PFAUDLER
Glass-Lined Technology

# Baffling

## Mixing Performance

GMM Pfaudler

# PFAUDLER

Glass-Lined Technology

For over 130 years, Pfaudler is the leader in developing new technologies to meet the highly specific chemical processing needs of its clients. One reason why our glass-lined equipment is trusted by over 90% of the world's top chemical companies is the sheer reliability of our reaction technologies and comprehensiveness of our glass-lined accessories. These technologies are critical to the safe containment of corrosive contents, maintaining the vessel pressure and ensuring the final batch quality.

In short, our glass-lined technologies are absolutely integral to an effective process.

## PRODUCTS & EQUIPMENT

- Glass Lined Reactors
- Glass Lined Mixing Systems
- Baffling Technoliges
- Storage Tanks & Receivers
- Glass Lined Columns
- Accessories
- Glass Lined Instrumentation
- Glass Lined Heat & Mass Transfer


50/5/50 t

# Definition of the Baffling

## Purpose of internal parts

### Definition of the baffling efficiency

The absence of a baffle is generally helpful and will reduce the power introduction to a minimum value. Flow pattern cannot be crated in a good manner.
Baffling degree is per definition 0. In case of 4 side wall baffles the power introduction is maximized. Additional baffles will not increase the power. Flow pattern is fully achieved.
Max Baffling degree is per definition 1. With 3 sidewall baffle 90% of the effectiveness of 4 baffles is reached.

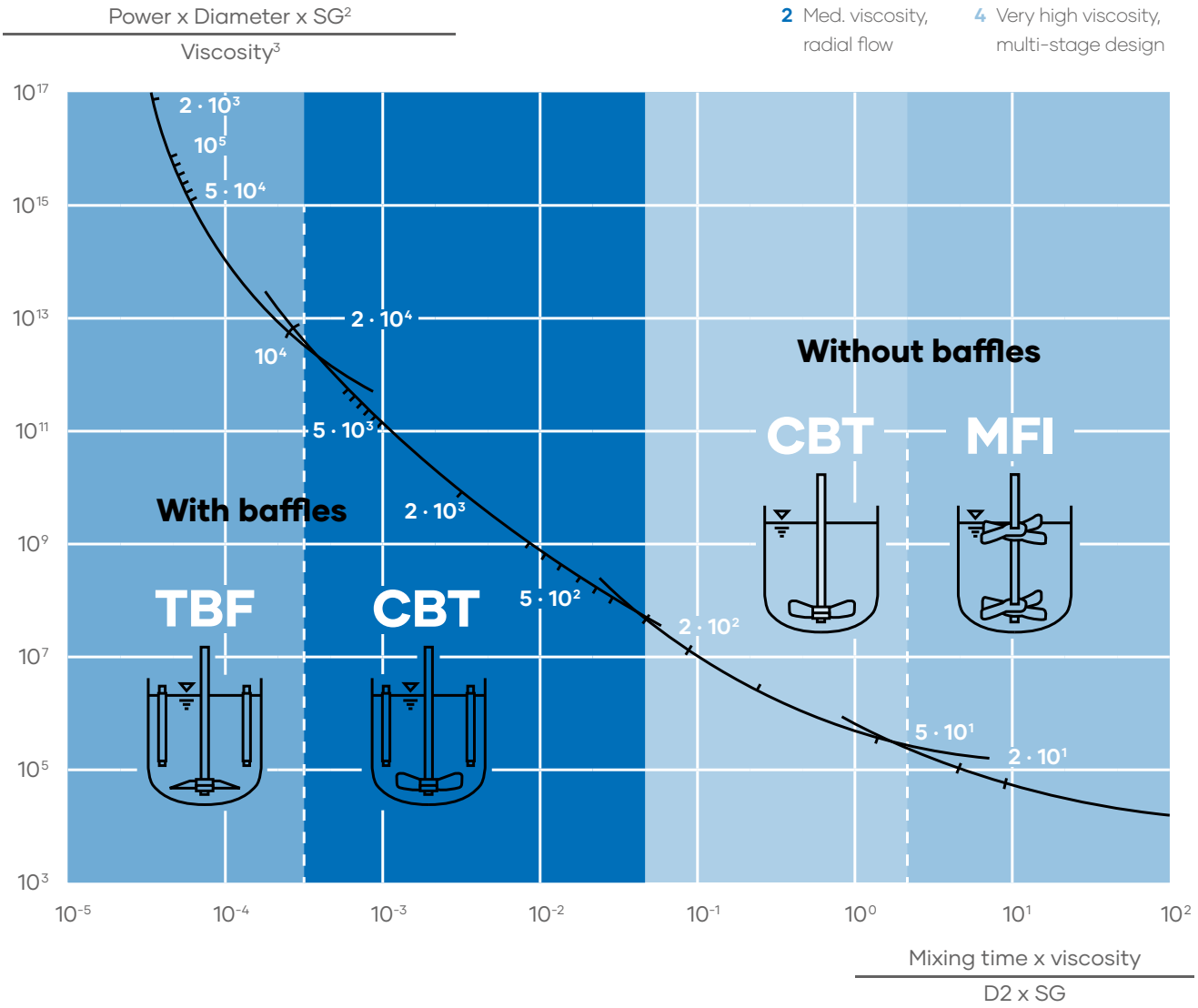
Baffling degree = 0.9 Same result can be reached by using 2 C-baffles which can be easily replaced. Other combinations are in between 0 and 1. Roughly above 10000 mPas baffles are not helpful for the flow but in most cases used as
a probe shell.

