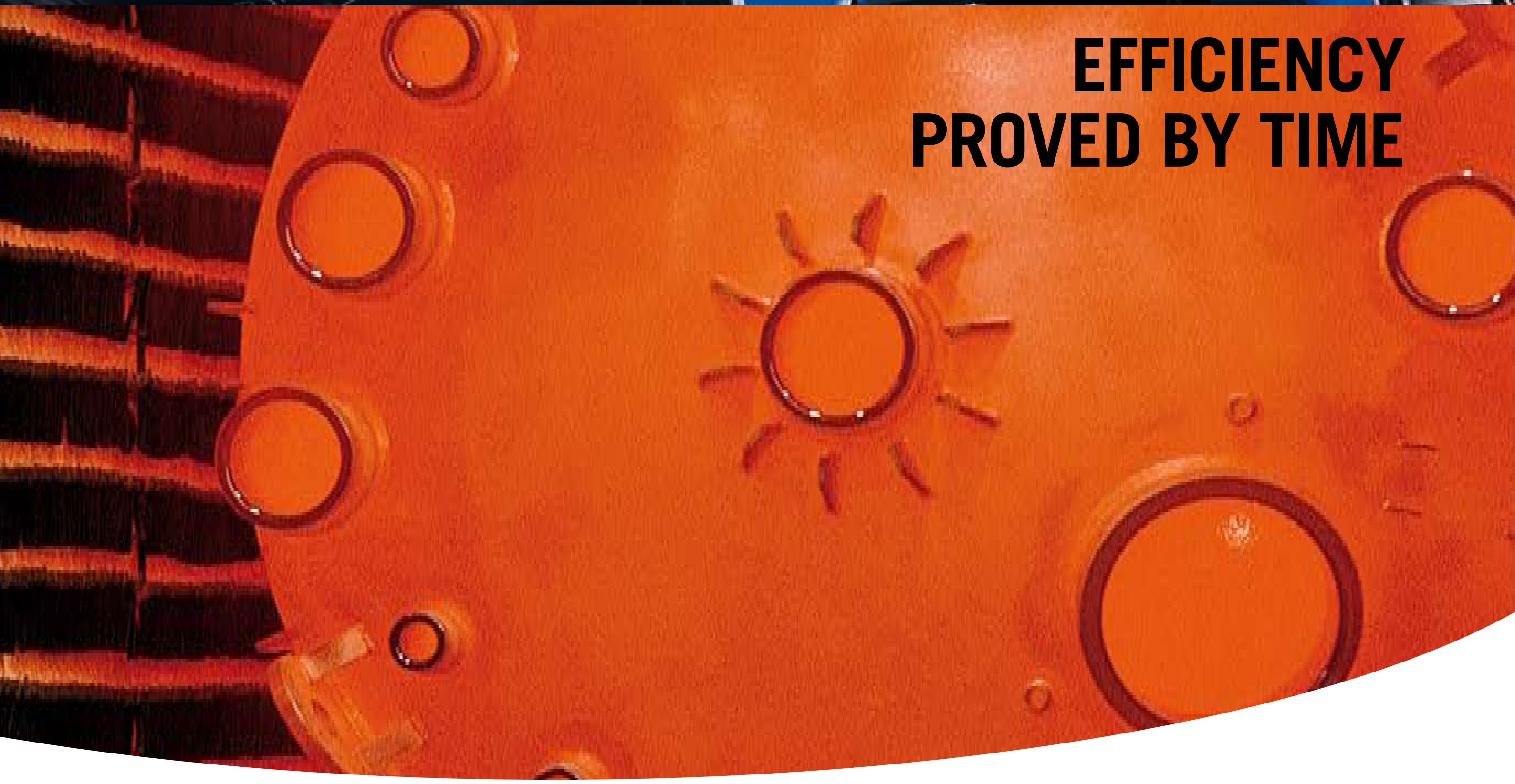
DD 3009 GLASS

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. With the DD 3009 glass, De Dietrich® offers an excellent resistance to corrosion, abrasion, mechanical and thermal shocks.

