Pressure resistant oblong toughened borosilicate glass panes for sight glasses for unrestricted use at low temperatures

DIN 7081

ICS 71.120.10

Supersedes
February 1996 edition.

Lange Schauglasplatten aus Borosilicatglas für Druckbeanspruchung ohne Begrenzung im Tieftemperaturbereich

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Foreword

This standard has been prepared by Technical Committee *Schaugläser und Fassungen* of the *Normenausschuß Chemischer Apparatebau* (Process Engineering Standards Committee).

Amendments

This standard differs from the February 1996 edition as follows.

a) The scope of the standard has been extended to cover sight glasses for use at fluid pressures of up to 100 bar.

b) General operating temperatures now apply.

c) The maximum allowable operating temperatures for continuous service have now been increased to 300 °C, subject to the conditions set out in subclause 4.2.2.

Previous editions

DIN 7081: 1975-08, 1996-02.

All dimensions are in mm.

1 Scope

This standard specifies dimensions, materials and requirements for new, pressure resistant oblong panes for sight glasses, made of reflective or transparent thermally toughened borosilicate glass, which are designed to withstand a continuous one-sided fluid pressure at the temperatures given below. [1])

It covers:

a) unprotected reflective or transparent panes designed for continuous exposure to saturated steam or hot water pressure up to 35 bar and a temperature up to 243 °C;

b) mica-film protected, transparent panes designed for continuous exposure to saturated steam or hot water pressure up to 70 bar and temperatures up to 300 °C (cf. subclause 4.2.2);

c) panes designed for continuous exposure to non-aggressive media at a temperature up to 280 °C. Under special conditions (cf. subclause 4.2.2), panes may be used at temperatures up to 300 °C.

This standard does not apply restrictions to the use of borosilicate glass panes below ambient temperature.

If glass panes are to be used at the maximum temperatures and pressures specified, care should be taken to ensure that the requirements specified in clause 10 are complied with.

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[1]) If glass panes are to be exposed to higher pressures or temperatures, this is subject to agreement between manufacturer and customer (cf. Explanatory notes).

Continued on pages 2 to 8.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

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2 Normative references

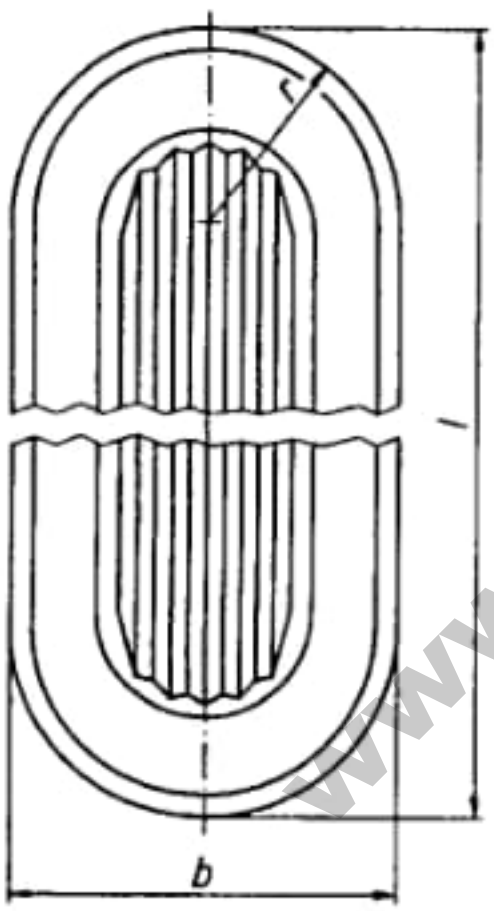
This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 52328	Determination of mean thermal expansion coefficient of glass
ISO 695 : 1991	Glass – Resistance to attack by a boiling aqueous solution of mixed alkali – Method of test and classification
ISO 718 : 1990	Laboratory glassware – Thermal shock and thermal shock endurance – Test methods
ISO 719 : 1985	Glass – Hydrolitic resistance of glass grains at 98 °C – Method of test and classification
ISO 1776 : 1985	Glass – Resistance to attack by hydrochloric acid at 100 °C – Flame emission or flame atomic absorption spectrometric method
ISO 2859-1 : 1989	Sampling procedures for inspection by attributes – Sampling plans indexed by acceptance quality level (AQL) for lot-by-lot inspection

