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Glass lining G2208

The glass-lining

Glasscoat's aim is to be recognised on the market for its considerable innovative ability in formulating glass linings. The G22 glass lining, used successfully for some time on the entire production range, has been further improved with the G2208, with superior chemical and physical characteristics, which has already been tested and approved by important customers.

Certain chemical and physical characteristics are shown in the table.

Schematically the procedure for applying the glass lining is divided into the following stages:

- Normalising treatment of the equipment at the end of fabrication to a temperature of 920°C in an electric furnace, to relieve internal stresses in the steel and to eliminate traces of oil and grease.
- First sandblasting.
- Penetrant liquid check to eliminate even the smallest surface defects on the sheet steel and on the welds.
- Second sandblasting.
- Application and firing in the furnace at 910°C of the base coat, which is required to create a chemical bond between the carbon steel and the cover coat.
- Check after firing of the ground coat, application and firing in the furnace of the first layer of the cover coat at a temperature of between 800°C and 850°C.
- Check after firing of the first layer of the cover coat, application and firing of the second layer.
- Check after firing, measurement of the thickness, dielectric testing to 20.000 Volts and application of the third layer.
- Repetition of the previous stage until the quality and thickness of the glass lining have reached the requirements provided by standards, by internal specifications and by the needs of the customer.

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The method of application of the glass lining used by 3V Glasscoat is technically known as “spray/dust”, and involves the application of a suspension of glass slip in water and in the subsequent application, over the wet layer, of dry glass powder only.

In this way, compared to the classic method of spraying a liquid suspension, less coats are required (4 heat treatments against the 5 or 6 normally carried out) resulting in less heat strain on the equipment in the furnace.

These benefits are particularly important with columns and special equipment.

The chemical and physical characteristics of our glass linings (base coat and cover coat). The innovative technologies developed for:

- The preparation of the liquid suspension and the powder.
- The check and preparation of the surfaces before application.
- The application of the spray-dust coat using a particular process.
- The programmed firing cycles.
- The checks after each firing.
- The extremely strict final inspection enable us to carry out, if requested, a dielectric check to 30.000 Volts.

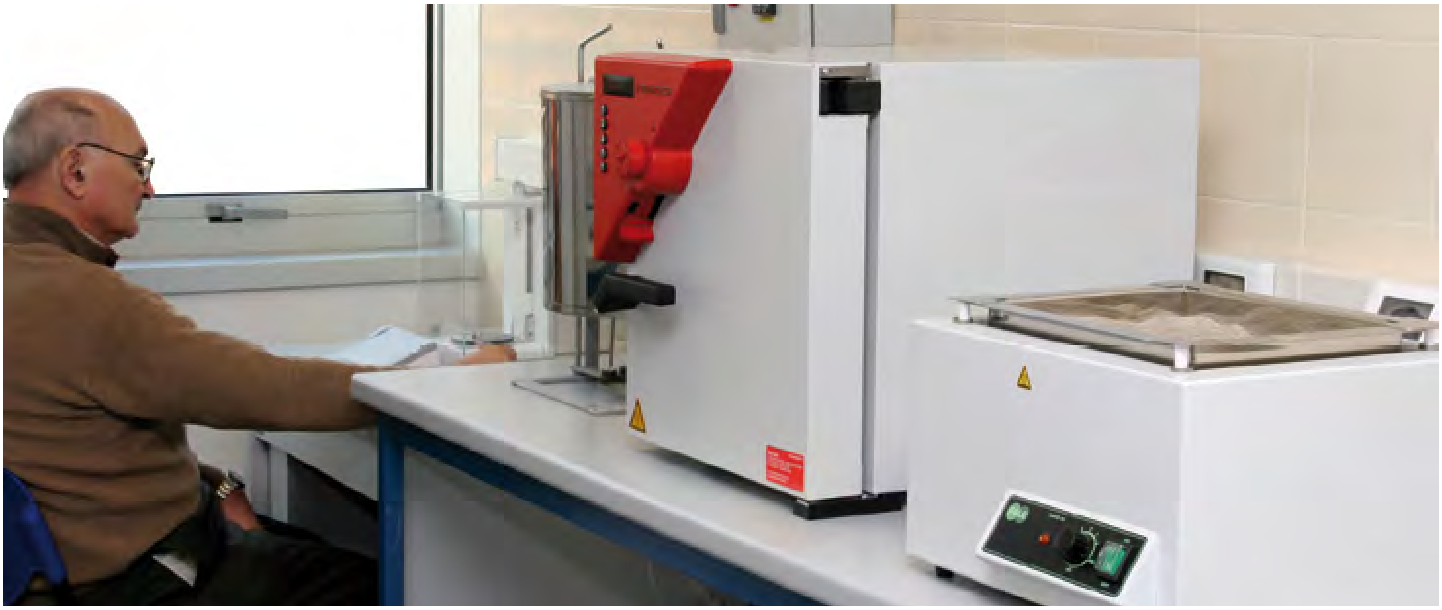
This ensures a smooth and compact vitreous layer without the presence of underlying microbubbles and without the smallest imperfection, thus guaranteeing better quality and a longer life even when used with very harsh process conditions.