**1** Low viscosity, axial flow

**2** Med. viscosity, radial flow

**3** High viscosity, radial flow

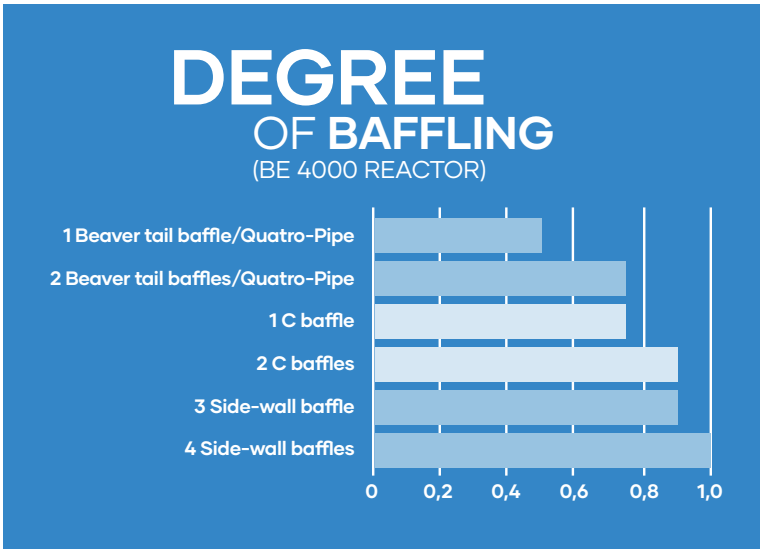
**4** Very high viscosity, multi-stage design

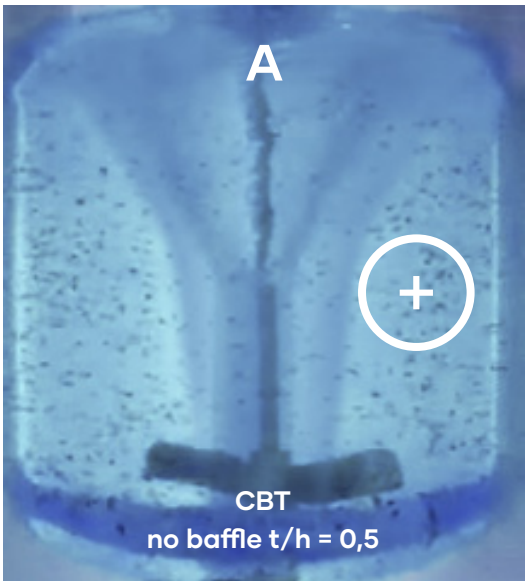


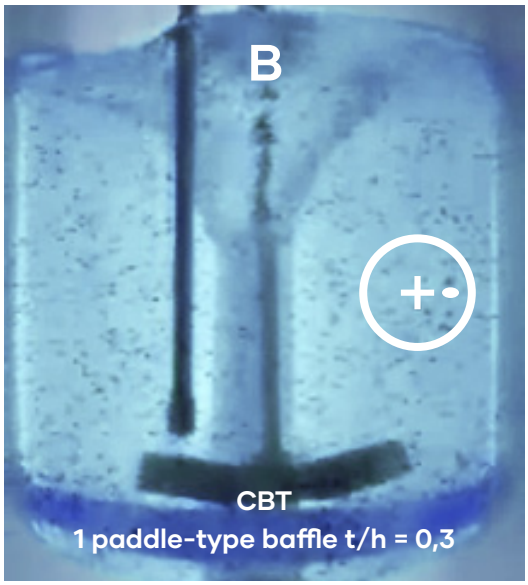
# Vortices

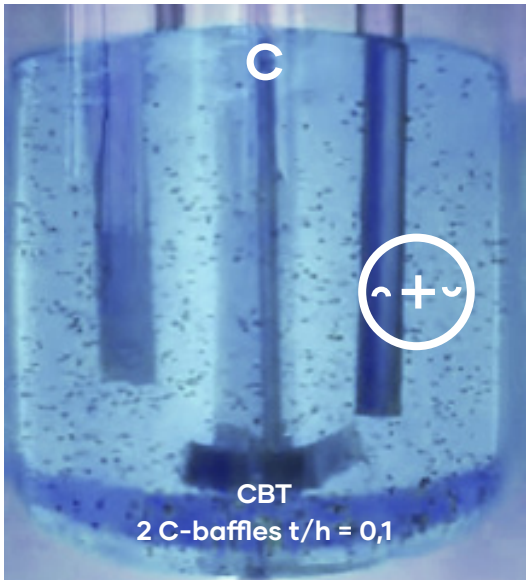
## Baffle effectiveness

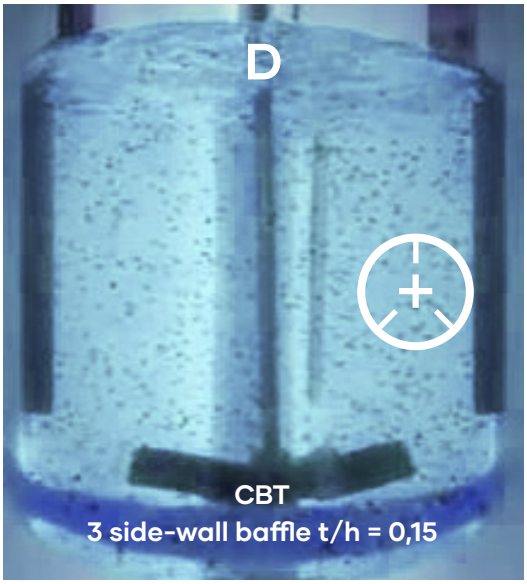
$$\frac{t}{h} = \frac{\text{Vortexdepth}}{\text{Reactorheight}}$$




**A** No baffle, deep vortex, no vertical exchange of liquid, poor flow pattern

**B** Typical constellation, clearly recognizable vortex, vertical exchange possible, defined flow pattern with irregularities