To increase productivity or to succeed in new syntheses, the chemical industry continually extends the limits of its processes: higher temperatures, lower temperatures, higher pressures, higher concentrations. This trend is possible only if at the same time the chemical and mechanical resistances of the glass that protects vessels, tanks and parts follow these requirements.

This is the reason why 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.

ONE GLASS WITH OPTIMUM QUALITY

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

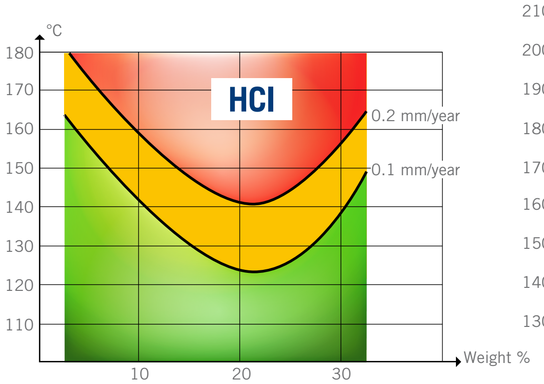
- **HIGHLY CORROSIVE PROCESSES**
- **MULTIPURPOSE MATERIAL / VARIETY OF USES**
- **ADAPTED TO cGMP REQUIREMENTS, CLEANING, CLEANLINESS, STERILIZATION**
- **IMPERVIOUS: NO CATALYTIC EFFECT, NO CONTAMINATION**
- **ANTI-ADHESIVE: POLYMERIZATION PROCESSES**

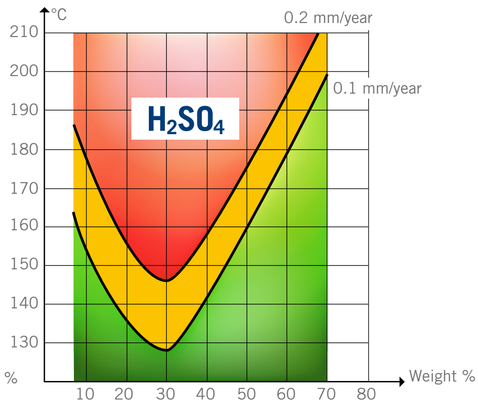
CHEMICAL PROPERTIES

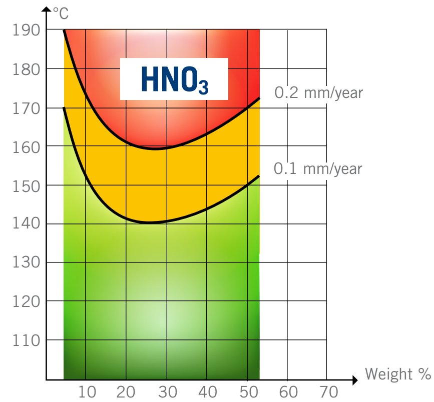
RESISTANCE TO ACIDS

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).





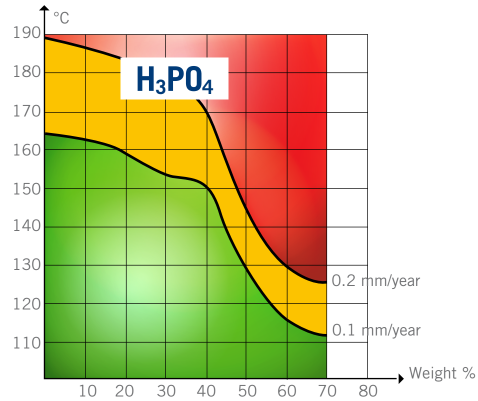


ISOCORROSION CURVES

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.

