Process Plant & Pipelines Technical Information

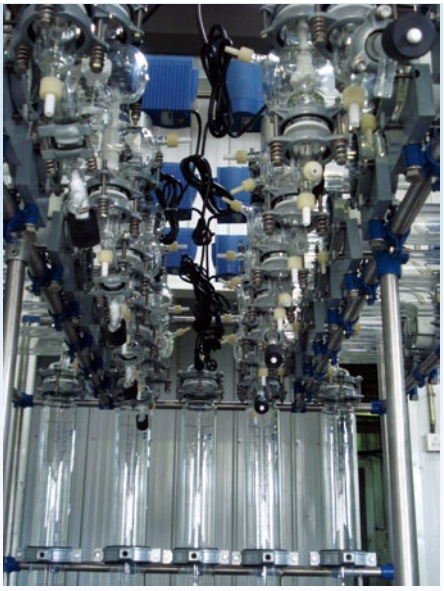
2. PROCESS PLANT & PIPELINES

Borosilicate glass 3.3 has excellent property and characteristics.
First, it has thermo stability due to low coefficient of linear thermal expansion and thus a high resistance against temperature changes up to 120℃, the maximum working temperature 400℃.
Second, it has excellent chemical stability. The United States has even chosen containers made of this specific glass to hold modern human items and tools and buried them underground for future human beings 5,000 years from now. Many western countries choose this kind of glass containers to preserve important government documents. Modern industries widely use this material to make equipment for products ranging from the synthesization of ribonucleic acid to the extraction of U 235.

International standards require that: borosilicate glass 3.3 is the only chemical equipment used to make glass material.

glass pipe and equipment, all using borosilicate glass 3.3 with PTFE manufacturing, to best satisfy chemical industry, scientific research and tests and medicine, the military research sector, distillation, distillation, extraction, absorption, reaction, crystallization, adsorption, storage and other production equipment requirements, production of non-related fields has become an ideal alternative to anti-corrosion material.

BOMEX®GLASS The correct choice for the process of highly erosive and pure substance.



2.1 The features of Bomex borosilicate glass industrial apparatus

- Highly corrosion—resistant

Corrosion-resistance to ensure long-term trouble-free operation; borosilicate glass 3.3 Can stand nearly all acids and organic solvents (with the exception of hydrofluoric acid and hot phosphoric acid).

- Smooth surface, no porosity defect

Easily washable, reducing the pressure loss to the minimum during the transit of the substance, and preventing deposit during the transit.

- Good transparency

Visibility of the whole process through transparent container, this providing convenience for monitoring during operation.

- No catalyzing effect

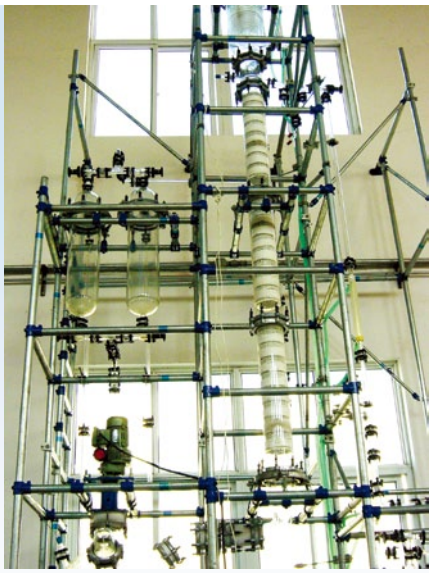
No infiltration of heavy metals, making it possible to produce high purity products such as chemical, pharmaceutical and food products.

- Mature connection flange sealing technology and excellent corrosion resistance of glass

Mature technology for connective closure, preventing leakage due to corrosion, greatly improving productivity of chemical production.

- Wide application range

In combination with the use of other excellent corrosion resistant materials such as ptfe, titanium, tantalum and graphite, borosilicate glass widens the application of chemical and pharmaceutical production processes.



BOMEX®GLASS means safety, economy, flexibility and quality service.

The use of Bomex glass industrial apparatus, in combination with other materials, can meet the demand of the customers in the processing of highly-corrosive and pure substances.

▪ Safety, reliability and low-cost maintenance are the prominent features of our glass industrial apparatus.

Flexibly assembled supporting structure systems, using standardized Bomex borosilicate glass units, can solve any problem of corrosion resistant processing apparatus.If used together with other corrosion resistant materials, such as PTFE, Titanium, Tantalum, Enamel, and graphite, our glass will make the apparatus even more economical and reliable.

▪ Corrosion-resistant coupling systems with safety

All Bomex processing apparatus and pipeline units are highly corrosion resistant and flexible in use. Reliable coupling systems ensure safe operation and low maintenance cost.

Any unit can be flexibly and quickly extended, modified and reused according to practical need.