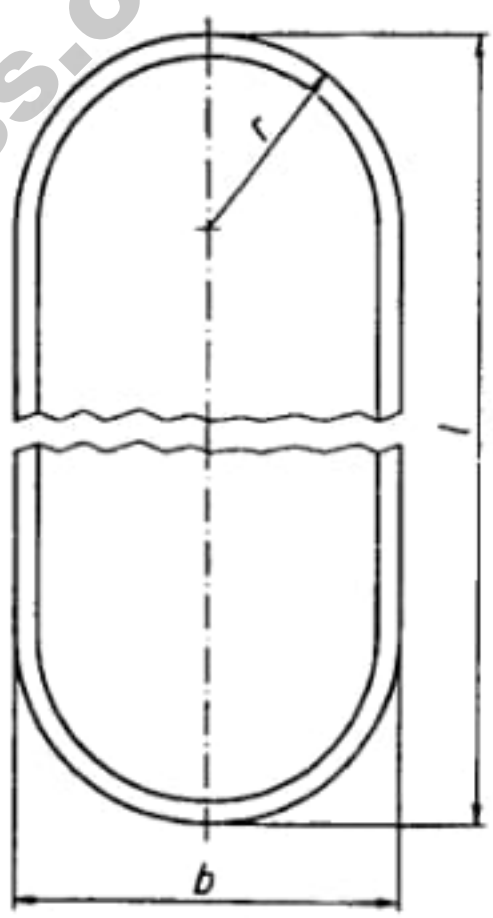
3 Dimensions and designation

The design shown here is for illustrative purposes only. Oblong panes shall, however, comply with the dimensions specified.

Type R Reflective pane



Type T Transparent pane



a) Exposed surface

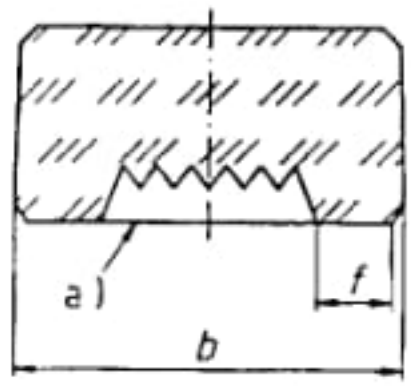
Figure 1: Oblong panes

Designation for an oblong borosilicate glass pane, type R, of a length, l, of 250 mm and a width, b, of 34 mm:

Pane DIN 7081 – R 250 × 34

Table 1: Dimensions

Width, b	Radius, r	Length, l									
30	15	140	165	190	220	250	280	320	340	–	–
34	17									370	400