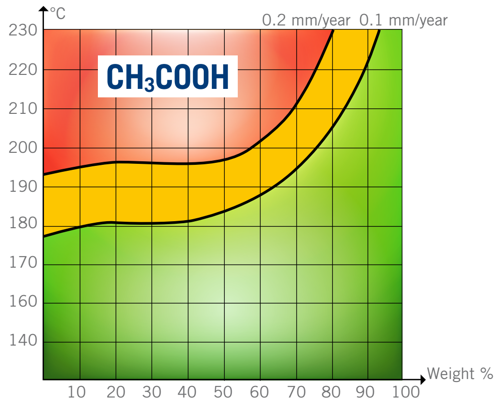
- **THE USE OF GLASS IS NOT ADVISABLE**
- **CARE MUST BE TAKEN OF THE ADVANCE OF THE CORROSION**
- **GLASS CAN BE USED WITHOUT PROBLEMS**

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.



RESISTANCE TO ORGANIC SUBSTANCES

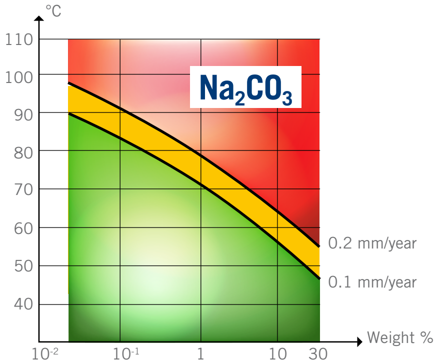
Chemical attack is very low in organic substances. If water is given off during the reaction, the rate of attack will depend on the amount of water in the solution. In the case of 0.1N sodium hydroxide in anhydrous alcohol at 80°C, the rate of attack is virtually nil. In methanol, there has to be more 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.

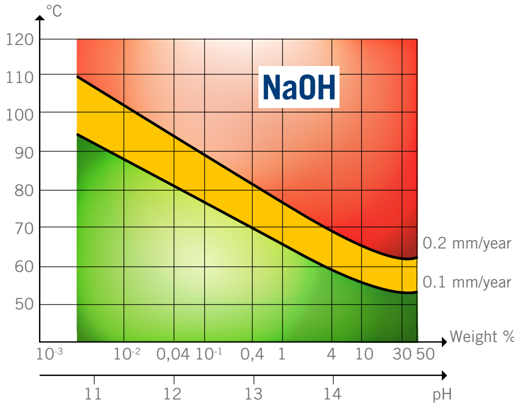


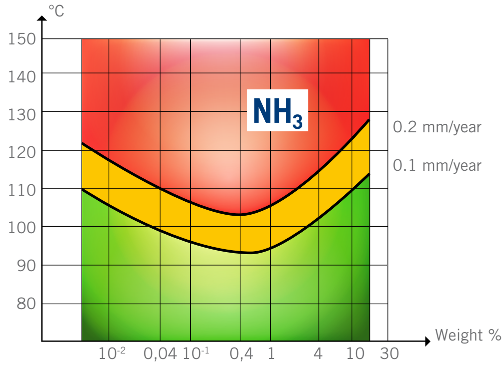
RESISTANCE TO ALKALIS

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.







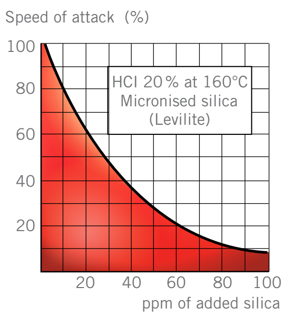
RESISTANCE TO WATER VAPOR

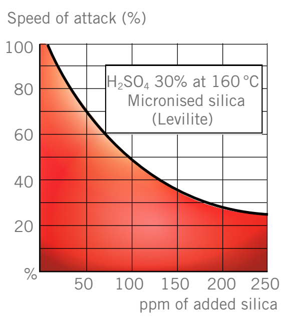
Resistance to water is excellent. The behavior of glass in neutral solutions depends on each individual case but in general is very satisfactory.