▪ With rich engineering experience, we can solve your problems.

Bomex can provide full-range processing apparatus, including reacting, mixing,distilling, evaporating, extracting, crystallizing, and rectifying, no matter whether it is for use in laboratory, trial production test, or production plant.

2.2 TECHNICAL INFORMATION

Nowadays, borosilicate glass 3.3 is used worldwide for the manufacture of corrosion-resistant chemical apparatus and laboratory apparatus. Its low coefficiency of linear thermal expansion is$(3.3\pm 0.1)10^{-6}/K^{-1}$, thus the name borosilicate glass 3.3, universally called Pyrex glass.

The international standard ISO 3587 specifies that all the glass components of chemical apparatus should be made of borosilicate glass 3.3.

BOMEX Glass pipe and equipment used in all international standards for manufacture borosilicate 3.3

Properties

Properties Chemical Composition (percentage of weight)

SiO2 80.4% B_2O_3 13% Al_2O_3 2.4% Na_2O 3.9%

Mechanical Properties

average linear thermal expansion: (20-300℃) $(3.3\pm0.1)\times10^{-6}K^{-1}$

density at 20℃: $2.23g/cm^3$

maximum tensile strength: $35\text{-}100Nmm^{-2}$

modulus of Elasticity E: $64KNmm^{-2}$

poisson ration μ: 0.2

Thermal Properties

Glass is not a conductor and is fragile. But borosilicate glass 3.3 is different, whose composition contains 12.7% of B_2O_3, thus boosting its thermal stability.

ISO3587 specifies:

Borosilicate glass 3.3 components with a diameter <Φ100mm should resist a thermal impact higher than 120℃.

Borosilicate glass 3.3 components with a diameter >Φ100mm should resist a thermal impact higher than 110℃.

ISO3587 also explains that special protection measures should be adopted for glass apparatus whose operating temperatures run higher than 100℃, to prevent breakage, should cold water be splashed onto them.

Thermal conductivity under stable pressure (20℃-100℃)

Heat transfer performance

Average thermal conductivity: (20-100℃) $\lambda=1.2Wm^{-1}K^{-1}$

Average specific heat: $Cp=0.98Jg^{-1}K^{-1}$

Shell and Tube Heat Exchangers:

$K=222.24V_t^{0.5038}$(water – water system, tube pass)

$K=505.36V_B^{0.2928}$(water – water system, shell pass)

$K=370.75V_b^{0.07131}$(steam – water system, tube pass)

Glass Coil Heat Exchangers:

$K=334.1V_c^{0.1175}$(water – water system, coil tube)

$K=264.9V_B^{0.1365}$(water – water system, shell pass)

$K=366.76V_c^{0.1213}$(steam – water system, coil tube)

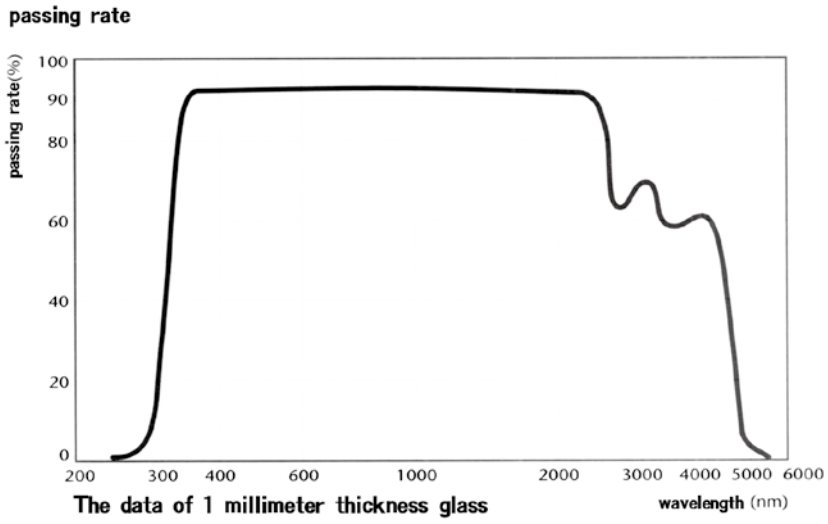
Chemical Properties

Borosilicate glass 3.3 has satisfactory chemical properties better than any known structural materials, with excellent chemical stability against corrosion of all kinds of liquids, even chlorine and bromine. Borosilicate glass 3.3 has strong corrosion resistance against aqueous alkali, with the exception of hydrofluoric acid, phosphoric acid and hot concentrated lyes.
which cause visible corrosion to the glass surface under high temperatures.