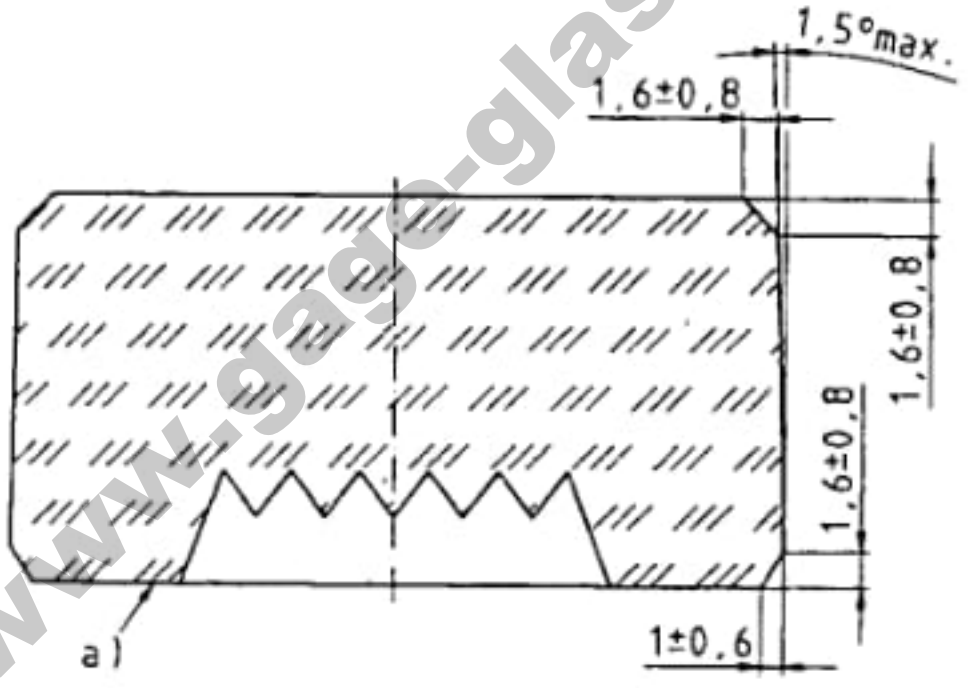


a) Exposed surface

Figure 2: Contact faces of pane

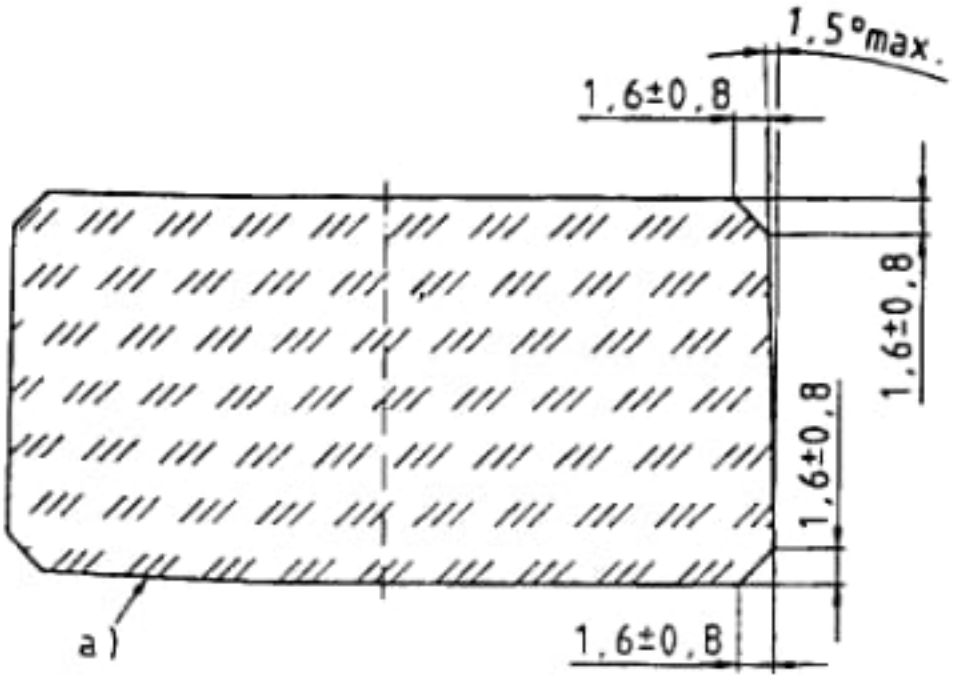
Table 2: Width of contact face

Pane width, b	Minimum width of contact face, f
30	5
34	6



a) Exposed surface

Figure 3: Edges of reflective panes



a) Exposed surface

Figure 4: Edges of transparent panes

4 Material

The material used for panes shall be thermally toughened borosilicate glass fulfilling the requirements given in subclauses 4.1 to 4.4.

4.1 Strength

Panes with an initial flexural strength of about 40 N/mm^2 shall be toughened so that the compressive stress induced is not less than 80 N/mm^2 (cf. Explanatory notes).

