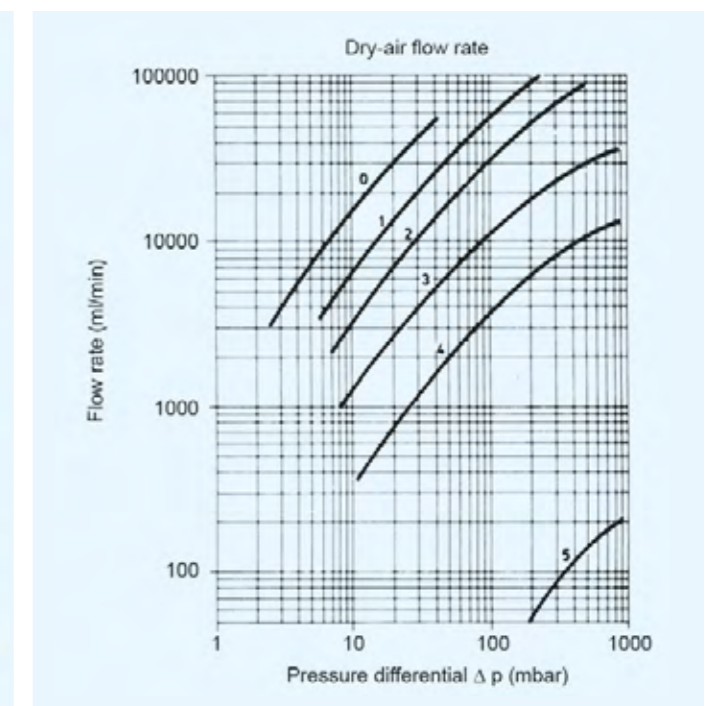
Suction filtration of an aqueous solution under vacuum using a suction filter with a 60 mm disk diameter and porosity 4. Figure 9 gives a flow rate of 200 ml/min for a pressure differential of about 900 mbar. Table 8 gives a flow volume of 200 x 2.5 = 500 ml/min for a 60 mm disk diameter. As the flow rate is heavily dependent on the pore diameter (pore radius to the power of 4), deviations from the values indicated may occur. Flow can also be obstructed by the formation of a filter cake over the surface of the filter disk. Further changes to the flow rate occur if liquids are used whose viscosity differs from that of water. The resultant flow rate is then inversely proportional to the viscosity. Differences for gases result when using filter disks that are coated with water or other liquids (gas flow in washing processes). More detailed information can be found in the literature<sup>1</sup>.

### Water flow rate



Water flow rate through filter discs of various porosities as a function of pressure differential. For filter discs with Ø 30 mm

### Dry-air flow rate



Air flow rate through filter discs of various porosities as a function of pressure differential. For filter discs with Ø 30 mm

<sup>1</sup> Frank, W: GIT (1967) Iss.7 pp. 683-688

### Care and cleaning of filtration apparatus

In addition to the information in the general section on page 209, please also note the following guidelines relating to thermal stresses, which apply specifically to filtration apparatus, in order to avoid glass breakage.

#### Temperature changes (thermal shock), drying and sterilisation

- The maximum permissible operating temperature is +450 °C.
- Uniform heating is recommended to avoid thermal stresses and resultant breakages.
- Heat glass filtration apparatus with disk diameters of more than 20 mm in initially cold ovens or sterilisers only.
- The heating or cooling rate should not exceed 8°C/min.
- When filtering hot substances avoid temperatures differences of more than 100 K; if necessary, preheat the filtration apparatus in a drying cabinet.
- 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 be stood on its rim (stem upwards) to allow air convection between the inside of the vessel and the oven chamber. 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 placing heat-insulating material under it.

#### Cleaning new glass filtration apparatus

Before using glass filtration apparatus for the first time, it should be rinsed with water (if applicable, acid), to remove any minor contamination that may be present.

#### Mechanical cleaning

In many cases, if no precipitate has infiltrated the pores, simple spraying of the surface (e.g. with a spray bottle) will suffice. Brushes or rubber wipers can also be used to clean the surface of the filter disk. If some precipitate has infiltrated into the pores, then back-flushing of the disk is required.

#### Important instructions:

- Glass filters should always be cleaned immediately after use.
- Do not use sharp objects to remove the filtrate to prevent damage to the filter surface.

### 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 used depends on the nature of the contamination (see example in the following overview).

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	acetone, isopropanol
Other organic substances	hot conc. sulfuric acid with addition of nitric acid, sodium nitrate or potassium dichromate

When chemical cleaning is completed, it should be followed by thorough rinsing with copious amounts of water. Use of hot concentrated phosphoric acid and hot alkali solutions is not recommended, as these may attack the glass surface.

#### Screwfilters with interchangeable filter disks

With 3 filter sizes, each having 4 filter disks of varying porosity, 12 different filter rates are available. 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. No. 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.

#### Note:

The filter disk should be located between 2 FKM gaskets.



## VOLUMETRIC PRODUCTS

DURAN® volumetric products have closely calibrated scales that permit very accurate determination and measurement of volumes. They are available in two accuracy classes: class A/AS and class B. The two classes differ in the accuracy of measurement with class A being the highest accuracy, and class B is approximately half that of class A. Class AS has the same tolerances as class A, but is designed to permit more rapid outflow; it is applicable to burettes and pipettes.

### Volumetric flasks

DURAN® volumetric flasks are manufactured from the chemically highly resistant borosilicate glass 3.3. Used for the accurate measurement of specific quantities of liquid they are, like virtually all volumetric glassware, volumetric analysis aids. They are mainly used for preparation and storage of standard solutions. Calibration is based on the amount of fluid contained ("In") at a +20 °C reference temperature, which means that when the circular graduation mark is reached, exactly the specified liquid amount is contained in the vessel. Thus the desired concentration can be precisely set. The volume content tolerances for volumetric flasks conform to accuracy class A, the accuracy limits of the German weights and measures regulation and to DIN and ISO guidelines.