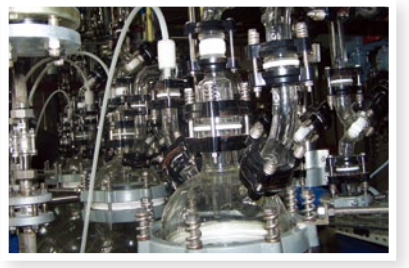
Water-resistance	A class	(GB6585 standard, when glass particles are under 98℃) (GB12416.2 standard, when glass particles are under 121℃)
Acid-resistance	A class	(GB15728 standard, when glass are put into boiling hydrochloric acid)
Alkali-resistance	B class	(GB6580 standard, when glass are put into boiling alkaline lyes)

Optical Properties

Glass chemical apparatus are transparent, and it is convenient for operation monitoring. Borosilicate glass 3.3 allows 92% of the visible light to go through, without apparent absorption in the visible spectrum, so it looks clear and colorless.
The transparency of borosilicate glass 3.3 to ultra violet rays plays an important role in the photochemical processing of glass apparatus. 90-92% of the ultraviolet ray within 360-400nm, and 92% of the infrared ray can go through this glass. The high transparency to ultraviolet ray makes the photochemical reaction possible to Chlorination and Chloro-sulphonation. A molecule of Chlorine absorbs heat at the spectrum of 280-400nm, acting as a carrier of radiation energy.
With those photosensitive substances, the glass assumes brown color, making the absorption of the short spectrum range better. The glass with brown color absorbs light of 500 nm of the spectrum range.



PERMISSIBLE OPERATING CONDITIONS



Permissible Operating Conditions

Pressure

The internal operating pressure safety of glass apparatus depends on the diameter, shape and operating temperature of the glass units, but full consideration should be given to all couplers and the materials of the sealing devices.The safe internal pressure of the whole system is normally decided by the units of the lowest pressure of the system.All Bomex glass units can be used in vacuum condition.

The maximum operating pressure (Mpa) of all chosen pipes, according to the diameter, should meet the following specifications:

DN	DN15	DN20	DN25	DN40	DN50	DN80	DN100	DN150	DN165 (Φ180)	DN200	DN215 (Φ230)	DN300 (Φ315)	DN400	DN600
MPa	0.2	0.2	0.15	0.15	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.07	0.07

Temperature

In the pipeline system all the glass components can operate at up to 150℃, thus no separate specifications for components working at lower temperatures.

The temperature limit is not only decided by the glass units, but also decided by the material feature of the connecting closure, the sealing unit and other components. And sharp cooling of the heated glass units should be avoided, to prevent fracture in the glass unit due to high stress.

Electrostatic Charging

Electrostatic charging could occur in many industrial processes, possibly leading to fire and even explosion. So, the following rules are made for the glass apparatus:

Under the average relative humidity(50%), the resistance at the glass surface is normally above 1011Ω. So there is no need for taking any measure if the glass is exposed to slight friction and the surrounding is not zero, If the glass unit contains electrically charged liquid, protective grounding measures should be taken especially when involving metal flanges or metal valves or metal frame supports for measurement devices.

Safety Screens

To ensure the glass apparatus installation and safe operation, Bomex recommends transparent safety screens, by using specially designed components to install safety screens in the Bomex framework system.

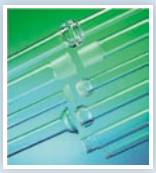
2.3 Standardization

BOMEX design and production comply with the following standards:

ISO3585-1991:	Characteristics of Borosilicate Glass 3.3
ISO3586-1976:	Rules for the Inspection, Installation and Use of Glass Apparatus, Pipelines and Spare Parts.
ISO3587-1976:	Standardization and Interchangeability of Glass Equipment, Pipelines and Spare Parts.
ISO4707-1978:	Spare Parts for Glass Apparatus and Pipelines
HG/T2435-93:	Glass Pipelines and Units.
HG/T2436-93:	Pressure Testing Method for Glass Pipelines and Units.
HG/T3116:	General Rules for the Inspection, Installation and Use of Glass Apparatus.
GB6580:	The Experiment Method and Classification for Corrosion Resistant Property of the Glass Against Mixed Boiling Alkaline Liquids.
GB6582:	The Experimentation Method and Classification for Water-resistant Particles at 980℃.
GB12416.2:	The Experimentation Method and Classification for Water-Resistant Particles at 121℃.

BOMEX borosilicate glass pipelines and apparatus can be connected and exchanged with glass pipeline products made by other countries according to international standardization.

2.4 Types and Dimensions of Ground Joints



For glass apparatus:

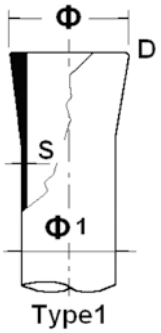
Standard Joints: sleeve Type 5
core Type 6
Thread joints inside screw Type 7
outside screw Type 8
Spherical joints Type 9

(For specific joint parameter, please refer to BOME special book for glass apparatus joints).

