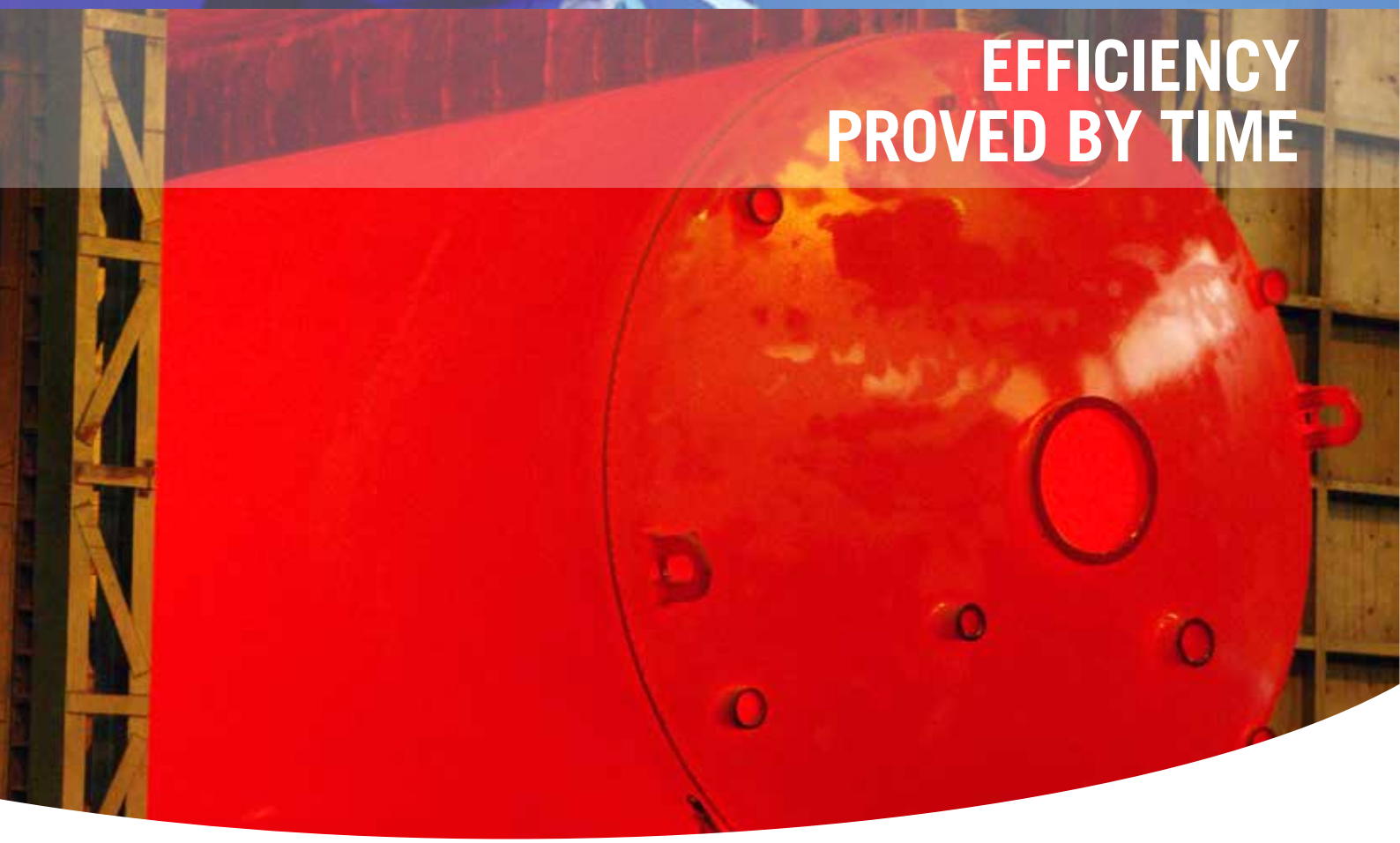
DD 3009 GLASS

EFFICIENCY PROVED BY TIME



De Dietrich
PROCESS SYSTEMS

DD 3009 GLASS

Glass-lined steel is mandatory when service conditions of the process are particularly difficult. De Dietrich® has always invested in research and development of new glass formulas with greater capabilities. The result of our ongoing research enabled us to offer the DD 3009 glass.

