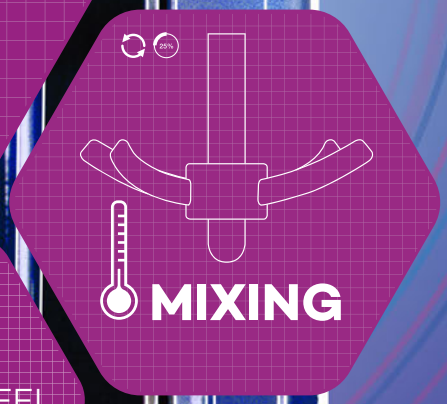
PFAUDLER
GLASS-LINED
& ALLOY SYSTEMS

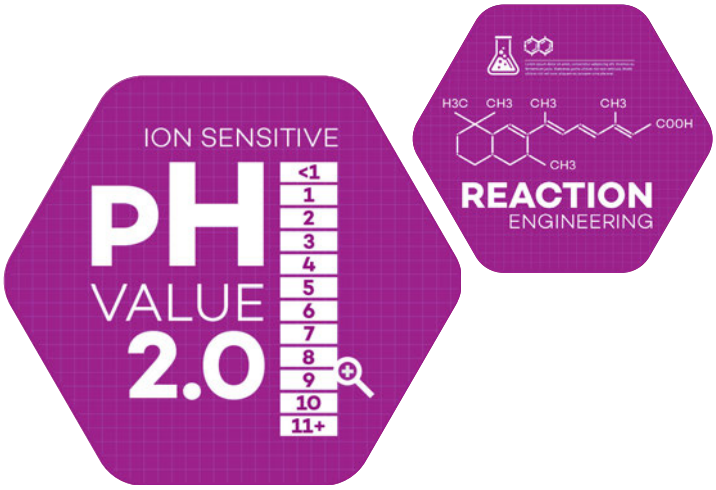
Pf Technologies

AGITATING AND MIXING

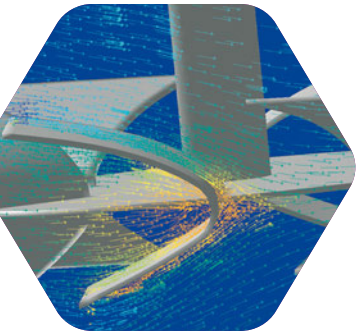


Pfaudler
Defining the standard

Contents



From Concept To Production

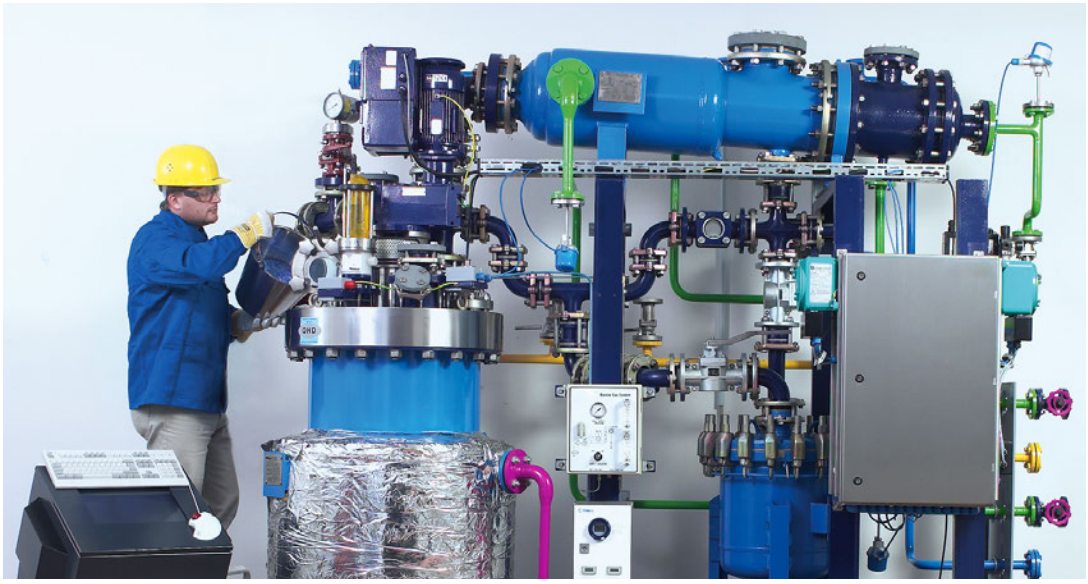


Agitating technology is another word for Pfaudler

Agitating and mixing in processes? Chemical engineers all over the world immediatly think of Pfaudler. For many a decade, our name has been standing for a functional, individual agitating technology — especially in the scope of glass-lined reactor systems.

The engineering plant — theory and practice

Our engineering plant is of particular importance. It has the facilities for an initial quick, efficient analysis of need. Furthermore, practical laboratory tests can be carried out, which also take our customers specifications into account. Their results can be transferred to the very production by way of a scale-up. We prepare computer and video logs and records of the agitating tests and make the results available to our customers.