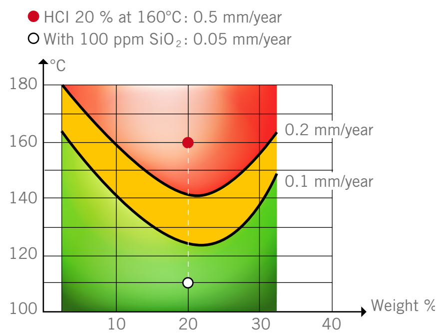
CORROSION INHIBITION

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.

MECHANICAL SHOCK

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.

ABRASION

The abrasion test (DIN 51152) 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.

	UNITS	DD 3009 GLASS
HCl – Vapor – DIN 51157 - ISO 2743	mm/year	0.036
HCl – 20 % 140 °C – V/S = 20	mm/year	0.2
NaOH 1N 80 °C – DIN 51158 – ISO 2745	mm/year	0.19
NaOH 1N 80 °C – V/S = 20	mm/year	0.35
NaOH 0.1 N 80 °C – V/S = 20	mm/year	0.18
H_2O – Vapor – DIN 51165 – ISO 2744	mm/year	0.017
Thermal shocks – Statiflux surface cracks	°C	220
Abrasion – DIN 51152	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 EN 15159 standard (parts 1, 2 and 3) 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.

• 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…

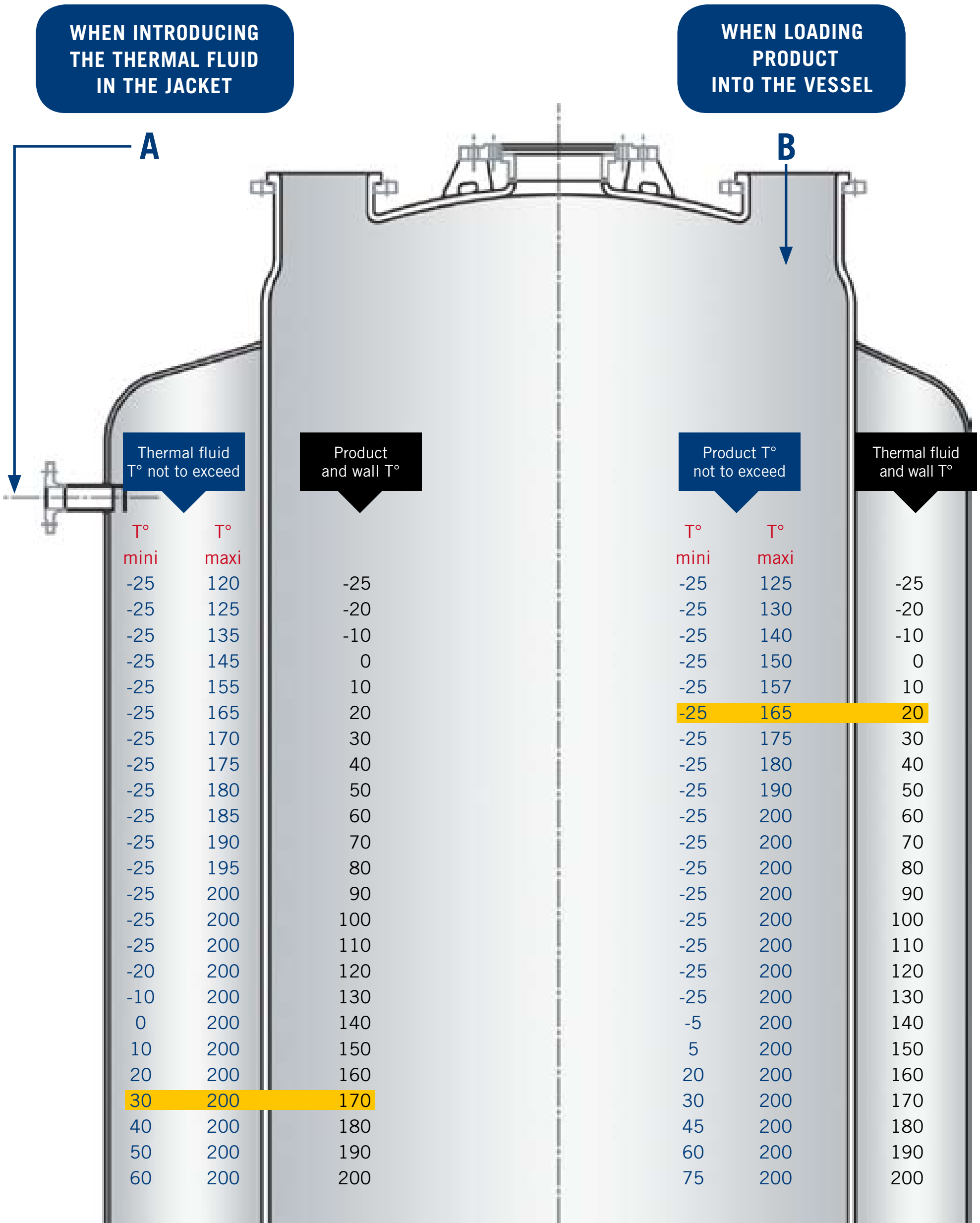
The following table is provided to enable you to validate your operating conditions and obviate the creation of excessive thermal shocks when introducing products into standard equipment or on changes in temperature in the thermal fluid (Multifluid system).