The formulation of this multipurpose glass gives the optimum properties of chemical resistance to acidic and alkaline mediums, of mechanical resistance to shocks and abrasion, of easy cleaning and anti-adhesion.

Across the world, all De Dietrich® plants apply the same quality of glass, the production of which is centralized in France. During the preparation of each batch of DD 3009 glass, numerous tests assure us a perfect and reproducible quality, suppressing any risk of production defect. Thanks to such rigorous control, we can confidently state that, at De Dietrich®, "Quality" is an everyday occurrence.

Monitoring R&D and production of our own glass in for De Dietrich® an emblem of quality, of competence, of independence.

PRODUCTION OF ENAMEL

Each batch of enamel is comprised of carefully selected and rigidly controlled raw materials, which are melted in a rotary furnace at approximately 1.400°C. The melted glass is then poured into water. This sudden tempering breaks the enamel into grains, which are dried and then ground and screened. To prevent any contamination, each batch is processed separately, between each operation, in closed containers.

GLASSING

A suspension is prepared with enamel powder and sprayed like a paint on the surfaces to be glass-lined. After this coat, called "biscuit", is air dried, the parts are charged into a furnace and fired at temperatures that affect fusion between glass particles.

After cooling, the result is an impervious, smooth coating of glass. The coat is then submitted to various controls: thickness, spark testing and visual inspection.

Then the item is sprayed with another coat that will be air dried, fired and Q.C. tested. These cycles are repeated, always by the same technician who will adjust and complete his work, until obtaining perfect glass lining according to ISO 28721-1 norm:

- Thickness between 1 and 2 mm
- Minimum spark test contact
- Good visual quality, smooth without any color variation

ONE GLASS WITH OPTIMUM QUALITY

DD 3009, ONE GLASS WITH OPTIMUM QUALITY FOR ALL PRODUCTS ALL OVER THE WORLD:

- **HIGHLY CORROSIVE PROCESSES**
- **ABRASIVE PRODUCT**
- **MULTIPURPOSE MATERIAL / VARIETY OF USES**
- **ADAPTED TO cGMP REQUIREMENTS, CLEANING, CLEANLINESS, STERILIZATION**
- **IMPERVIOUS: NO CATALYTIC EFFECT, NO CONTAMINATION**
- **ACCORDING TO FOOD CONTACT (EC REGULATION N° 1935/2004)**
- **ANTI-ADHESIVE: POLYMERIZATION PROCESSES**

COLOUR

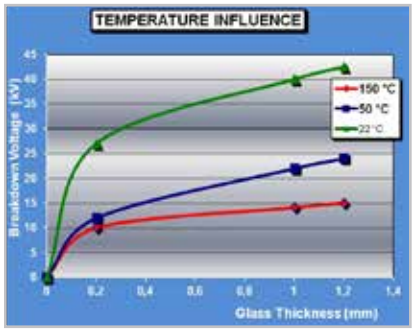
- Blue (DD 3009)
- White (DD 3009U)
- Light blue (DD 3009LB)

DD CONDUCTIGLASS®

PROBLEME OF ELECTROSTATIC CHARGES

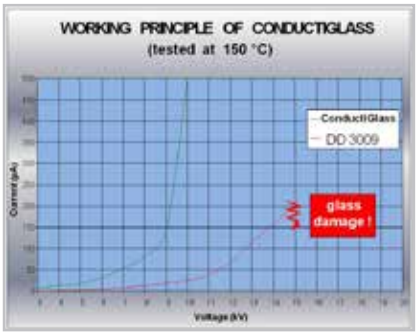
The mixing of non conductive products in a glass-lined reactor may lead to the development of electrostatic charges in the heart of the reaction medium.

This phenomenon is accelerated by the temperature: for a glass thickness of 1mm, the breakdown voltage which is 40 kV at 22°C falls down to 14 kV at 150°C.



DELETE ANY RISK OF ELECTROSTATIC DAMAGE

The principle of the ConductiGlass® solutions consists in increasing the conductivity of the glass-lining to a value high enough to allow the discharge to the ground of the electrostatic charges as soon as they are created in the reaction medium, prohibiting then their accumulation up to dangerous voltages.