General information regarding the glass lining	
Colour	Blue, light blue and white
Applied thickness	1,0 – 2,2 mm
Specific weight	2,5 kg/dm^3
Chipping tendency	None if subjected to normal conditions of use
Flexibility	Bends until permanent deformation of the steel
Tensile strength	Resists until the yeld point of the steel
HV hardness	650 – 700
Thermal conductivity	1,2 W/mK
Specific heat	0,9 kJ/kgK
Electrical resistivity	1012 - 1014 Ω/cm at 20°C
Dielectric rigidity	30 - 35 kV/mm
Surface condition	Extremely smooth, shiny, easy to clean, impermeable to gas, with good resistance to wear.
Quality control	EN 15159 - 1,15159 - 2,15159 - 3

Chemical resistance of the glass lining G2208		
Type of test	Reference standard	Speed of corrosion
20% HCl vapour at boiling point	EN 14493 - 2	0,03 mm/year
20% HCl liquid at 140°C	EN 14493 - 5	0,17 mm/year
0,1N NaOH liquid at 90°C	EN 14493 - 4	0,16 mm/year

Resistance to thermal shock of the glass lining G2208		
Type of test	Reference standard	Speed of corrosion
Statiflux crack formation temperature	ISO 13907	220°C

Glass lining G2208



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The G2208 glass lining has excellent resistance to all types of chemical products, both organic and inorganic, oxidising or reducing, both chlorinates and non-chlorinates, with the exception of hydrofluoric acid and fluoridated substances, if in an acid environment, since the fluoride ions attack the siliconoxygen bond in the glass lining, even at very low concentrations and temperatures.

Other exceptions include concentrated basic products at medium to high temperatures and very concentrated phosphoric and phosphorous acid at high temperatures.

In the area below the yellow line, the G2208 glass lining has excellent resistance, regardless of the type of product (with the only exception being hydrofluoric acid). In the area between the yellow and white lines, the resistance of the glass lining depends on the type and concentration of the product.

In the area above the white line, the glass lining is not resistant. Corrosion is practically inexistent with anhydrous organic products.

The mechanism corrosion for glass linings is completely different and much simpler compared to that of steel. Metals, being conductors, undergo electrochemical attack. Glass linings, being non-conductors, undergo, in the case of an acid attack, a reaction of ionic exchange.

In other words, the corrosion mechanism with acid products in an aqueous solution is a simple reaction between the alkaline and earth alkaline ions present on the surface of the glass lining and the hydrogen ions. In the case of a basic attack undergo a reaction of solubilisation.

As a consequence a film of hydrated silica is created which slows down the further progress of corrosion. The greater the ionic strength of the acid solution, the greater the corrosion.

The silicon-oxygen bond is practically inert to this type of attack. With basic products, the reverse occurs and the silicon-oxygen bond is attacked, therefore as a rule the resistance to corrosion is lower.

The graphs show the resistance to corrosion of the G2208 glass lining with certain important acids and bases. With a corrosion rate of up to 0,1 mm/year, corrosion is not a problem. With a corrosion rate of more than 0,1 mm/year and up to 0,2 mm/year, we recommend using the equipment only occasionally and/or checking the integrity of the glass lining more frequently.