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 EN 15159 NORM



A – When introducing the thermal fluid in the jacket

Thermal fluid T° not to exceed: T° mini	Thermal fluid T° not to exceed: T° maxi	Product and wall T°
-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

B – When loading product into the vessel

Product T° not to exceed: T° mini	Product T° not to exceed: T° maxi	Thermal fluid and wall T°
-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

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.

GUARANTEED TRACEABILITY

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.

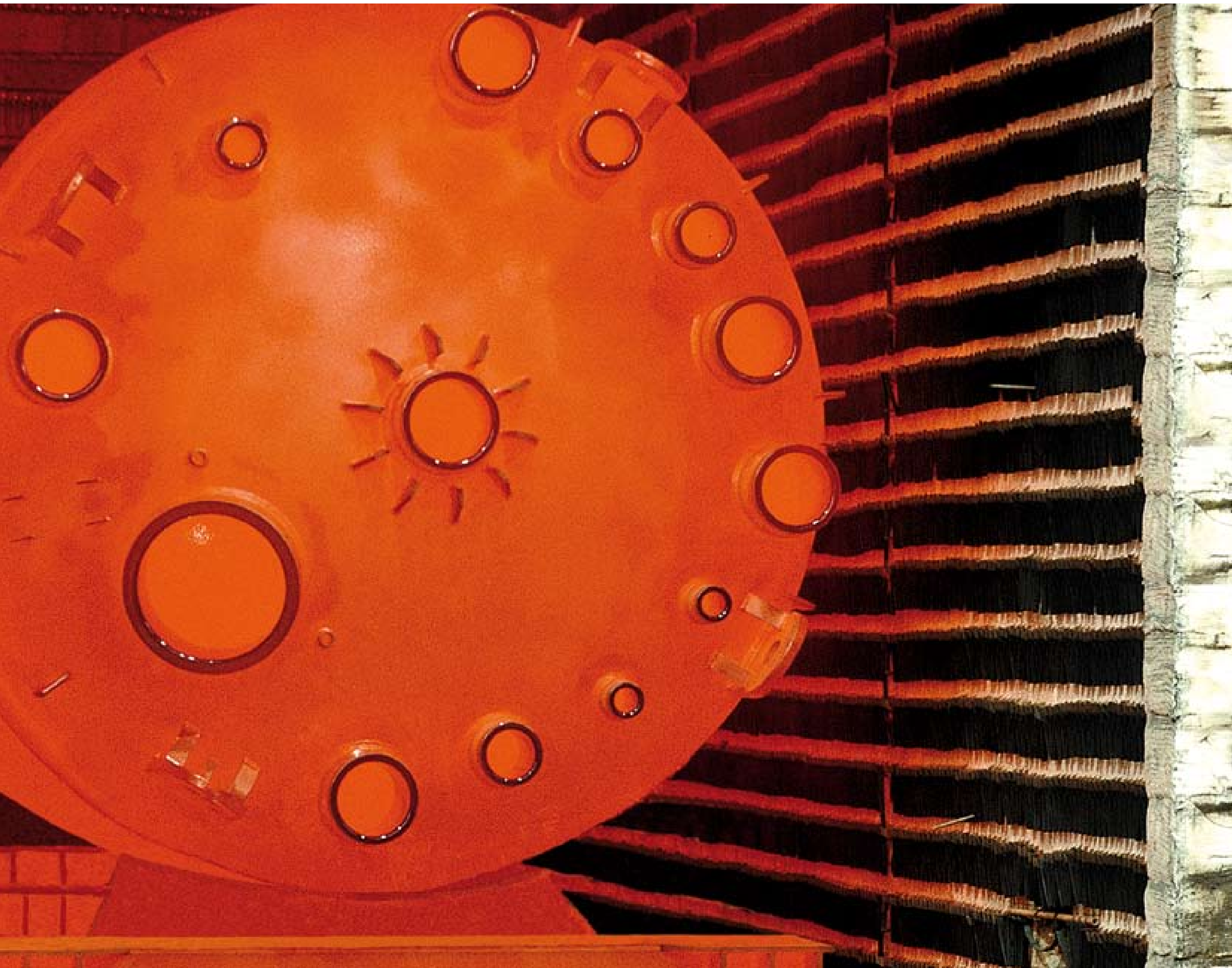
Then the item is sprayed with another coat that will be air dried, fired and Q.C. tested. These cycles are repeated, always by the same technician who will adjust and complete his work, until obtaining perfect glass lining:

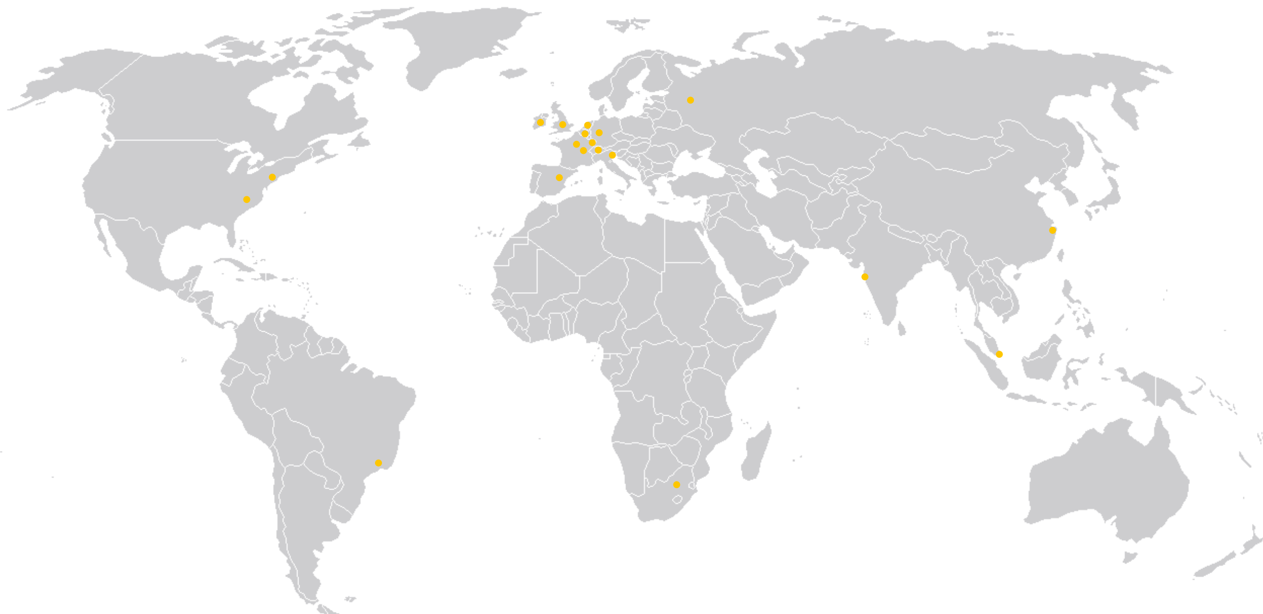
- Thickness between 1 and 2 mm
- Minimum spark test contact
- Good visual quality, smooth without any color variation