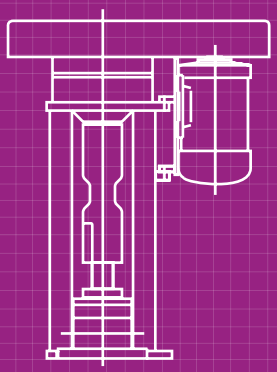


The right solution to each task

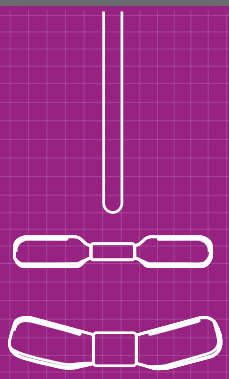
Different industries and applications make different demands on agitator systems. Therefore, the special features of the chemical, pharmaceutical and food industry have to be accounted for without neglecting an efficient production. These influencing variables are satisfied by the concepts of our agitating technology.
We find a solution to each substance and heat transfer process.

Pfaudler glass — highly resistant and smooth

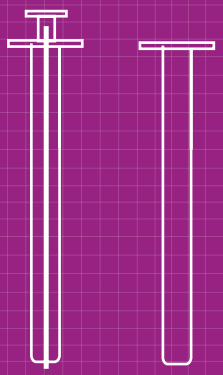
With its extreme corrosion resistance and smooth surface Pfaudler glass is particularly suitable for processing aggressive substances in the chemical industry, highly pure products, chemical and pharmaceutical substances that react with metals, food products as well as tough, sticky substances of any kind.



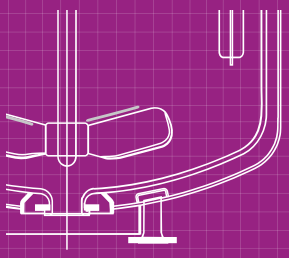
Agitator drives for all performance ranges