For pipelines joints

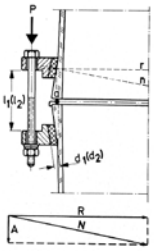
Conical joints: Type 1
Spherical joints: ball Type 2
socket Type 3
plane Type 4

Conical joints Type 1



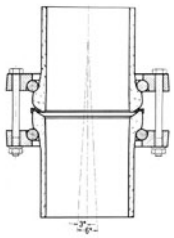
SIZE D	Φ mm	Φ1 mm	S mm
1/2”	26.5	18	2.5
3/4”	35	25	3.0
1”	43	32	3.3
1.5”	56	45	3.5
2”	71	58	4.0
3”	99	85	4.7
4”	131	113	5.6
7”	196	180	7.0
9”	250	230	7.5

TYPES AND DIMENSIONS OF GROUND JOINTS

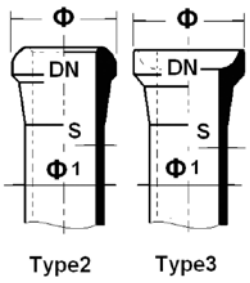


Due to their special structure and shapes, the conical joints have many defects of their own:

- Too many rubber units connected to the flange are likely to cause poor sealing effect due to the weakness of rubber.
- The design of conical joint causes equal radial force and tautness which will damage the apparatus, especially for large diameter apparatus during installation .
- The design of conical joints can hardly guarantee connecting parallelism in production, which will result in poor parallel connection, bringing about difficulty in installation and even leakage.



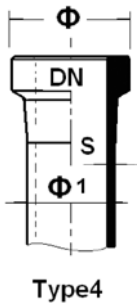
With the development of corrosion-resistant design and bio-pharmaceutical industry, conical joints have been replaced by spherical ground joints both at home and abroad. Spherical ground joints are developed by Bomex based on foreign corrosion-resistant glass units. The spherical ground joints are connected with each other through the ball and socket joints.±30 tolerance is allowed on each end of the tubings and no leakage occurs. This can guarantee the assembly without any stress. A slope is allowed for the standby tubings, which is more convenient for installation. There is no need for any further special components.



Spherical ground joints, ball and socket Type 2 and Type 3

DN	Φ mm	Φ1 mm	S mm
15	30	22	2.5
25	44	32	3.3
40	62	45	3.5
50	76	58	4.0
80	110	85	4.7
100*	131	113	6.0
150*	185	165	7.0

* DN100/DN150 spherical ground joint are under testing



Spherical ground joints, plane Type 4

DN	Φ mm	Φ1 mm	S mm
15	30	22	2.5
25	44	32	3.3
40	62	45	3.5
50	76	58	4.0
80	110	85	4.7
100	130	113	5.6
150	185	165	7.0
Φ180	200	180	7.0
200	233	215	7.5
Φ230	250	230	7.5
300	338	315	7.5
400	465	415	7.5
600	684	620	10.0

Compared with conical joints, spherical ground joints have the following advantages:

- Thermosetting resin inserts are used for spherical ground joints, thus raising high temperature endurance of the products.
- With the use of temperature compensation springs, the connecting sections do not leak when temperature changes.
- The seals are made of PTFE, without any use of rubber.

So, our series of products have gone through field tests and are domestically widely used because of these advantages.

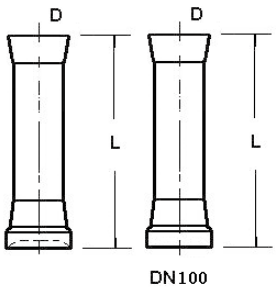
Our series of products have become the indispensable equipment for the production of extra-pure products and corrosion-resistant processing in chemical industry, one of the effective ways of boosting efficiency in the industry.

BOMEX recommends our customers to use spherical ground joints products.

2.5 Spherical Ground Joints and Conical Ground Joints Exchange Pipe Sections

To provide convenience for connections of all types of apparatus and the modification of old apparatus, Bomex provides exchange pipe sections.

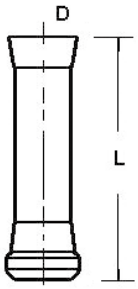
Pipe Sections Type C



DN	D	L mm	CAT. NO.
25	1”	100	QGD-25/100C
40	1.5”	100	QGD-40/100C
50	2”	100	QGD-50/100C
80	3”	150	QGD-80/150C
100*	4”	150	QGD-100/150C

* DN100 are now plane joints; ball and socket joints are now under test.

Pipe Sections Type D



DN	D	L mm	CAT. NO.
25	1”	100	QGD-25/100D
40	1.5”	100	QGD-40/100D
50	2”	100	QGD-50/100D
80	3”	150	QGD-80/150D
100*	4”	150	QGD-100/150D

* DN100 are now plane joints; ball and socket joints are now under test.