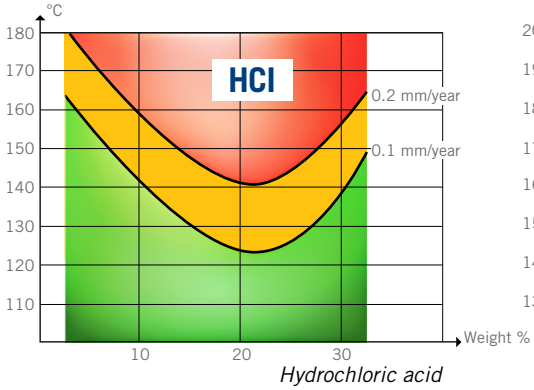
- **CONTINUOUS INTRINSIC PROPERTY OF THE WHOLE THICKNESS OF THE GLASS-LINING**
- **SAME ANTICORROSION PROPERTIES AS OUR STANDARD ENAMEL**
- **ISOCORROSION CURVES IDENTICAL TO ENAMEL DD3009**
- **NO HARMFUL SIDE EFFECTS SUCH AS CATALYTIC EFFECTS**

The ConductiGlass® is manufactured under license by N.G.K. Insulators Ldt/Japan.

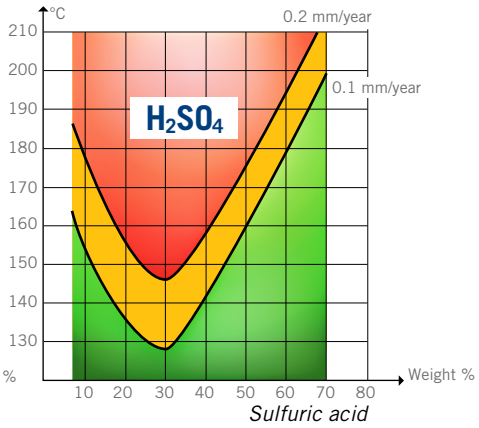
CHEMICAL PROPERTIES

RESISTANCE TO ACIDS

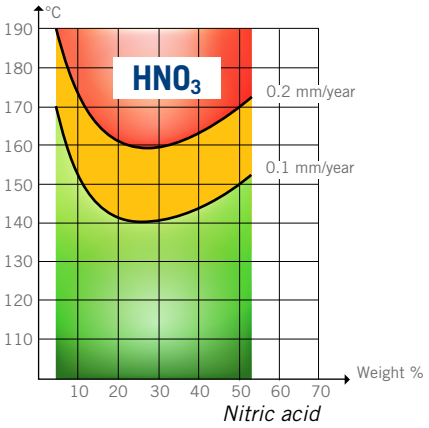
Generally, DD 3009 glass has a high degree of resistance to acids whatever their concentration, up to relatively high temperatures. For most of the inorganic acids, the resistance of the glass passes through a minimum for a concentration of 20-30% weight, then increases with the acid concentration. For example, the 0.1 mm/year rate is found at 128°C in H_2SO_4 30% and at 180°C in H_2SO_4 60%. Exceptionally, in the case of phosphoric acid, the speed of attack increases with the concentration: 0.1 mm/year at 163°C for 10% concentration and at 112°C for 70% concentration.
Hydrofluoric acid completely and quickly dissolves the glass whatever the temperature is. Its concentration in the product must not exceed 0.002% (20 ppm).



Hydrochloric acid



Sulfuric acid



Nitric acid

ISOCORROSION CURVES

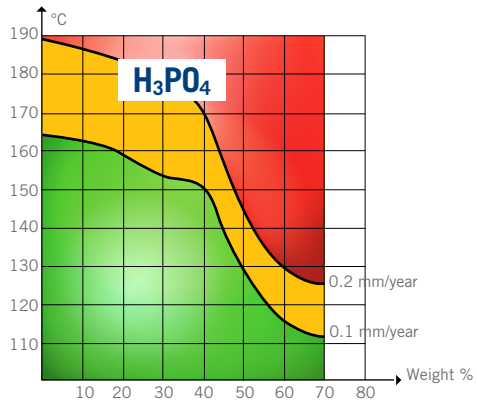
OUR ISOCORROSION CURVES ARE ESTABLISHED FOR MOST CURRENT PRODUCTS. THEY SHOW AS A FUNCTION OF PRODUCT CONCENTRATION THE TEMPERATURES AT WHICH THE WEIGHT LOSSES CORRESPOND TO 0.1 AND 0.2 MM/YEAR.