**C and D** Baffling degree 0,9 Minor vortex, practically not recognizable, optimized flow pattern

# Mixing Performance

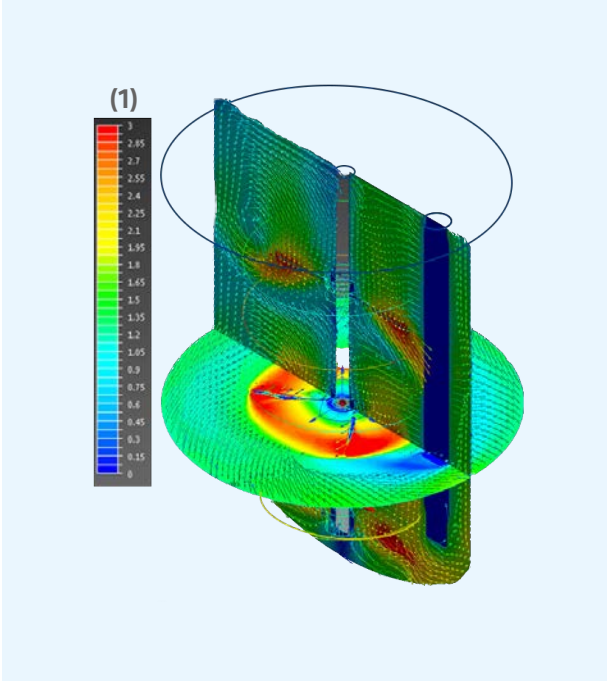
## Optimization of baffling

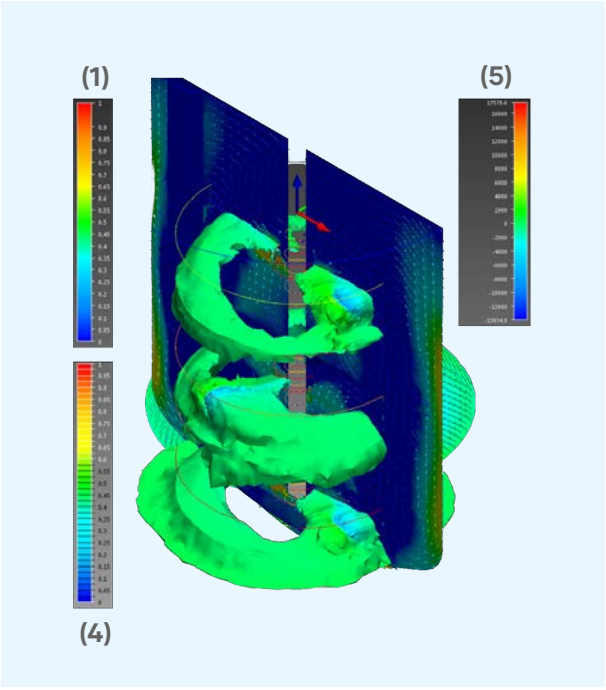
### CFD in mixing technology

The numerical fluid mechanics (Computational Fluid Dynamics, CFD) is an approved method of fluid mechanics itself. Beside applications for automotive and aircraft industries CFD is also used in the process and mixing industry. CFD offers nowadays the possibility to calculate such problems and to show results with demonstrative pictures and videos. The user will get results like flow velocities and directions, shear forces, local energy dissipation, mechanical power input, heat transfer coefficients, local pressure distribution, suspending possibilities as an abstract of the most important results. CFD is a fast and economic method compared to lab experiments or field tests. The influence of geometrical variations like modified blade pitch, width of blades, new customized turbine designs can be examined if it will be helpful for the process or not.

Additional CFD is very helpful in case of retro-fit projects like changing old fashioned mixing system or baffles to up to date systems like Cryo-Lock™. More effective or energy saving designs can be validated. A large number of process related questions or issue can be analyzed in advance before any manufacturing step of equipment is started.

Pfaudler is successfully using CFD related to mixing/process technology and heat transfer. We have practical experience to verify mixing systems and doing feasibility studies. Own data bases with all standard equipment like turbines, baffles and vessel geometries are available. As a result of this 3D-models, the base of each CFD calculation, are available in a short period of time. All results are included in a final report with suggestions, recommendations, pictures of results and video clips. We are offering beginning with the CFD analysis until the delivery of mixing system everything from one source.