4.2 Thermal properties

4.2.1 Mean coefficient of linear thermal expansion

The mean coefficient of linear thermal expansion, α (20 °C/300 °C), shall not exceed 5,0 · 10^{-6} · K^{-1} when panes are tested as in DIN 52328.

4.2.2 Operating temperatures

Panes designed for continuous service shall resist temperatures up to 280 °C.
Temperatures exceeding 280 °C may cause the induced compressive stress to be relieved, reducing it to approximately 90 % of its initial value following a service of 300 hours at 300 °C. Panes may be used at temperatures between 280 °C and 300 °C provided the pane is protected using mica-film, and the service hours at temperatures above 280 °C total no more than 300.

4.2.3 Thermal shock endurance

When tested in accordance with subclause 7.3, panes shall resist temperature differences of up to 230 °C (cf. ISO 718).

4.3 Chemical resistance

Panes shall fulfil the following requirements:

- hydrolytic resistance: class HGB 1, as specified in ISO 719;
- hydrochloric acid resistance: up to 100 µg Na_2O per 100 cm^2, as specified in ISO 1776;
- alkali resistance: class A2, as specified in ISO 695 (cf. Explanatory notes).

4.4 Imperfections

The following requirements shall be fulfilled to ensure that the mechanical strength and transparency of panes are not impaired.[2]

4.4.1 Blisters

Blisters with a diameter greater than 2 mm, oval blisters for which the sum of the breadth and length divided by 2 is greater than 2 mm, and tear-shaped blisters are not permissible.
The number and size of round blisters shall not exceed specifications given in table 3.

Table 3: Permissible number of blisters

Diameter of blisters, d	Length of pane, l	
	Up to 250	Over 250
Less than 0,3	3 per cm^2 of pane surface	
From 0,3 to below 0,5	10 per pane	15 per pane
From 0,5 to below 1	4 per pane	6 per pane
From 1 up to 2	2 per pane	3 per pane

4.4.2 Knots and streaks

Obvious knots and streaks are not permissible.

4.4.3 Solid inclusions

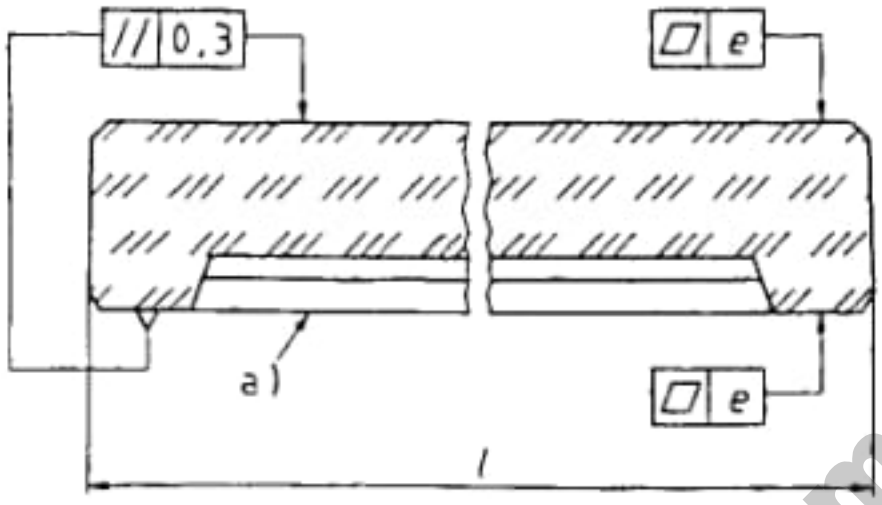
No more than three solid inclusions are permissible per pane, and they shall not be greater than 0,6 mm in diameter.

5 Finish

Panes shall be toughened as specified in subclause 4.1 (cf. Explanatory notes). The top and bottom of the pane shall be bright or polished, and the side face ground or polished (at the manufacturer's discretion). Edges shall be chamfered (pressed or ground, at the manufacturer's discretion).