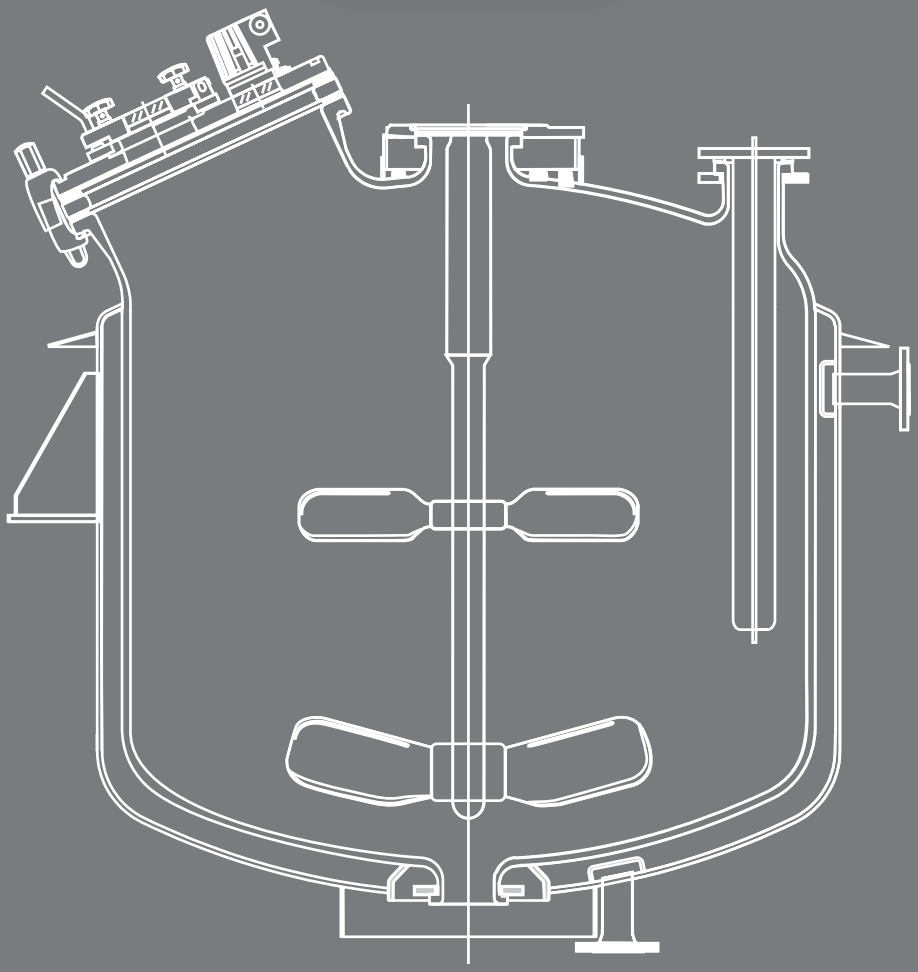
The optimum agitator shape for each process



Baffles and the Quatro pipe system



Glasslined reactors for many industries



DIN Agitator Drives

VSO 8/80 up to 130/160 open and service-friendly

Construction

A coupling between the gear box and the agitator shaft provides for time saving installation or removal of a mechanical seal to DIN without removing the gear box. The agitator remains in the reactor and is supported at the agitator flange by a special fixture. All parts are easily accessible, and additional accessories, such as assembly tools for easier performance of all works, or monitoring devices for the drive can be attached without any problems. Rotating parts are equipped with machine guards.

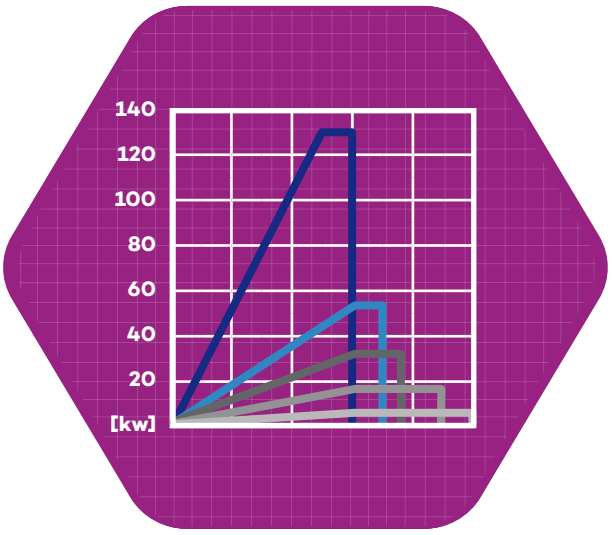
Design

The VSO agitator drives are supplied as standard drives. The different drive modules that can be attached include three-phase current motors with constant rpm, pole reversal or frequency control, or hydrostatic control gears.

A conductive V-belt drive transmits the motor power. It may be used to adapt the speed precisely to the operating conditions in order to prevent overload of the unit and increase its useful life and reliability. Direct in line or direct angular gear drives are also available as alternative to the V-belt version.

- Low-maintenance, safe construction
- Efficient maintenance through open design
- Accessories easy to attach
- Possibility of implementing customer-specific options

Agitator drives DIN VSO 8/80 to 130/160 for reactors to DIN 28136 with a volume of 1,600 l or more, with different power/speed ranges.