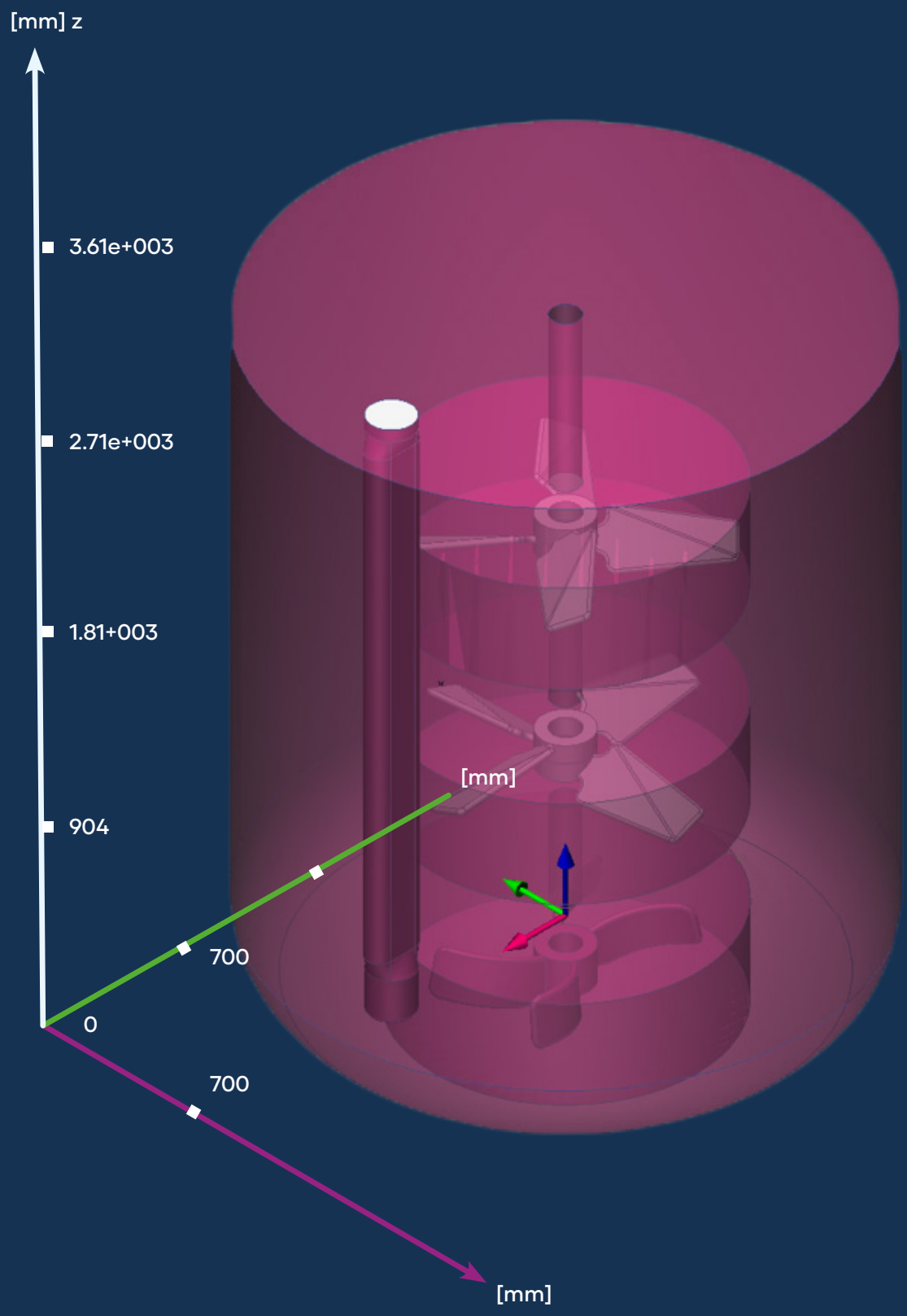



**(1)** Amount of twist – m/s

**(4)** Vz-Speed – m/s

**(5)** Static pressure - Pa


[mm] z
3.61e+003
2.71e+003
1.81+003
904
[mm]
700
0
700
[mm]

# Purpose of Internal Parts

## When using baffles

When using baffles? Baffles are breaking the vortex do that the vessel content will not rotate as fast as the agitator itself. The typical flow pattern of turbines can only be optimized by using baffles in low and medium viscosity ranges. Al kind of useful baffle shapes are available. Are baffles hindering flow or do they sometimes have a negative influence? Yes, in case of high viscosities. If viscosity is increasing the velocities hitting baffles are very low. A good example is mixing pudding in a cooking pot. Baffles inside would create death zones and mixing times would increase going along with agglomerates and a poor quality.

A good guide is approx. 5000 mPas or more to think about running without baffles. But you have to pay attention that baffles are sometimes equipped with probes.

### Maintainability

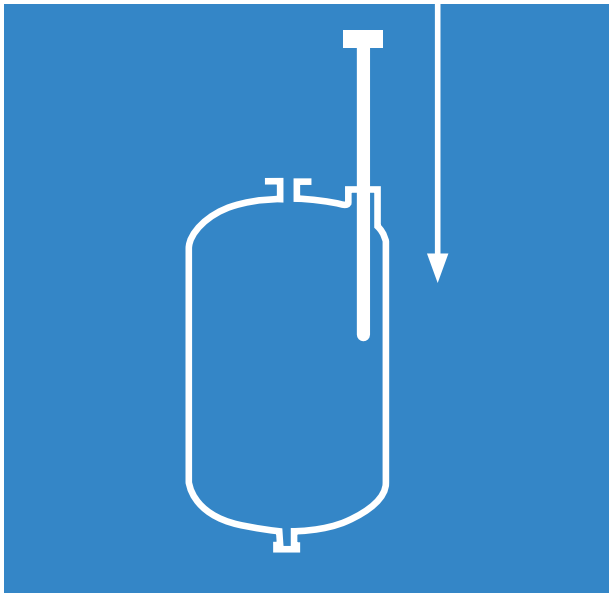
As described above baffles are sometimes very helpful and sometimes not. But there is another important issue. Baffles are wear parts which are forced by vibration, abrasion, glass corrosion, bending. The life span of baffles is not endless and baffles must be changed from time to time. The life time of a vessel is typically longer. So baffles and other parts inside the vessel which are stressed by e.g. velocities and solid hits are spares like turbine blades which have a life span too. Especially high efficiency baffles have even highest stress and wear.
Hence all parts as the vessel itself must be checked in a period of time depending on load described above. A damage on a baffle can be repaired very reliable by replacing it and doing a re-glassing of the damaged one. All risks can be minimized as much as possible.

### Purpose of internal parts

- Preventing or avoiding vortex formation
- “Breaking up” the liquid surface
- Introducing measuring systems
- Intensifying the heat exchange between the liquid and the heat transfer surface
- Increasing the mixing power input
- Diverting the flow towards the wall or the center – the possibility to be rotate an important feature