Where, for manufacturing reasons, the side face of panes is to be bevelled to an angle of 1,5°, the width and length of the pane shall be the largest measures taken (cf. figure 4).

6 Tolerances



a) Exposed surface

Figure 5: Flatness and parallelism
(illustration shows type R[1])

6.1 Limit deviations

Table 4: Limit deviations

Limit deviations for	Width of pane		
	30 Length		Above 30
	250 or less	Above 250	Any length
length, l	± 0,8	± 1,0	0 - 1,5
width, b	± 0,8	± 0,8	+ 0,2 - 0,8
thickness (17 mm)	± 0,5	+ 1,5 - 0,5	± 0,5

6.2 Flatness tolerances

Table 5: Tolerance on flatness, e

Length, l	Tolerance, e
Up to 165	0,05
Over 165 up to 220	0,08
Over 220	0,13

[1]) The geometrical tolerances illustrated also apply to type T panes.

7 Testing

The manufacturer shall be responsible for testing the properties of panes as specified in clauses 3 to 6 and shall declare compliance by marking the products in accordance with clause 8.

7.1 Checking for compressive stress

Prior to sampling and testing in accordance with subclauses 7.2.1 and 7.2.2, the surface of each pane, held horizontally and viewed from above, shall be checked for clearly drawn, isochromatic oval lines running parallel to the edges (cf. figure 6).

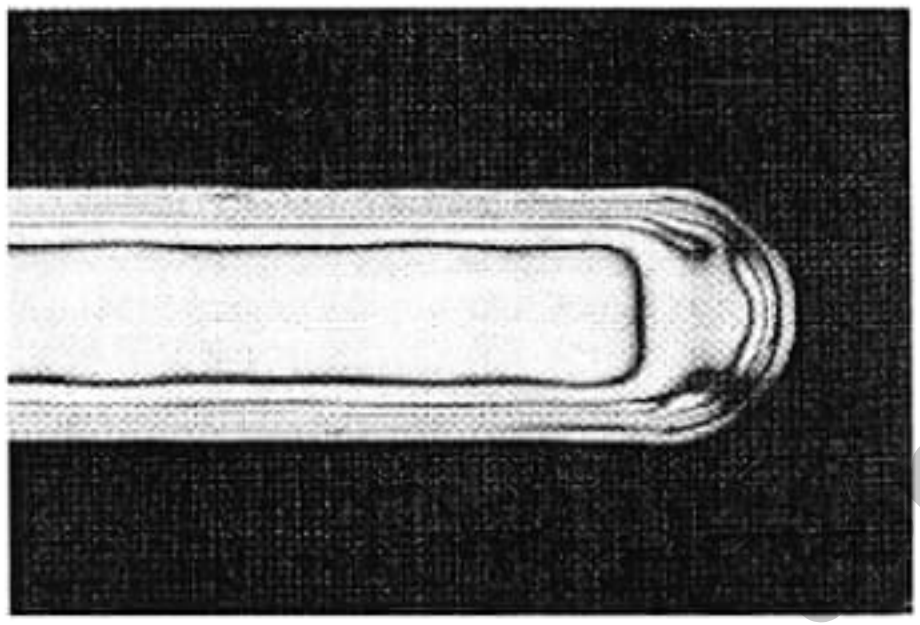


Figure 6: Glass pane viewed under polarized light

7.2 Bend test

7.2.1 Number of samples

Testing shall be performed on a predetermined number of samples taken in accordance with the following sampling plan:

1 sample for batches of less than 20 panes;

2 samples for batches of 20 to 50 panes;

3 samples for batches of more than 50 panes.

7.2.2 Procedure

Perform circular wet grinding on the centre area of one side of the sample covering an area equal to $0{,}5 \times l$ in diameter. Type R panes are to be ground on their flat side. Use grain size 220 emery paper taken from a single batch to avoid differing results, and draw it over a metal blade so that grinding does not cause streaks.