THE USE OF GLASS IS NOT ADVISABLE

CARE MUST BE TAKEN OF THE ADVANCE OF THE CORROSION

GLASS CAN BE USED WITHOUT PROBLEMS

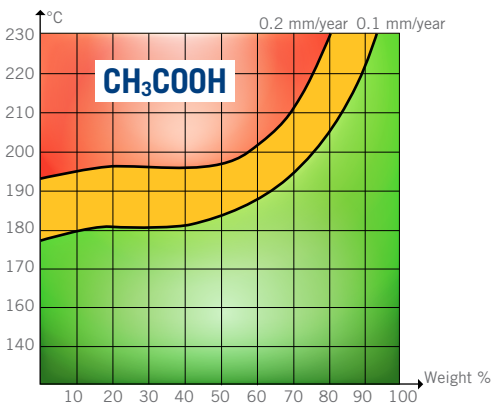
ALL THE TEST HAVE BEEN PERFORMED IN TANTALUM LINED REACTORS AND USING A RATIO VOLUME OF PRODUCT / SURFACE OF ENAMEL (V/S) > 20 TO AVOID THE INHIBITION OF THE ATTACK BY DISSOLVED SILICA.



Phosphoric acid

RESISTANCE TO ORGANIC SUBSTANCES

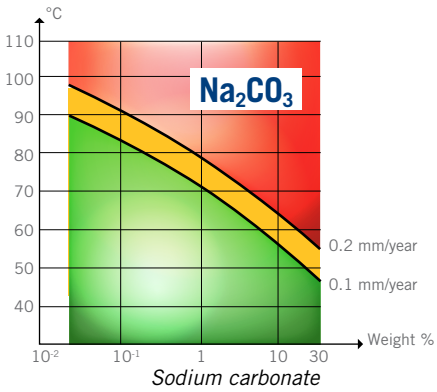
Chemical attack is very low in organic substances. If water is given off during the reaction, the rate of attack will depend on the amount of water in the solution. In the case of 0.1N sodium hydroxide in anhydrous alcohol at 80°C, the rate of attack is virtually nil. In methanol, there has to be more than 10% water before the loss of weight can be measured, whereas in ethanol with 5% water, the weight loss is already half of what it is in aqueous solution.



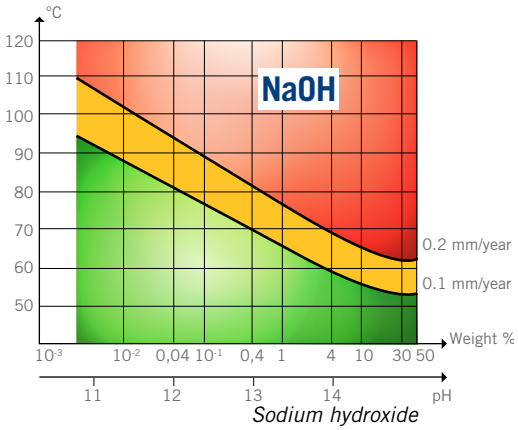
Acetic acid

RESISTANCE TO ALKALIS

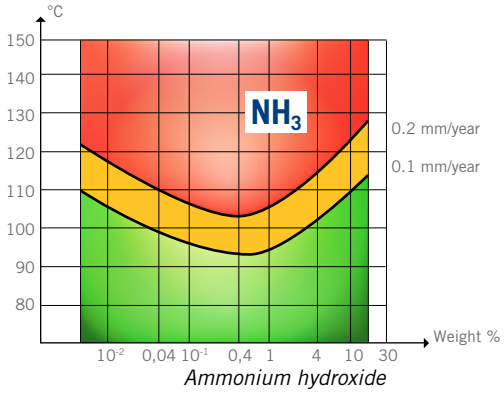
Here the permissible temperature limits are lower than for acids. At pH = 13 (NaOH 0.1N) this maximum is 70°C. Therefore, it is important to be cautious when using hot alkalis. Temperature must be controlled, as an increase of 10°C doubles the rate of attack of the glass. Care must be taken for the introduction of alkalis into a vessel. Avoid the flow of alkalis along the warm vessel wall by using a dip pipe.