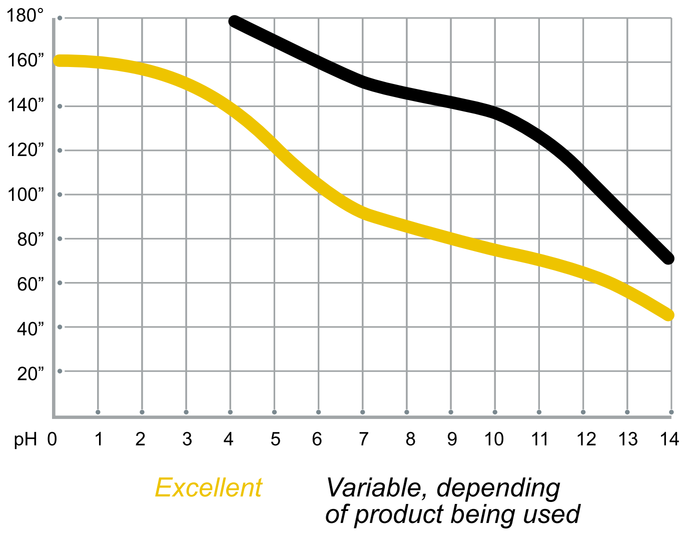
With a corrosion rate of more than 0,2 mm/year, the use of the equipment is not recommended. If however its use is indispensable, we recommend verifying beforehand with 3V Glasscoat and anyhow checking the integrity of the glass lining more frequently.

The graphs were obtained from laboratory tests using pure chemical products and with the absence of inhibition phenomena. With product mixtures, or with products that contain impurities, the values could be different.

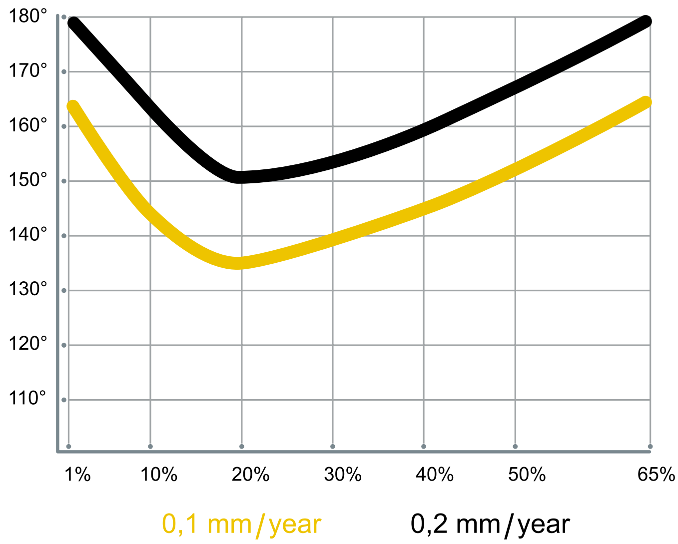
As an example: *If hydrated silica is present together with the product, the corrosion rate is considerably reduced. If iron chloride is present with hydrochloric acid, the corrosion rate is higher. If an acid solution, instead of being only aqueous, is obtained from a mixture of water and alcohol, the corrosion speed is lower. In the event there is a doubt we recommend contacting 3V Glasscoat directly.*

The graph shows the resistance to corrosion of the G2208 glass lining as a function of temperature and pH.