### C-Baffles

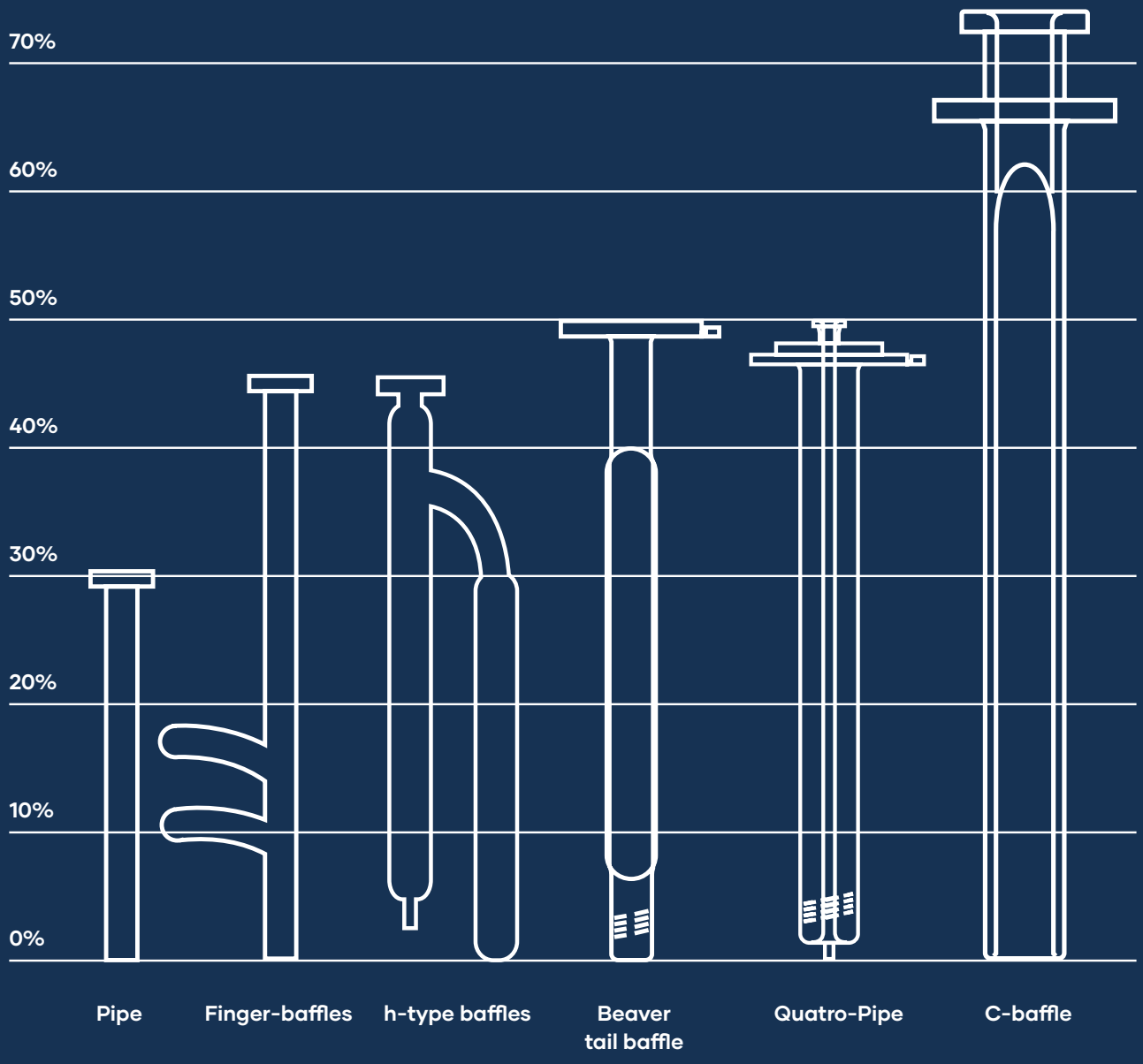
- Optimum baffling efficiency in the reactor
- No additional nozzle necessary
- Can be retrofiled at any time
- Available with temperature measuring technology
- Available with glass monitoring
- Gentle to drives

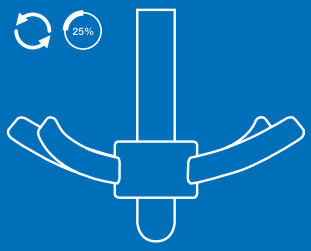


**Important**
Baffles are wear parts which must be able to be replaced in case of glass corrosion, abrasion, damages, etc.