Sodium carbonate



Sodium hydroxide



Ammonium hydroxide

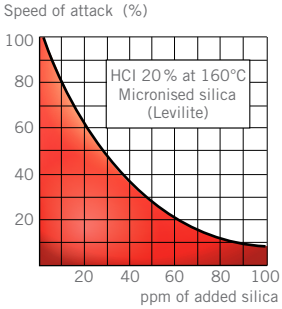
RESISTANCE TO WATER VAPOR

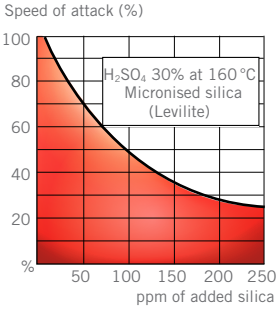
Resistance to water is excellent. The behavior of glass in neutral solutions depends on each individual case but in general is very satisfactory.

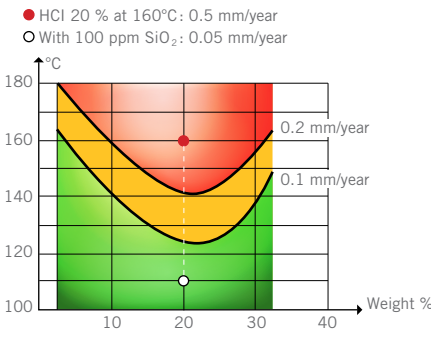
CORROSION INHIBITION

Chemical reactions are sometimes so severe they cause a rapid wear on the enamel surface. The use of additives to the reacting substance can inhibit this corrosion permitting the use of glass-lined equipment. When using acids, several tens or several hundreds ppm of silica protect the enamel and considerably reduce the rate of corrosion during the liquid phase. The same result can be obtained at the vapor stage by adding silicon oils. Generally speaking, the higher the temperature, the greater the quantity of silica required, and more the acid is concentrated, the more the amount of silica can be reduced. In presence of fluorine, silica also has a favorable influence. We always recommend a pre-test as each reaction is different. An attack inhibitor can be useful in one case and yet non-effective in another.

	Pure Product	500 ppm $CaCO_3$	300 ppm SiO_2	Silicon Oil 2 ml/l
NaOH 1N 80 °C	0.18 mm/year	0.09 mm/year		
Buffer pH= 1 ; 100°C + HF 430 ppm	1.5 mm/year		0.42 mm/year	
HCl 20 % vapor 110 °C	0.036 mm/year			< 0.005 mm/year







MECHANICAL PROPERTIES

Enamel is a glass with its qualities but also its main weaknesses which are brittleness and low tensile strength. Since the resistance of glass to compression is well above its tensile strength, one of the solutions to improve the mechanical resistance is to put the glazed layer under compressive pre-stress. This is achieved during controlled cooling after each firing. During mechanical work (deformation, mechanical or thermal shock) the compressive stress must first be offset by an equivalent tensile before the glass could be put under dangerous tensile stress.

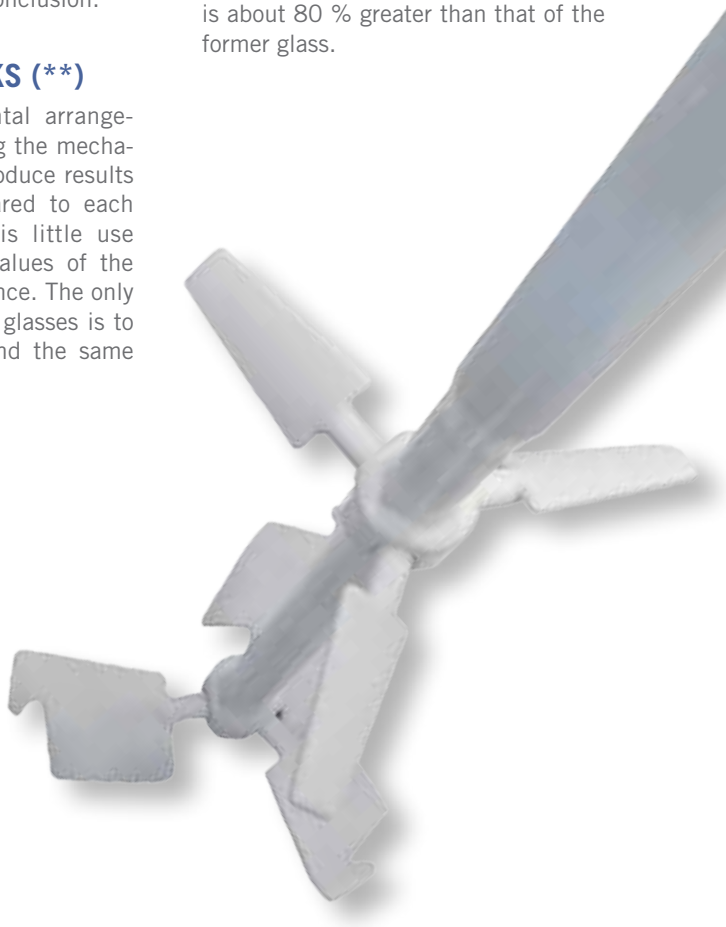
ABRASION (*)