Glass-Lining corrosion



HNO_3 Nitric Acid



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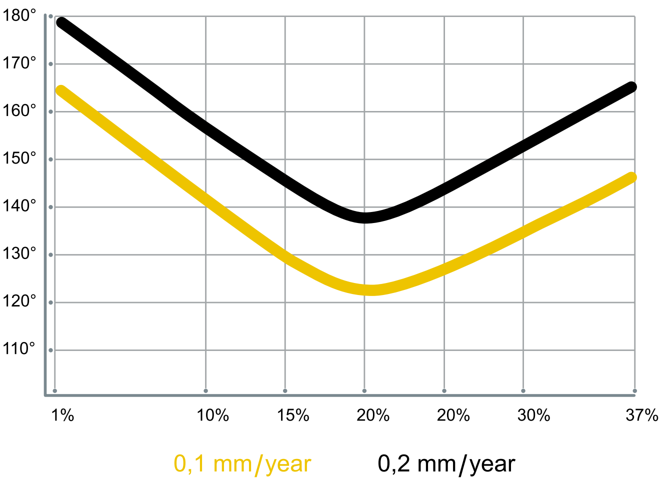
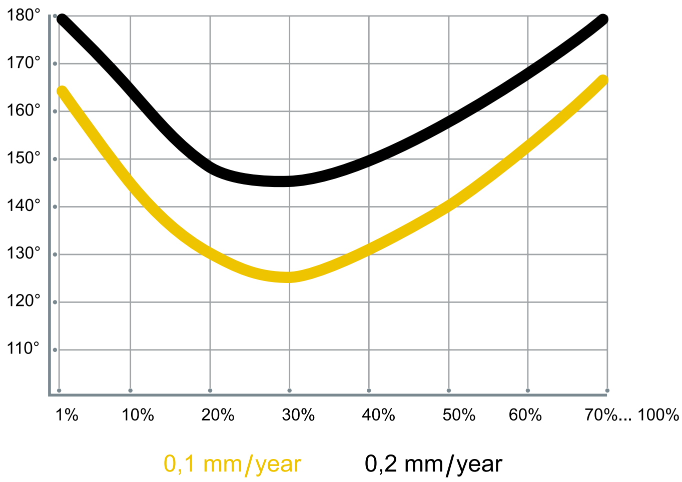
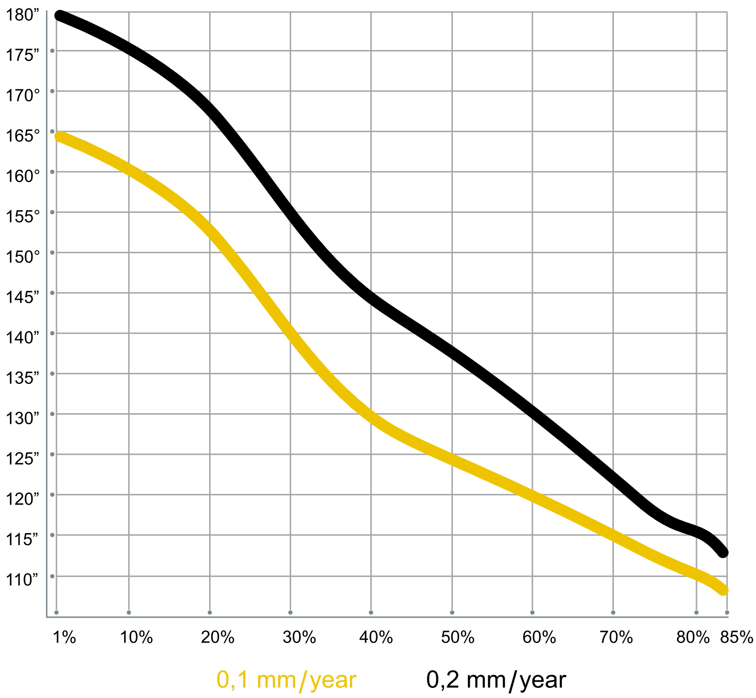
HCl Hydrochloric Acid