130/160 64/125, 64/140
32/100, 32/125 16/80, 16/100
8/80

Glasringdichtungsaustausch mit Hilfe des Austauschwerkzeugs

DIN Agitator Drives

VSO 1, 2, 3, 4 – The compact power packs

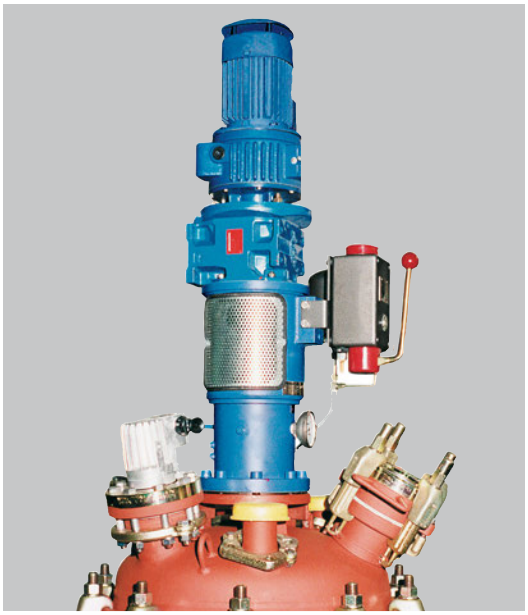
Construction

The drives are available in 4 performance ranges. You may choose between motors with constant rpm, pole reversal or frequency control. The agitator drives are supplied in compact, space-saving design (inline). The agitator and gear box are directly linked by a disc clutch. The drive support stool is based on the mechanical seal.

Sealing pressure system

A static sealing pressure system is available as a standard. The pressure is generated manually, and kept inside the system. On request, we also supply a seal lubrication system with circulating seal fluid, a so-called thermosyphon system.

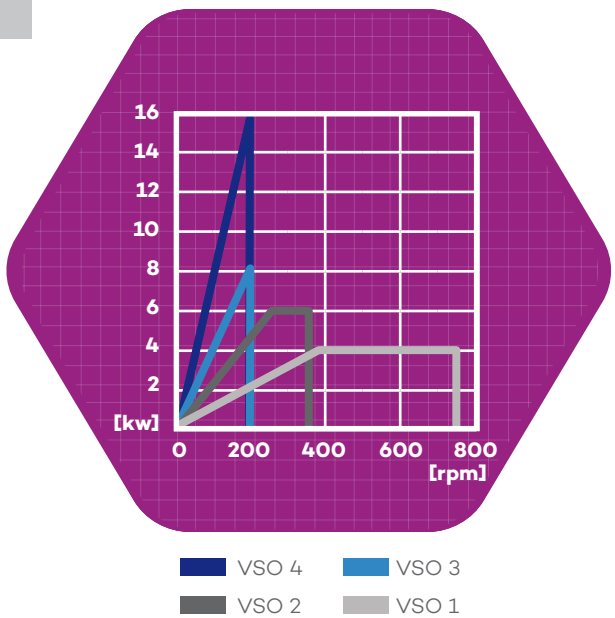
- Compact design
- Expandable



Agitator drives VSO 1, 2, 3, 4 for reactors to DIN 28136 with a volume of 63 to 2,500 l, with four different power ranges.

Mechanical seal

A double-acting mechanical seal to DIN 28138 has been integrated. Its bearing is located above the seal fluid chamber. Therefore, this component is not subject to the customary restrictions concering the seal fluid choice. If necessary, the mechanical seal can be directly cooled through the cooling jacket, a standard component. The entire range of Pfaudler mechanical seals has been designed for the VSO drives.