Then subject the sample to a three-point loading test until it fractures. To prevent injuries caused by shattering glass, samples should be wrapped in plastic film prior to loading.

The rupture stress of the sample, σ_{BG}, shall be calculated as a function of the maximum force at rupture, the minimum section modulus, and the span (distance between supports). Panes have passed the test if they satisfy the following condition:

$$\sigma_{BG} - \sigma_{BU} = \sigma_{DV} \geq 80 \text{ N/mm} \qquad (1)$$

where

σ_{BG} is the rupture stress of toughened panes, in N/mm²;

σ_{BU} is the rupture stress of non-toughened panes, in N/mm²;

σ_{DV} is the induced compressive stress determined by the test, in N/mm².

σ_{BU} shall also be determined for panes that have been heated and then gradually cooled, by subjecting them to a three-point loading test. σ_{BU} may also be derived from the average obtained during internal control checks, the most recent results being no older than six months.

7.3 Thermal shock endurance test

Select samples in accordance with subclause 7.2.1, heat them to 250 °C, then immerse them in a water bath maintained at a temperature of 20 °C for at least one minute, and check them for fractures.

7.4 Dimensional check

Check the dimensions of samples (length, width, thickness, flatness and parallelism) using acceptance quality level *AQL* 10 as specified in ISO 2859-1. Samples intended for testing in accordance with subclauses 7.1, 7.2 and 7.3 may be used for this check.

7.5 Test report

The results of testing shall be recorded, and the test report made available to the purchaser upon request. The report shall include the following details:

- symbol identifiying the batch;
- values determined for σ_{BG}, σ_{BU}, and $\sigma_{BG} - \sigma_{BU}$;
- statement that all items of the batch have passed the check for compressive stress;
- results of the thermal shock endurance test;
- results of the dimensional check.

8 Marking

As shown in figure 7, the surface of the pane which is not to be exposed to pressure shall be durably marked with the DIN number.

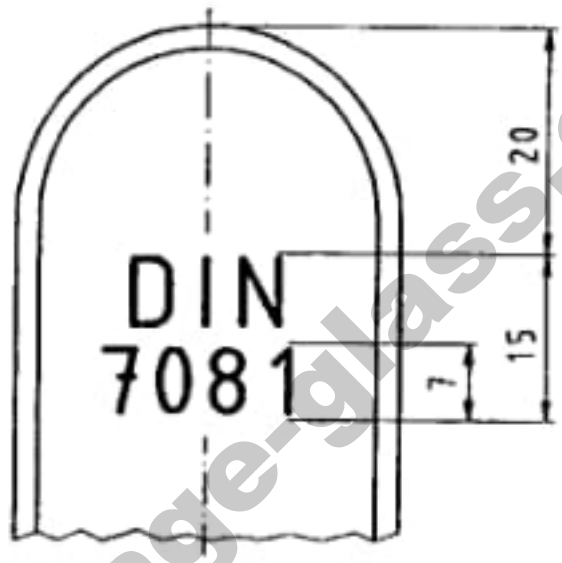


Figure 7: Area for marking

The name of the manufacturer or trade mark and the symbol identifying the batch shall be marked on the side face of the pane. The symbol shall provide a clear reference to the relevant test report.

9 Packaging

The panes shall be packaged individually in order to ensure safe transportation and storage. Otherwise, packaging shall be at the manufacturer's discretion.

10 Framing of panes

In order to withstand service pressures, the panes shall be mounted in rigid, evenly tightened frames, with the larger surface of the pane as the inside of the sight glass.

The personnel responsible for framing panes shall be instructed to handle them carefully and to clean all parts making up the sight glass (i.e. the frame, pane, gasket and fittings) before assembly in order to exclude foreign elements.

Used panes shall be discarded when sight glasses are dismantled.

