CAUTION: "Safe" operating temperatures vary with conditions. Because so many variables are involved temperature ranges are given only as a guide. When practical, operation below the maximum and above the minimum is recommended. Contact GMM Pfaudler for details.

Glassing Breakthrough

Score another first for Pfaudler research, which has pioneered most of the major developments in glassed-steel equipment. For the 70-some years that stainless steel has been available as a material of construction, it has rejected all efforts to bond glass reliably to it -- until now. After decades of effort, Pfaudler researchers have developed a new glass formulation, along with special application and firing techniques. It’s called Glasteel 4000 and it is the first high-voltage test glass that can be applied and tested to guarantee a reliable glasslining of uniform thickness and quality on stainless steel. No thin spots, no bare metal, no exposed base coat -- all of which can occur with other glasses on stainless steel.

Glasteel 4000 glass made possible the invention of the revolutionary Pfaudler Stainless Steel Pharmaceutical Glasteel Reactors. This series fulfilled a long-felt need for pharmaceutical manufacturers concerned with meeting FDA Good Manufacturing Practices.

The highly polished exteriors of conventional all-stainless reactors are easy to clean and sanitize, which largely accounts for their widespread use. But the bare stainless interiors can interact with powerful corrosives in the process solutions, and this can both contaminate the product and shorten equipment life.

The Stainless Steel Glasteel reactor provides the same smoothly polished, easy-to-maintain exterior, but the interior has a lining of virtually inert glass that resists corrosion, abrasion, thermal shock, and product adherence. The inert glass will not contaminate the product and functions to protect the product purity, color, and quality. In addition, the stainless steel substrates and Glasteel 4000 linings of the Stainless Steel reactors also make them valuable for other applications, such as cryogenic processes and pure products for electronics.

Glasteel 4000 is not only used in the Stainless Steel reactor, it has already been used in other series and, in fact, could be used in any standard Pfaudler glass lined reactor capable of being fabricated from stainless steel. In addition, it has been used to cover special agitators and other accessories made of stainless steel.
Temperature Limits
Although Glasteel 4000 has a high degree of helpful compressive stress in the glass layer, there are definite limits to the level of thermal stress that the glass can withstand without incurring damage. Only two conditions must be considered when determining the temperature limits:

1. Introducing media into a vessel. The limits are determined from Chart A

2. Introducing media into a jacket. The limits are determined from Chart B

In both cases, the safe operating range lies within the polygons as outlined in the charts. The left and right sides of the polygons represent, respectively, the minimum and maximum wall temperatures allowed. The bottom and top of the polygons represent, respectively, the minimum and maximum reactant temperatures allowed (Chart A), and the minimum and maximum jacket temperatures allowed (Chart B).

With Chart B, it is also necessary to know the heat transfer film coefficient of the jacket medium. Three curves are shown: one for heating steam and cooling water (8500 W/m²K) and two for typical heating/cooling oils (1500 and 1000 W/m²K).

Corrosion Resistance
The graphs that follow the present isocorrosion curves for Glasteel 4000 glass. These curves are for pure acids and bases most commonly used in the chemical industry. They take into account, technically relevant parameters which may include, volume to surface area ratio, inhibition effects, concentration, and temperature.

In practical operation, these corrosives are nearly always encountered with liquid additives, dissolved substances, or gases, any of which may have positive or negative effects on resistance. Therefore GMM Pfaudler recommends performing corrosion tests or contacting a GMM Pfaudler specialist to assure material suitability for specific processes.
- NITRIC ACID
- HYDROCHLORIC ACID
- PHOSPHORIC ACID
- SULPHURIC ACID
- ACETIC ACID
- AMMONIA
- POTASSIUM HYDROXIDE
- SODIUM HYDROXIDE
- SODIUM CARBONATE

- \% \text{HNO}_3\ by\ weight
- \% \text{HCl}\ by\ weight
- \% \text{NH}_3\ by\ weight
- \% \text{KOH}\ by\ weight
- \% \text{H}_2\text{SO}_4\ by\ weight
- \% \text{Na}_2\text{CO}_3\ by\ weight
- \% \text{H}_3\text{PO}_4\ by\ weight
- \% \text{CH}_3\text{COOH}\ by\ weight

- Volume to Surface Area Ratio (V/O) = 20

- 0.5 mm/year
- 0.2 mm/year
- 0.1 mm/year Fully resistant