The abrasion test (ISO 6370-2: 2011) is far from the actual working conditions of a glass-lined reactor where the effects of the chemical attack enhance those of abrasion. Nevertheless, it allows a comparison between glasses, showing DD 3009 advantageously. Statistically, it has been shown that in practice the cases of destruction by abrasion are negligible. However, should any doubt arise when an abrasive substance is being used, only a comparative test performed with that product could lead to a conclusion.

MECHANICAL SHOCKS (**)

The different experimental arrangements used for measuring the mechanical shock resistance produce results which cannot be compared to each other. Therefore, there is little use trying to give intrinsic values of the mechanical shock resistance. The only way to compare different glasses is to use the same method and the same criteria.

In our method, a 1 kg mass equipped with a 15 mm ball is dropped onto a glass-lined plate (glass thickness: 1.5 mm). This plate is locked onto a magnetic base, thereby making it thicker and increasing the shock efficiency (no energy absorption through steel vibrations). The plate is electrically grounded, and the electric current going through an electrolyte deposited at the shock location is used as assessment criteria. When tested to this procedure, which is close to the real service conditions, the mechanical shock resistance of the DD 3009 glass is about 80 % greater than that of the former glass.



	REFERENCE NORM	UNITS	DD 3009 GLASS
HCl 20% – Vapor 108°C	ISO 28706-2 : 2008	mm/year	0.036
HCl 20 % - 140 °C – V/S = 20	ISO 28706-2 : 2008	mm/year	0.2
NaOH 1N 80 °C – V/S = 20	ISO 28706-4 : 2008	mm/year	0.35
NaOH 0.1 N 80 °C – V/S = 20	ISO 28706-4 : 2008	mm/year	0.18
H_2O – Vapor	ISO 28706-2 : 2008	mm/year	0.017
Thermal shocks – Statiflux surface cracks	ISO 13807 : 1999	°C	220
Abrasion (*)	ISO 6370-2 : 2011	mg/cm²/h	2.35
Mechanical shocks (**)	Improvement against former glass : 80 %		

THERMAL PROPERTIES

The large majority of equipment that we manufacture is designed with a system that enables the heating and cooling of their contents. As heat transfers may cause serious damage to the enamelled coating, the user should respect the limits described in this chapter, which take account both of the data in the ISO 28721-3: 2008 norm and our experience as a constructor of glass-lined equipment.

A DISTINCTION SHOULD BE MADE BETWEEN:

• The "thermal shock" proper, which is characterised by an abrupt change in temperature applied either to the surface of the enamel (introduction of a product into the appliance: reagent, cleaning water), or to the steel (such as jacket nozzle location when introducing for example super-heated steam).

• The «thermal stresses», which are mechanical stresses related to temperature gradients which appear temporarily in the steel during phases of temperature changes. These are related to the design of equipment and may generate stresses in the enamel, which may cause its rupture, and/or result in fissuring of the passivation layer in coils and foster the development of corrosion under stresses, which may lead to the appearance of transverse cracks.

Glass-lined equipment is more or less sensitive to thermal shocks and thermal stresses, depending on their geometrical or structural characteristics. This requires us to make a distinction between:

• On one hand, standard equipment, in which the calculation data are –25°C to +200°C regarding the temperature, and –1 to 6 bar regarding the pressure.

Example A
If the product and the glass-lined wall are at 170°C, the fluid temperature should be between +30°C and +200°C.

Example B
If the glass-lined wall and the thermal fluid are at 20°C, products between -25°C and +165°C may be safely introduced.

• On the other hand, specific equipment, either because of their calculation and/or operating conditions, which are different from standard (very high temperature, very low temperature, high pressure, ...), or because of a particular material or design such as glass-lined stainless steel equipment, columns without compensator, dissymmetrical appliances (lyre and lateral nozzle), non-standard thicknesses, non-standard lengths, jacketed piping, etc...