Agitator Drives

VL – The small powerpacks

Construction

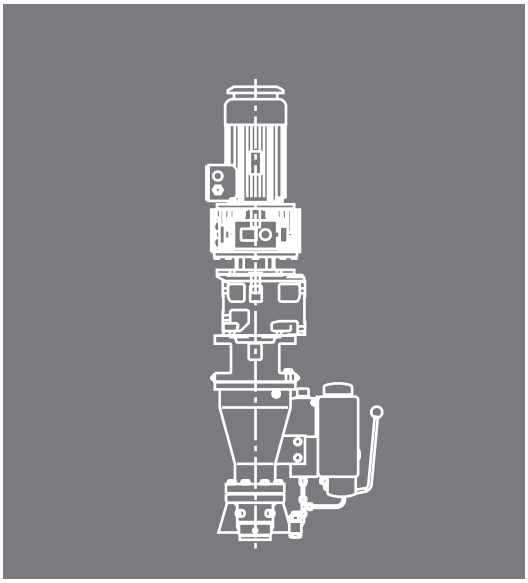
The Pfaudler VL drives are available in three sizes and power ranges with a maximum agitator speed of 180 to 800 rpm. The in-line arrangement provides for a compact, space-saving design. A robust shaft coupling with a rubber core links the gearbox and the motor, offering benefits in mass accelaration.

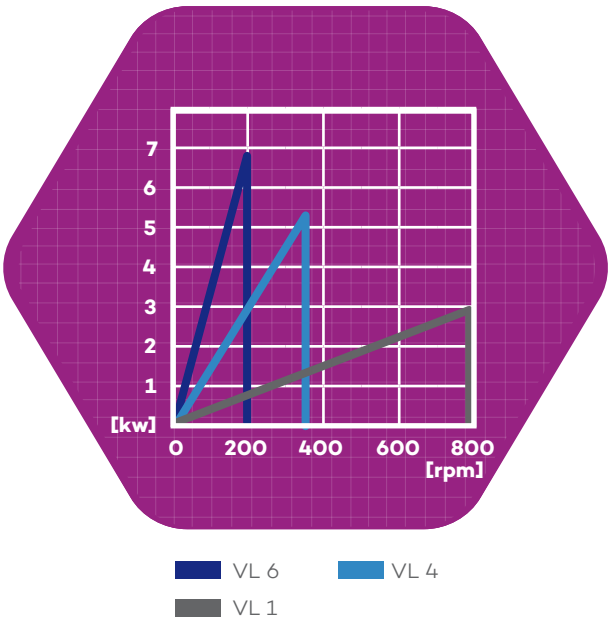
Mechanical seal

Each VL drive comprises the gear box, mechanical seal housing, and seal fluid reservoir. The mechanical seal unit consits of the external and internal pair of mating rings. A static thermosiphon system (SAM) is an integral component of the drive unit. Water-lubricated drives are available as special designs.

- Compact, space-saving design
- Extremely high pressures (up to 40 bar in standard design) possible

VL Agitator drives for small reactors up to a volume of 800l, in three power ranges. Special design VLH FCR pressures up to 100 bar.





Bottom Drives

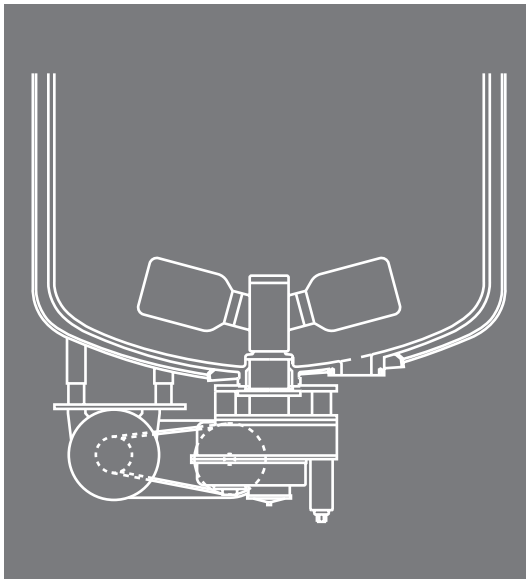
HU – High rotating speed for large reactors