### Measuring and mixing cylinders

DURAN® measuring and mixing cylinders are manufactured from borosilicate glass 3.3 and therefore are very resistant to mechanical and thermal stresses. Measuring cylinders are for holding and simultaneously measuring different liquid amounts. Mixing cylinders are for diluting solutions and mixing several components in a given quantity ratio. Their large hexagonal base prevents the cylinder from rolling. The base is equipped with three knobs that increase its stability. The cylinders have uniform wall thickness over the entire measurement range, so wedge errors are avoided. Calibration is based on contained fluid ("In") at a +20 °C reference temperature, which means that when the circular graduation mark is reached, exactly the specified liquid amount is contained in the vessel. Thus the desired concentration can be precisely set. Volume content tolerances for measuring and mixing cylinders conform to DIN and ISO accuracy limits.

### Burettes

DURAN® burettes are manufactured from chemically highly resistant borosilicate glass 3.3. They are primarily used for titration. The precise scale permits exact reading of the liquid quantity required for the titration. Calibration is based on the released volume ("Ex") at a +20 °C reference temperature. The fluid quantity released can be taken exactly from the scale, as the liquid adhesion to the glass is taken into account in the calibration. This only applies, however, if the specified waiting times for reading the scale are adhered to. Volume content tolerances for burettes conform to DIN and ISO accuracy limits. The DURAN® Class B burettes' accuracy limits are roughly one and a half times the Class AS accuracy limit. The tolerances are thus stricter than specified by DIN.

By the specification of a class "AS", the German weights and measures regulations have, within the scope of the 15th Amendment Regulations, acknowledged 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 draining times than previously required but with the same accuracy limits is now admitted by the calibration regulations.

Capacity ml	Accuracy limits class AS suitable for official calibration DIN 12 700 ± ml	Accuracy limits class B	
		DIN 12 700 ± ml	DURAN ± 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 <sup>1</sup>	0.08	0.2	0.15

<sup>1</sup> Non-DIN size.

### Pipettes

Measurement and bulb pipettes are made from soda-lime glass (see page 219, for more information on soda-lime glass). Pipettes are for precise measurement and filling of liquids. Measurement pipettes are graduated to permit the taking up of varying liquid quantities and then dispensing of the same or different amounts. Bulb pipettes are designed to repeatedly take up and discharge a fixed volume for each pipette size. Calibration is based on the released volume ("Ex") at a +20 °C reference temperature. The fluid quantity released can be taken exactly from the scale, as the liquid adhesion to the glass is taken into account in the calibration. This only applies, however, if the specified waiting times for reading the scale are adhered to. Volume content tolerances for calibrated pipettes conform to DIN and ISO accuracy limits. DURAN® Class B pipettes' accuracy limits are roughly one and a half times the Class AS accuracy limit. The tolerances are thus stricter than specified by DIN.

By the specification of a class "AS", the German weights and measures regulations have, within the scope of the 15th Amendment Regulations, acknowledged 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 draining times than previously required but with the same accuracy limits is now admitted by the calibration regulations.

Capacity ml	Accuracy limits class AS suitable for official calibration ISO 385 ± ml	Accuracy limits class B	
		ISO 385 ± ml	DURAN ± ml
0.1 <sup>1</sup>	-	-	0.003
0.2 <sup>1</sup>	-	-	0.004
0.5	-	0.01	0.008
1	0.006	0.01	0.008
2	0.010	0.02	0.015
5	0.030	0.05	0.040
10	0.050	0.10	0.080
25	0.100	0.20	0.150

<sup>1</sup> Non-ISO size, graduated pipettes 0.1 and 0.2 ml are calibrated to contain ("In").

### Usage tips:

- To ensure a long service life for your volumetric glassware and to exclude possible volume changes, these products should not be heated above +180 °C in drying cabinets or sterilisers.
- Never heat volumetric glassware on a hot plate.
- Always heat up and cool down volumetric glassware gradually, to avoid thermal stresses and thus any possible breakage of the glass.

## GLASS-CERAMIC LABORATORY PROTECTION PLATES

Due to low thermal expansion stresses, these glass ceramic plates are well suited to heating glassware with a Bunsen burner.

### Energy and time savings

The high transparency to infrared radiation means heat energy is transferred to the material being heated with low losses that shortens heating time and results in energy savings of 20% or more. In addition, several vessels can be placed on the plate's square, stable surface.

### Chemically resistant

When working in the laboratory it is impossible in practice to avoid aggressive media boiling over or spilling. The glass-ceramic laboratory protection plate is resistant even against highly corrosive media.

### Trouble-free cleaning

The pore-free smooth surface of the glass-ceramic laboratory protection plate can be cleaned easily either manually or mechanically.

### High temperature resistance

Service temperature from  $-200\text{ }^{\circ}\text{C}$  to  $+700\text{ }^{\circ}\text{C}$ . The glass-ceramic laboratory protection plate is may be used continuously at high temperatures. Durability at  $700\text{ }^{\circ}\text{C}$ : 6000 h; at  $750\text{ }^{\circ}\text{C}$ : 750 h. Even when a hot plate is quenched with cold water, there is no risk of breakage, since it is resistant to thermal shock even with a  $\Delta T > 650\text{K}$ . To avoid overheating, care must be taken not to exceed the above-mentioned limits when working with a Bunsen burner. The glass-ceramic laboratory protection plate retains its shape, remains flat and does not age.

**Note:** Further information about DURAN® laboratory glassware is available upon request.