H_2SO_4 Sulphuric Acid



H_3PO_4 Phosphoric Acid



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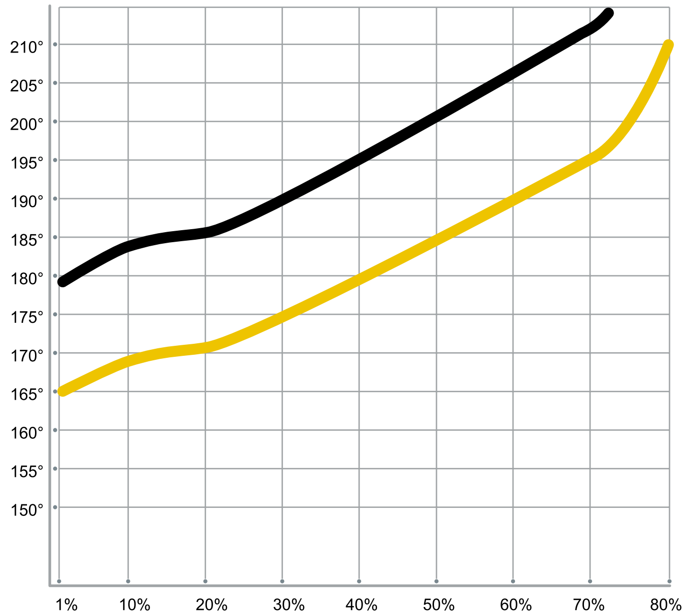
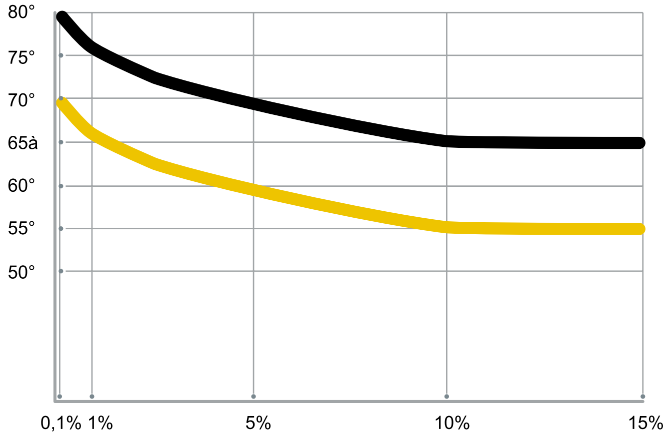
The best resistance to corrosion

CH_3 COOH Acetic Acid



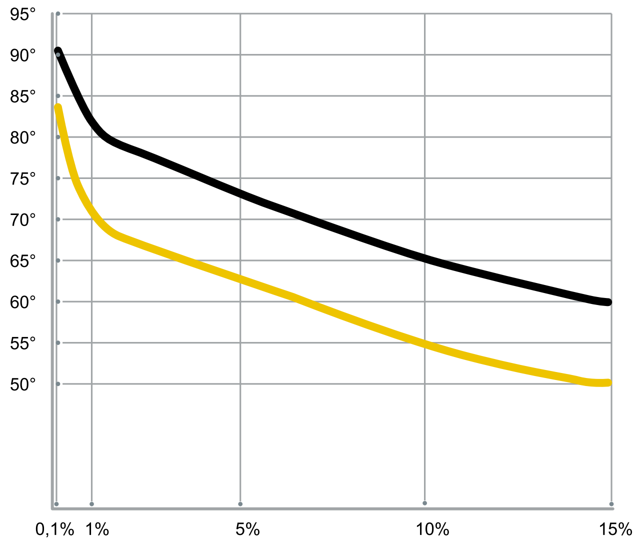
0,1 mm/year 0,2 mm/year

NaOH Sodium Hydroxide



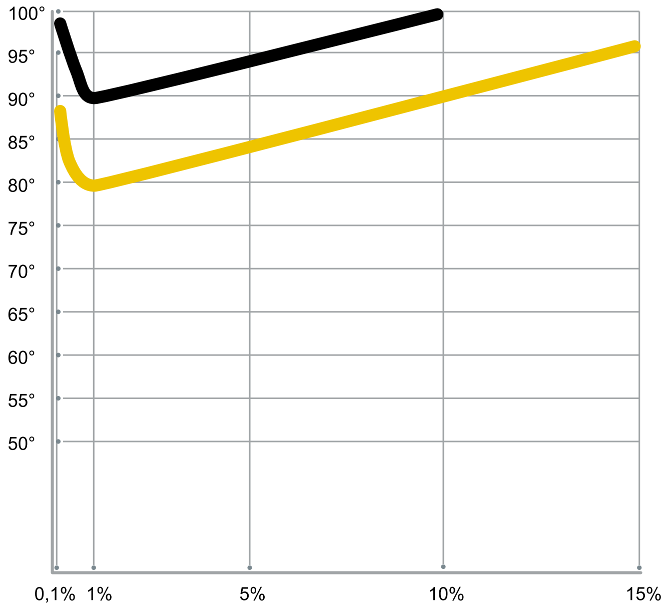
0,1 mm/year 0,2 mm/year

Na_2CO_3 Sodium Carbonate



0,1 mm/year 0,2 mm/year

NH_4OH Ammonia



0,1 mm/year 0,2 mm/year

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The table below shows the resistance of the G2208 glass lining to some chemical products.