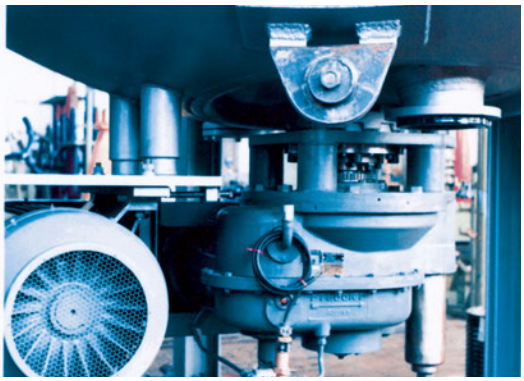
Construction

Long agitator shafts are not suitable for high speeds due to the vibration and shaft excursions produced. The HU drives solve this problem from below using a short agitator shaft. In this way, both optimum speeds and a high operating reliability can be achieved in large reactors, e.g. of the type used for polymerization. For use with aggressive media, the HSU drive is additionally available.

- Variable agitator shape, also in Cryo-Lock® design - easily adjustable
- High speed range, advantageous torque, easy speed change – powerful
- Easy replacement of mechanical seal through gear box swiveling device – easy maintenance
- Double mechanical seal with secondary sealing – safe
- Emergency seal; the reactor need not be emptied to change the mechanical seal

HU agitator drives for large and high reactors with high torques and power, in five power ranges.



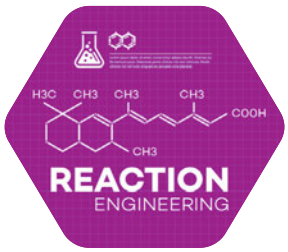


Mechanical seal

The drives are equipped with a double mechanical seal. In the event that both seal faces should fail, the secondary seal will ensure tightness long enough to complete a batch. Continous lubrication protects the seal faces against direct contact with product. We recommend using our static lubrication system for lubricating the seal. Rinsing equipment is available in standard design or in customized versions theat match the individual requirements.

More Process Efficiency

For all agitating tasks



Aiming at the optimum

Our engineering plant is focused on diversity. The complexity of our customers demands is increasing. Before an agitator moves, flow simulations on the computer screen or practical laboratory tests help us find the most suitable technical option and the most efficient solution for new and existing plants requiring optimization:

- To improve the agitating efficiency, e.g., through retrofits
- To reduce the raction and mixing times
- To minimize cost or maximize the efficient use of energy
- To optimize the product quality, yield, and throughput

Residual amounts or small filling volumes also have to be accounted for.

Homogenization

Two liquids soluble in each other have to be completely mixed. It is important to balance different temperatures and concentrations in order to ensure a high degree of homogeneity. This requirement is satisfied by choosing an agitator with a high revolving capacity.

Dispersion
Liquid/liquid

This task involves mixing of insoluble liquides, e.g., extractions or emulsions. A liquid (disperse phase) is distributed in another insoluble liquid (continous phase) by this process which requires agitating systems with high circumferential speeds and shearing forces. A spezial incident of this application is polymerization, which requires low shearing forces and constant flow rates.

Liquid/gaseous (mixing fluids and gases)

Gas bubbles inside a liquid have to be broken into very fine bubbles in order to improve the substance transport. This requires a long dwell time, while bubble coagulation of the gas has to be avoided. This is achieved by very high shearing forces and local sudden pressure changes at the agitator. We design the proper agitator with respect to the type of mixture between gas and liquid, and the viscosity. Our GST turbine is ideal for mixing external gases and liquides.

Suspension

Suspension involves whirling up solids in a liquid. For this application, the interphase has to be enlarged in order to accelerate the solvent processes and catalytic reactions. The optimum choice are agitators that output a direct impulse on the solids, thus ensuring an optimum whirl and a maximum interphase between the solid and the fluid.

Thermal transfer

The time required for heating up or cooling down a reactor is basically determined by the thermal transfer at the reactor wall between the heating/cooling system (e.g. double jacket or half-coil pipe) and the medium inside the ractor. A good thermal transfer is achieved at high flow rates along the wall and by thoroughly mixing the reactor volume. Multi-step agitator systems have proven to be most effective.