Explanatory notes

Mechanical strength

Panes for sight glasses should be made from borosilicate glass so that they are resistant to pressure, thermal shock and chemical attack. In order to withstand the stress caused by the frame or the fluid pressure, panes are to be thermally toughened, so that the initial flexural strength of about 40 N/mm² is increased, and a minimum compressive stress of 80 N/mm² is induced. To prevent the pane from shattering, care should be taken that no tensile stress is induced in the glass surface either by framing or the fluid pressure. If the glass has not been prestressed, the stress created as a result of framing may cause the pane to fragment. A higher compressive stress also improves the thermal shock endurance of panes.

Since panes are more frequently damaged as a result of tensile stresses induced during framing than by fluid pressure or thermal expansion, this standard has established the rupture stress as a function of the average tensile stress induced during framing.

Panes for vessels operated at pressures up to 10 bar need not be toughened. However, panes must be prestressed before being framed. Non-toughened panes may be used at temperatures up to 430 °C. They are common in systems operated with heat transfer media other than water, and in petrochemical units.

Panes that have been used at temperatures above 280 °C, beyond which a reduction of the induced compressive stress is likely, should be discarded once they have been removed from their frame. Safety regulations require that panes that are used above this temperature should not be subjected to thermal shock.

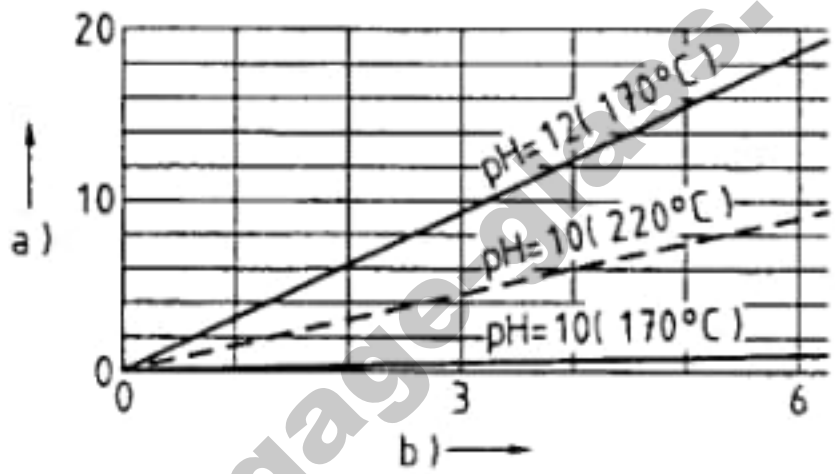
One method of assessing the degree of compressive stress existing in a sample is to compare the fracture pattern with that of a pane, the flexural strength of which is known.

As it is an acknowledged fact that sight glasses subjected to cold water pressure do not burst below a pressure of 300 bar, this standard does not require cold-water hydrostatic pressure tests to be carried out.

Resistance to chemical attack

If sight glasses are used in boilers, a loss in mass may occur, increasing exponentially as a function of the operating temperature and pH value of the aqueous medium. This effect is enhanced by the type and amount of chemicals added for water treatment and may eventually result in a distortion of the pane, impairing safe operation. One of the major factors influencing the loss in mass is the alkalinity of the media. The other is the temperature, particularly in cases where panes are subjected to temperatures far above 200 °C.

The loss in mass caused by the chemical attack of two solutions with a different pH value at 170 °C within a given period is illustrated in figure 8. The broken line represents standard laboratory conditions, i.e. the loss in mass caused by the attack of a solution with a pH of 10 at a temperature of 220 °C.



a) Loss in mass, in mm
b) Time, in months

Figure 8: Loss in mass

Bibliography

ISO 1101 : 1993 Technical drawings – Geometrical tolerancing – Tolerancing of form, orientation, location and run-out – Generalities, definitions, symbols and indications on drawings

[1] Novotny, V and Kavka, I., Stress relaxation in toughened glass, Glass Technology, 1977: **18** (5).

[2] Jebsen-Marwedel, H. and Brückner, R. *Glastechnische Fabrikationsfehler* (Imperfections in glass products). *Springer Verlag*: Berlin, Heidelberg, New York.