Symbols:

- **A:** resistant.
- **B:** variable resistance according to the concentration.
- **C:** non resistant.
- **A.S.:** Aqueous solution.

Resistance to corrosion of some ofthe main chemical compounds				
Product	T=	50°C	100°C	200°C
Acetaldehyde		A	A	A
Acetone		A	A	A
Acrylic acid	[A.S.]	A	A	A
Hydrobromic acid	[A.S.]	A	A	C
Hydrofluoric acid	[A.S.]	C	C	C
Phosphorous acid	[A.S.]	A	A	C
Trichloric acid	[A.S.]	A	A	B
Distilled water		A	A	C
Ethyl alcohol		A	A	A
Methyl alcohol		A	A	A
Ammonium fluoride	[A.S.]	C	C	C
Ammonium nitrate	[A.S.]	A	A	B
Ammonium sulphate	[A.S.]	A	A	B
Acetic anhydride		A	A	A
Sulphur dioxide		A	A	A
Aniline	[A.S.]	A	B	C
Barium chloride	[A.S.]	A	A	B
Benzaldehyde		A	A	A
Benzene		A	A	A
Benzoic acid	[A.S.]	A	A	A
Boric acid	[A.S.]	A	A	B
Bromine		A	A	A
Calcium chloride	[A.S.]	A	A	B
Carbon dioxide		A	A	A
Carbon monoxide		A	A	A
Carbon tetrachloride		A	A	A
Citric acid	[A.S.]	A	A	B
Chloroacetic acid	[A.S.]	A	A	C
Chlorine		A	A	A
Chlorobenzene		A	A	A
Chloroethylene		A	A	A
Chlorosulphuric acid	[A.S.]	A	A	B
Chloroform		A	A	A
Polyvinyl chloride		A	A	A
Dibromoethylene		A	A	A
Dichlorobenzene		A	A	A

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Resistance to corrosion of some ofthe main chemical compounds				
Product	T=	50°C	100°C	200°C
Dichlorophenol		A	A	A
Dimethyl sulphate		A	A	A
Ether		A	A	A
Ethyl acetate		A	A	A
Phenol		A	A	A
Iodine		A	A	A
Lithium hydroxide	[A.S.]	A	C	C
Magnesium chloride	[A.S.]	A	A	B
Magnesium sulphate	[A.S.]	A	A	B
Nitrobenzene		A	A	A
Potassium chloride	[A.S.]	A	A	B
Copper chloride	[A.S.]	A	A	B
Sodium bromide	[A.S.]	A	A	B
Sodium citrate	[A.S.]	A	A	C
Sodium chloride	[A.S.]	A	A	B
Sodium hypochlorite	[A.S.]	A	B	B
Toluene		A	A	A
Xylene		A	A	A