# BAFFLE
## EFFECTIVENESS

$$S_x = \frac{P_x - P_{s=0}}{P_{s=0} - P_{s=0}}$$

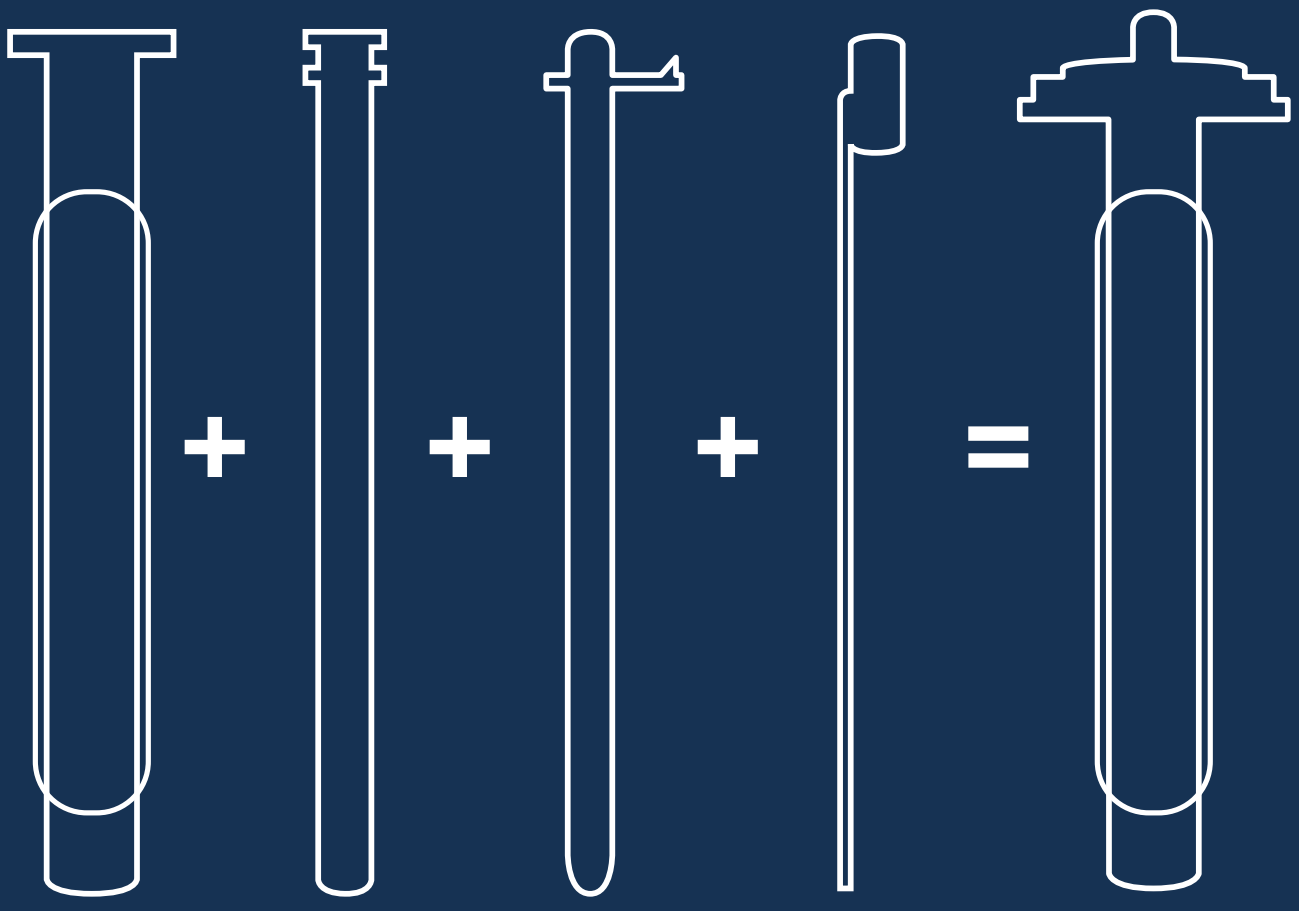





**MIXING**

HIGH
**QUALITY**
COMPONENTS

ANALITICAL
**DATA**



Baffle + Dip-Pipe + Probe + Sampling = Quatro-Pipe

Probe
- temperature
- corrosion monitoring

# Quatro-Pipe and Polycon

## The best solution for every requirement

### 4 or more functions in 1 nozzle

With the Pfaudler baffles Polycon and Quatro-Pipe, you can arrange several important functions in a single nozzle of a vessel.

### Function 1 – Flange baffle

The Pfaudler Polycon and Quatro-Pipe has all properties of baffle with a constant counter agitating effect. It can be removed without necessitating vessel entry.

### Function 2 – Dip pipe

The glasslined internal tube of the Pfaudler Polycon and Quatro-Pipe can be used for numerous additional applications:

- as product inlet
- as product sampling access
- for mixing of gas and fluids
- sparging

### Function 3 – Sensors for temperature measurement and Glass monitoring

**Quatro-Pipe:**

Quick measurement results are essential for optimal temperature control. Using the fused-in glass lining Pfaudler TW temperature sensor offer a clear advantage – response time can be divided by up to 5.

**Glass monitoring:**

The Pfaudler P-probe can be integrated into the Quatro-pipe. This unit continuously monitors the integrity of the glass lining and warns when lining damage occurs, minimizing the change for expensive damage and increasing the availibility and reliability of your process.

**Polycon:**

For slow processes in which optimal temperature regulation is not required, simple and cost-effective temperature measurement is available. Pfaudler's type TRI temperature probe is a robust, simple and cost-effective solution for measuring temperature.

Quatro-Pipe

Polycon

# Quatro-Pipe and Polycon

## The best solution for every requirement

### Function 4 – Sampling system

The **Pfaudler Polycon** and **Quatro-Pipe** can be easily converted into a continuous sampling system by fitting a PTFE internal tube and an external structure. During the process, this system does not require any additional nozzle or cleaning. The representative sampling point and high operational reliability are the fundamental properties of the technology from Pfaudler.

The Quatro-Pipe does not have any gaskets in the product area. It's design permits easy application of the glasslining and makes the Quatro-Pipe extremely safe.

### Technical Data

The **Pfaudler Polycon** and **Quatro-Pipe** have been standardized for each vessel size and can bedelivered quickly and retrofitted to existing vessels. It can be combined with all agitator types.

- Installation
  Flange connection to DIN 2501. Installation in ANSI nozzles possible by replacing the loose flange
- Glasslining
  All surfaces of the **Quatro-Pipe** which are in contact with the product are protected by Pfaudler Glass WWG 9115.
  The glass is extremely resistant to chemical and mechanical stress.
- Operation conditions (**Quatro-Pipe**)
  Admissible operation pressure:
  -1 ... +6 bar
  Admissible operation temperature:
  -25 ... +200°C

| Vessel size [nominal volume in litre] | | | nozzle DN | ET [mm]* | B [mm]* |
|---|---|---|---|---|---|
| AE | 630 | | 150 | 1,035 | 135 |
| AE | 1,000 | | 200 | 1,250 | 180 |
| CE | 1,600 | | 200 | 1,300 | 180 |
| AE BE | 1,600 | | 200 | 1,550 | 180 |
| CE | 2,500 | | 200 | 1,550 | 180 |
| AE BE | 2,500 | | 200 | 1,750 | 180 |
| CE | 4,000 | | 250 | 1,900 | 180 |
| AE BE | 4,000 | | 250 | 2,100 | 180 |
| CE | 6,300 | | 250 | 2,460 | 180 |
| AE BE | 6,300 | | 250 | 2,660 | 180 |
| BE CE | 8,000 | 0 2,000 | 250 | 2,660 | 180 |
| BE CE | 8,000 | 0 2,200 | 300 | 2,600 | 260 |
| BE CE | 10,000 | | 300 | 2,600 | 260 |
| BE CE | 12,500 | | 300 | 3,300 | 260 |
| BE CE | 16,000 | 0 2,600 | 300 | 3,600 | 260 |
| BE CE | 16,000 | 0 2,800 | 300 | 3,300 | 260 |
| Contact us for different vessel sizes | | | | | |

* ET: length below flange
* B: baffle width

FLEXAMPLER LOOP

**SAMPLING SYSTEM**
FUNCTION 4

FLEXAMPLER STANDARD

**BAFFLE**
FUNCTION 1

**DIP-PIPE**
FUNCTION 2

**PROBE**
FUNCTION 3

TEMPERATURE AND/OR CORROSION DETECTION

**PFAUDLER QUATRO-PIPE**

# Temperature Measurement

## Sometimes speed is key

Early recognition of process temperatures enables you to regulate it precisely and minimise fluctuations. Lower energy input and lower energy losses result in well-balanced energy management and therefore lower costs. Various technologies are available, depending on the application.

Quick measurement results are essen-tial for optimal temperature control.
Pfaudler's fused-in glass lining solutions closely offer a clear advantage – they are in contact with the medium. Sometimes speed is key!