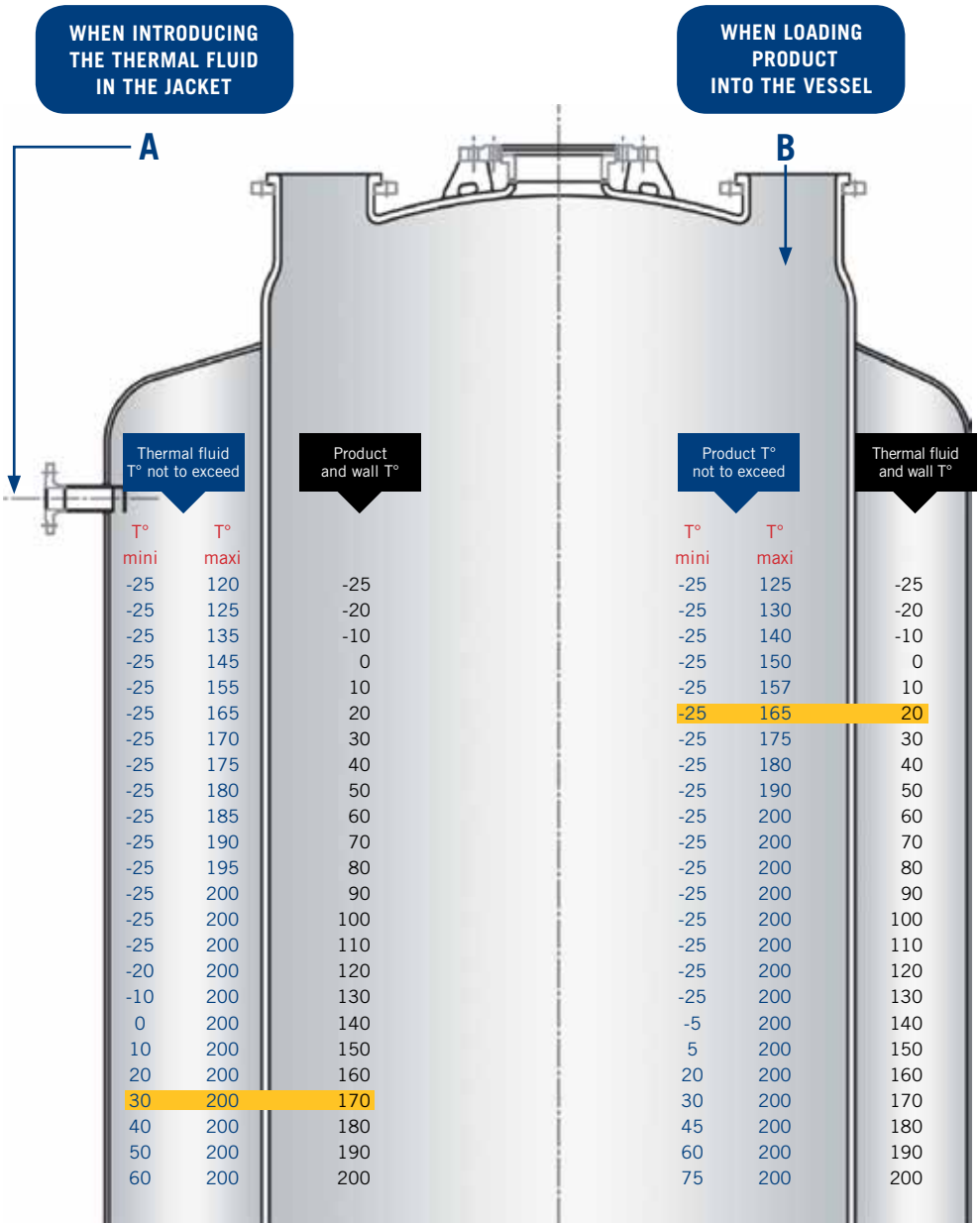
The following table is provided to enable you to validate your operating conditions and obviate the creation of excessive thermal shocks when introducing products into standard equipment or on changes in temperature in the thermal fluid (Multifluid system).

The maximum ΔT values given in these tables MUST be respected. They are limit values which must not be exceeded.