COLOUR

DD 3009 glass is available in two colours having exactly the same chemical and mechanical properties:

- Blue (DD 3009)
- White (DD 3009U)





De Dietrich
PROCESS SYSTEMS

DE DIETRICH SAS
Château de Reichshoffen
F 67891 Niederbronn Cedex
Phone +33 3 88 80 26 00
Fax +33 3 88 80 26 95
www.dedietrich.com

BENELUX
De Dietrich Process Systems N.V.
B - Heverlee-Leuven
Phone +32 16 40 5000
Fax +32 16 40 5500
info@benelux.dedietrich.com

BRAZIL
De Dietrich Do Brasil Ltda
São Paulo
Phone +55 11 2703 7380
Fax +55 11 2702 4284
brasil@dedietrich.com.br

CHINA
De Dietrich Process Systems Co. Ltd
Wuxi
Phone +86 510 8855 7500
Fax +86 510 8855 9618
info@dedietrichchina.com

FRANCE
De Dietrich S.A.S.
Zinswiller
Phone +33 3 88 53 23 00
Fax +33 3 88 53 23 99
sales@dedietrich.com

De Dietrich S.A.S.
Evry
Phone +33 1 69 47 04 00
Fax +33 1 69 47 04 10
eivs@dedietrich.com

De Dietrich Process Systems Semur S.A.S.
Semur-en-Auxois
Phone +33 3 80 97 12 23
Fax +33 3 80 97 07 58
info@rosenmund.com

GERMANY
De Dietrich Process Systems GmbH
Mainz
Phone +49 6131 9704 0
Fax +49 6131 9704 500
mail@qvf.de

GREAT BRITAIN
De Dietrich Process Systems Ltd
Stafford
Phone +44 1785 609 900
Fax +44 1785 609 899
sales@qvf.co.uk

INDIA
De Dietrich Process Systems (India) Pvt, Ltd
Mumbai
Phone +91 22 28 505 794
Fax +91 22 28 505 731
ddps.india@dedietrich.com

IRELAND
De Dietrich Process Systems Ireland Ltd
Shannon
Phone +353 61 366924
Fax +353 61 366854
sales@dedietrich.ie

ITALY
De Dietrich Process Systems Srl
San Dona' Di Piave (VE)
Phone. +39 0421 222 128
Fax +39 0421 224 212
info-it@dedietrich.com

RUSSIA
De Dietrich Rep. Office
Moscow
Phone +7 495 663 9904
Fax +7 495 663 9905
info@ddps.ru

SINGAPORE
De Dietrich Singapore (PTE) Ltd
Singapore
Phone +65 68 61 12 32
Fax +65 68 61 61 12
info.sg@dedietrich.com

SOUTH AFRICA
De Dietrich South Africa (PTY) Ltd
Dunswart
Phone +27 11 918 4131
Fax +27 11 918 4133
info.za@dedietrich.com

SPAIN
De Dietrich Equipos Quimicos S.L.
Barcelona
Phone +34 93 292 0520
Fax +34 93 21 84 709
comercial@dedietrich.es

SWITZERLAND
De Dietrich Process Systems AG
Liestal
Phone +41 61 925 11 11
Fax +41 61 921 99 40
info@rosenmund.com

UNITED STATES
De Dietrich Process Systems Inc.
Mountainside, NJ
Phone +1 908 317 2585
Fax +1 908 889 4960
sales@ddpsinc.com

Charlotte, NC
Phone +1 704 587 04 40
Fax +1 704 588 68 66
rosenmund@ddpsinc.com

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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