**TW**
FUSED-IN RESISTANCE THERMOMETER

### Fused-in resistance thermometer

The functionality of Pfaudler's type TW temperature probe relies on the temperature dependence of the electric resistance of platinum. The platinum measuring unit, a PT 100 resistance thermometer, is fused into the glass lining of baffles or thermometer wells, providing an quick detection of temperature variation. Compared to conventional glass lined temperature measurements the Thermal inertia of fused-in sensors is lower, ensuring extremely low half-value times.

- Fastest glass-lined temperature probe
- No sealing elements
- Long service life, excellent long-term stability and maintenance free
- No drifting

**T**
FUSED-IN THERMOCOUPLE

### Fused-in thermocouple

In the Pfaudler type T temperature probe, the temperature is measured exactly where it is needed. A Pallaplat thermocouple is fused into the glass lining of C-baffles or valve cones, providing a **quick detection of temperature variation**.

- Up to six measurement points on one probe carrier
- No sealing elements
- Long service life, excellent long-term stability and maintenance free
- No drifting

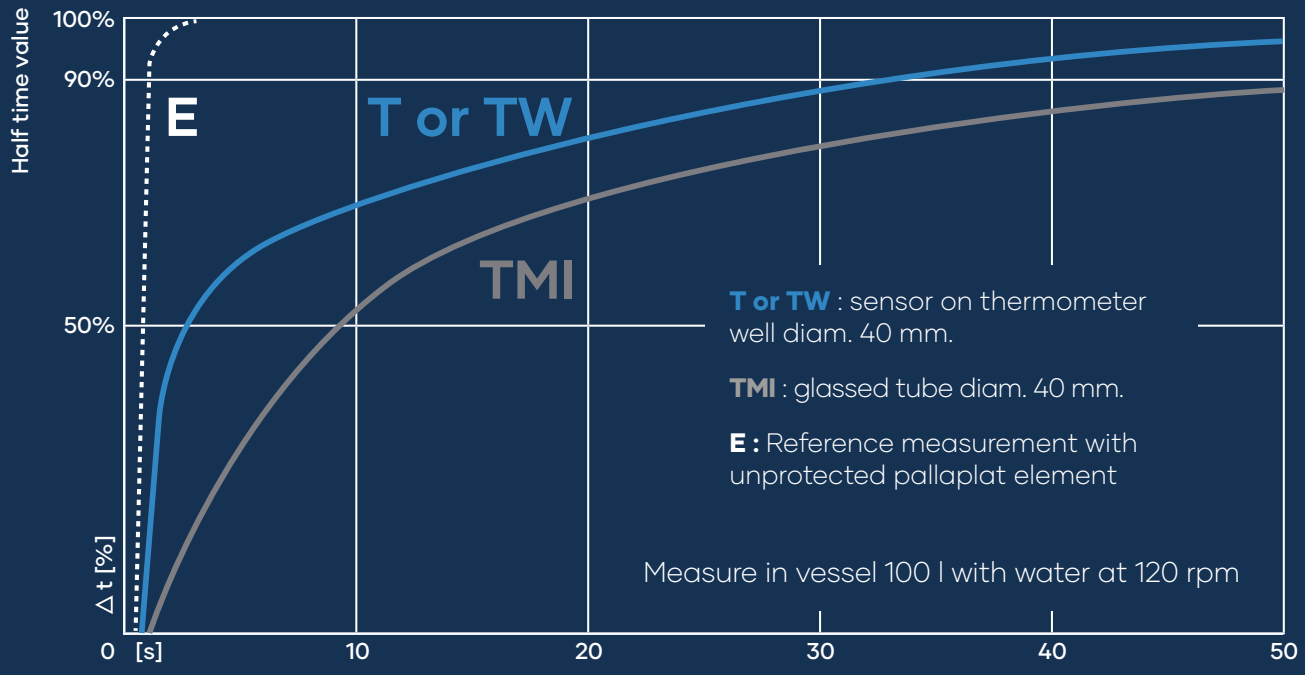
**TMI**
INSERTED TEMPERATURE SENSOR

### Inserted temperature sensor

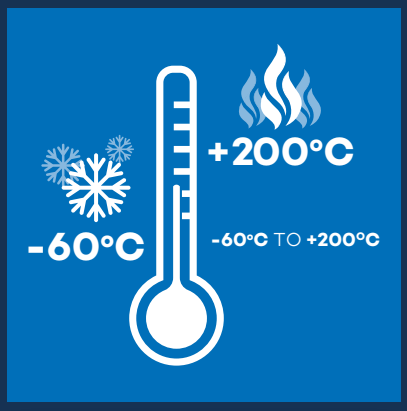
Pfaudler's type TMI temperature probe is a **robust, simple and cost-effective solution**. The measuring insert – a Pt 100 resistance thermometer – is pressed by spring action to the bottom of the baffle or valve cone.

- Up to six measurement points on one probe carrier
- No sealing elements
- Long service life, excellent long-term stability and maintenance free
- No drifting

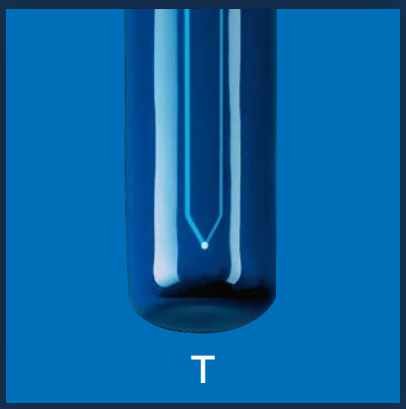
## Time response











# Corrosion Monitoring

## The right decision

The Pfaudler technology not only enables to monitor glass-lined surfaces but also other corrosion-resistant surfaces (e.g. PTFE-coated) of reactors including fittings.

Thanks to the implemented algorithm false alarms are ruled out. Reliable information about the condition of the reactor are obteined and the systems connected components.

Solutions are available for continuous corrosion monitoring and systems for periodical mobile corrosion testing.
It is thus possible to storage vessels regularly for corrosion damage at low costs and effort.

Corrosion monitoring must be above all – reliable!