NOTE

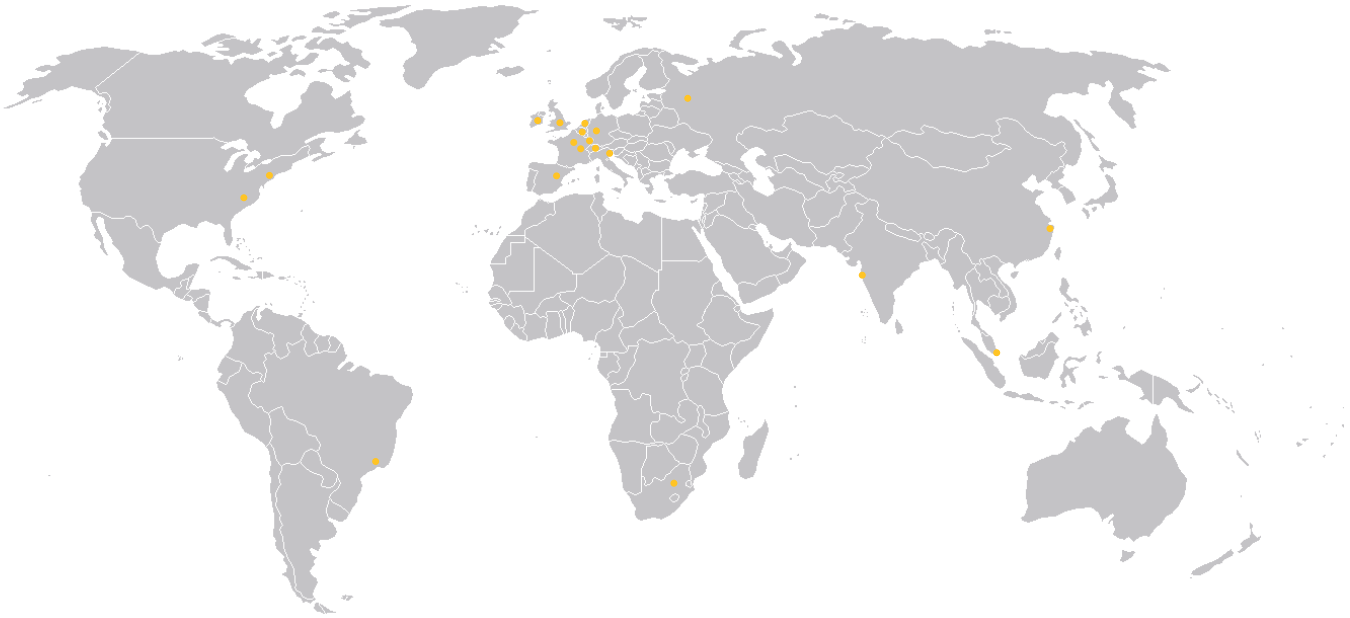
Instructions devoted entirely to the thermal properties of the enamel are attached to the Maintenance Manual of our equipment to enable their installation and use in complete safety, as far as both your operators and the equipment are concerned.

GENERAL CASE OF STANDARD VESSELS CALCULATED FROM -25°C TO +200°C ISO 28721-3 NORM



Thermal fluid T° not to exceed		Product and wall T°
T° mini	T° maxi	
-25	120	-25
-25	125	-20
-25	135	-10
-25	145	0
-25	155	10
-25	165	20
-25	170	30
-25	175	40
-25	180	50
-25	185	60
-25	190	70
-25	195	80
-25	200	90
-25	200	100
-25	200	110
-20	200	120
-10	200	130
0	200	140
10	200	150
20	200	160
30	200	170
40	200	180
50	200	190
60	200	200

Product T° not to exceed		Thermal fluid and wall T°
T° mini	T° maxi	
-25	125	-25
-25	130	-20
-25	140	-10
-25	150	0
-25	157	10
-25	165	20
-25	175	30
-25	180	40
-25	190	50
-25	200	60
-25	200	70
-25	200	80
-25	200	90
-25	200	100
-25	200	110
-25	200	120
-25	200	130
-5	200	140
5	200	150
20	200	160
30	200	170
45	200	180
60	200	190
75	200	200



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The international business group De Dietrich Process Systems is the leading provider of system solutions and reactors for corrosive applications as well as plants for mechanical solid/liquid separation and drying. The system solutions from De Dietrich Process Systems are used in the industrial areas of pharmaceuticals, chemicals and allied industries.

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