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Thermal shock

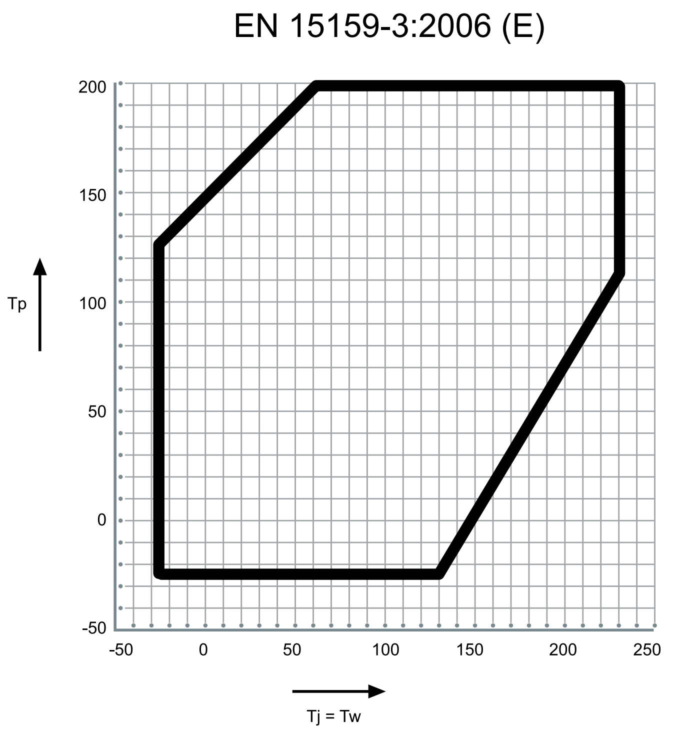
Glass linings, being composite materials, can be damaged if subjected to too severe thermal shock. The G2208 glass lining has been formulated to reduce this risk in truly extreme cases. The graphs show the temperatures limit recommended in four typical conditions:

- Introduction of hot fluid in the jacket with a cold product inside the vessel.
- Introduction of cold fluid in the jacket with a hot product inside the vessel.
- Introduction of a hot product inside the vessel with a cold fluid in the jacket.
- Introduction of a cold product inside the vessel with a hot fluid in the jacket.

Symbols:

- **Tp:** temperature of the product inside the vessel.
- **Tw:** temperature of the glass-lined wall.
- **Tj:** temperature of the fluid in the jacket

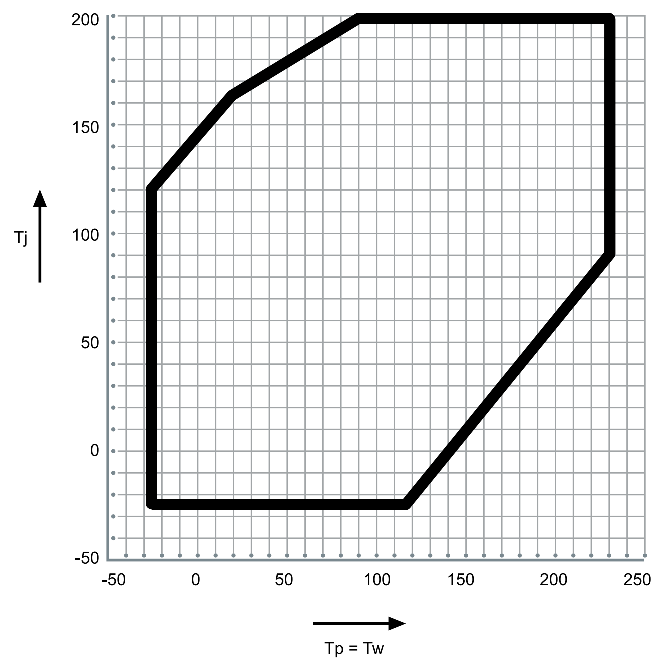
Thermal shock on glass-lining side.



Examples:

- *With the fluid in the jacket at a temperature of -20°C (Tj = -20°C) and therefore with the glass-lined wall at a temperature of - 20°C (Tw = -20°C), the maximum temperature of the product to be introduced into the vessel is 130°C (Tp = 130°C).*
- *With the fluid in the jacket at a temperature of 180°C (Tj = 180°C) and therefore with the glass-lined wall at a temperature of 180°C (Tw = 180°C), the minimum temperature of the product to be introduced into the vessel is 50°C (Tp = 50°C).*

Thermal shock on steel (jacket side).



Examples:

- *With the product inside the equipment at a temperature of -20°C (Tp = -20°C) and the refore with the glass-lined wall at a temperature of -20°C (Tw = -20°C), the maximum temperature of the fluid in the jacket is 130°C (Tj = 130°C).*
- *With the product inside the equipment at a temperature of 180°C (Tp = 180°C) and therefore with the glass-lined wall at a temperature of 180°C (Tw = 180°C), the minimum temperature of the fluid in the jacket is 40°C (Tj = 40°C).*