CD
CORROSION DETECTOR

### Continuous corrosion monitoring

Continuous corrosion monitoring can be carried out with measuring electrodes fused into the glass lining of baffles and/or valve cones – the **P-probe** – in conjunction with the associated electronics – the **Corrosion Detector**.

P
P-PROBE

This not only enables to monitor glass-lined surfaces but also other corrosion-resistant coatings (e.g. PTFE) of reactors and their associated glass lined components. Thanks to the implemented algorithm, **false alarms are ruled out**.

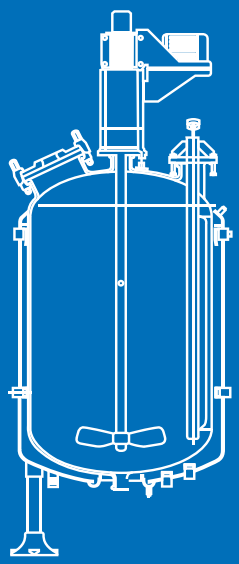
- Principle of **decomposition voltage analysis**
- Measurement **not influenced by electrically conductive elements**
- Control measurements **rule out false alarms**
- Certified for ATEX

CDP
CORROSION DETECTOR PORTABLE

### Mobile corrosion testing

The Corrosion Detector Portable offers corrosion testing according to a maintenance plan or when required, and tolerates electrically conductive elements. The hand-held device is supplied with a PTFE dip probe, a reference electrode and an earthing clamp. Measurements can be transmitted to a PC using the USB adapter cable provided. The associated software is provided on a USB stick.

- Principle of **decomposition voltage analysis**
- Measurement **not influenced by electrically conductive elements**
- Control measurements **rule out false alarms**
- Can store up to 10,000 measurements
- Certified for ATEX



# GLASTEEL

ANTI CORROSION
ANTI STICK
ANTI STATIC

CORROSION DETECTOR
PORTABLE

CORROSION
DETECTOR


# P

P-PROBE

ON
VALVE STEM

ON ROD-PROBE
OR BAFFLE

# Global Services Capability

Pfaudler guarantees a global service during the whole process, pre and post sales, with the largest service organization in different sectors.

Our Service Centers are close to your site to guarantee fast and flexible services. More than 150 people are at your service. We are present in several countries with field engineers who can provide you with comprehensive support for installation, commissioning and maintenance of your facilities and plants.

## Our Services

From comprehensive engineering and technical services to our rapid, reliable field services and aftermarket parts supply, you can count on us to keep your process system operating properly:

### Engineering

- Consultancy Services
- Pilot testing / toll operation
- Process engineering

### Installation, Commissioning, Start up

- Planning
- Project management
- Installations
- Lining measurement technologies

### Maintenance and aftersales

- Maintenance & repair
- Troubleshooting
- Glass inspection, reglassing and repair
- Shutdown services
- Spare / Replacement parts
- Mechanical seal exchange

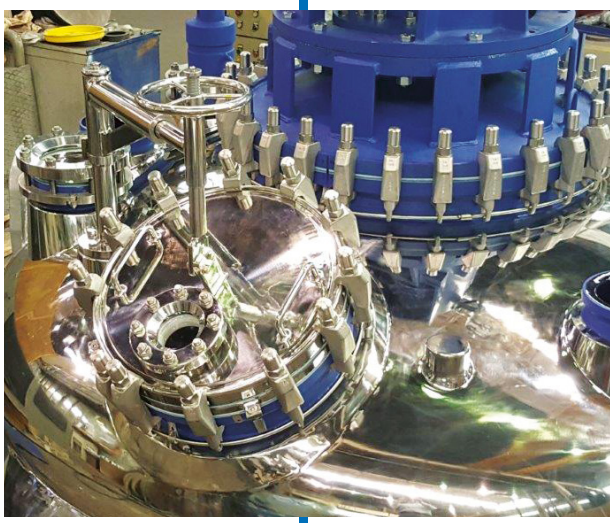
## Pfaudler Safety First

Delivering excellent safety performance is necessary for any company operating in the process industries. Over the years, and all over the world, Pfaudler has provided security in its products and highly-qualified service teams.

We are committed to safety and our field service organization that provides installation and maintenance for your facility, has developed strict safety policies to ensure a safe working environment.

Pfaudler guarantees:

- skilled professionals properly prepared and qualified on security and risk management
- observance of international standards
- use of professional personal protective equipment
- reduced operating risks



## Refurbishing, reglassing and inspection

In addition to its expertise in manufacturing and market products and engineered solutions, Pfaudler has core expertise in the service area of full equipment refurbishing. The reactors are completely reglassed, refurbished combined with a suitable retrofitting of all devices or accessories, producing an appropriate program to meet specific customer needs and timeframes. All this is in compliance with international and European standards. Our technicians provide a complete glass lining inspection program to ensure your reactor is in proper condition for safe and efficient operation.

Our commitment to quality components means that our technologies are often in service for many years. However, our pioneering approach means that during this time we have developed new solutions. Whether your process is changing or you are looking to further optimise performance levels, an upgrade to our new technologies can improve the capabilities of your reactor.

# Worldwide Presence

GMM Pfaudler


GMM Pfaudler is a global leader in corrosion-resistant technologies, systems, and services for the chemical, pharmaceutical, food and energy industry.

Our Branded Product Lines that include PFAUDLER, NORMAG, MAVAG, MIXION, INTERSEAL, EQUILLOY and EDLON, showcase our strength as a group, our capabilities, and our pursuit for constant innovation. With an end-to-end solutions-oriented approach, a global footprint, and a perfectly integrated offering system we are able to meet complex industry demands worldwide.

GMM Pfaudler is driven by 1500+ individuals across 4 continents and 14 global manufacturing facilities around the world. The Group's targeted investments in strategic markets, innovation and competitiveness paves the way forward for GMM Pfaudler's continued legacy.

**100**
Countries

**1500 +**
Employees

**04**
Continents

# Our Global Contacts

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Manufacturing Facilities  Sales & Services Organization

GMM Pfaudler

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