Combined agitating tasks

Especially in the chemical and pharmaceutical industry, additional demands have to be accounted for:

- Agitating residual amounts
- Product incrustation
- Foaming products
- Floating solds

Our experience, combined with the large number of our systems, enables us to solve event these demanding agitating tasks in a convincing manner.

Optimization Of

Mixing performance

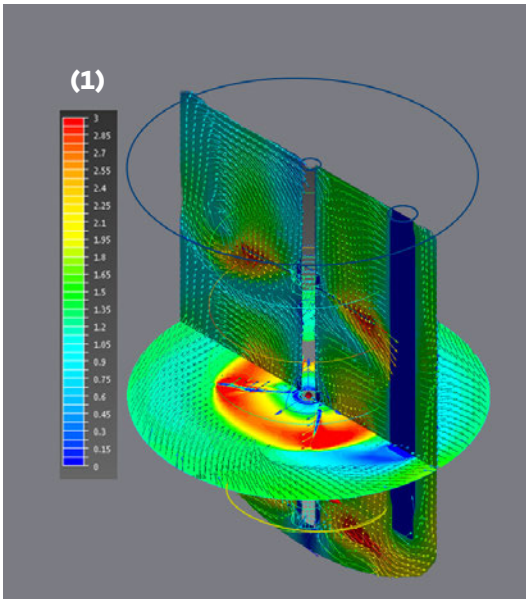
CFD in mixing technology

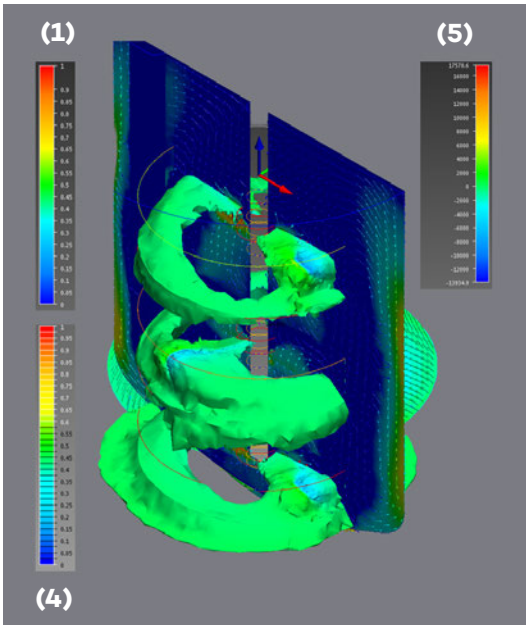
The numerical fluid mechanics (**C**omputational **F**luid **D**ynamics, CFD) is an approved method of fluid mechanics itself. Beside applications for automotive and aircraft industries CFD is also used in the process and mixing industry.

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 questions can be analyzed in advance before any manufacturing step of equipment is started.

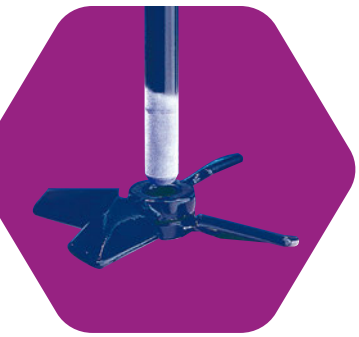
Pfaudler is successfully using CFD related to mixing/process technology and heat transfer. We have practical experience to verify mixing systems and doing feasibility studies. Own data bases with all standard equipment like turbines, baffles and vessel geometries are available. As a result of this 3D-models, 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

Cryo-Lock® Joining System



Small opening, great safety

Before Cryo-Lock® was invented, the agitator dimensions determined the size of the principal opening of a glasslined reactor. To obtain the smallest possible opening, and thus increased safety, was the motivation and the objective of developing Cryo-Lock®. Large openings (e.g. on reactors AE and CE) offer disadvantages, namely, the long gasket lengths. The Cryo-Lock® developed by Pfaudler turns the manhole into the largest opening (reactor BE), without having to split the agitator shaft, which in turn would require complicated joining methods.

Connection without joints

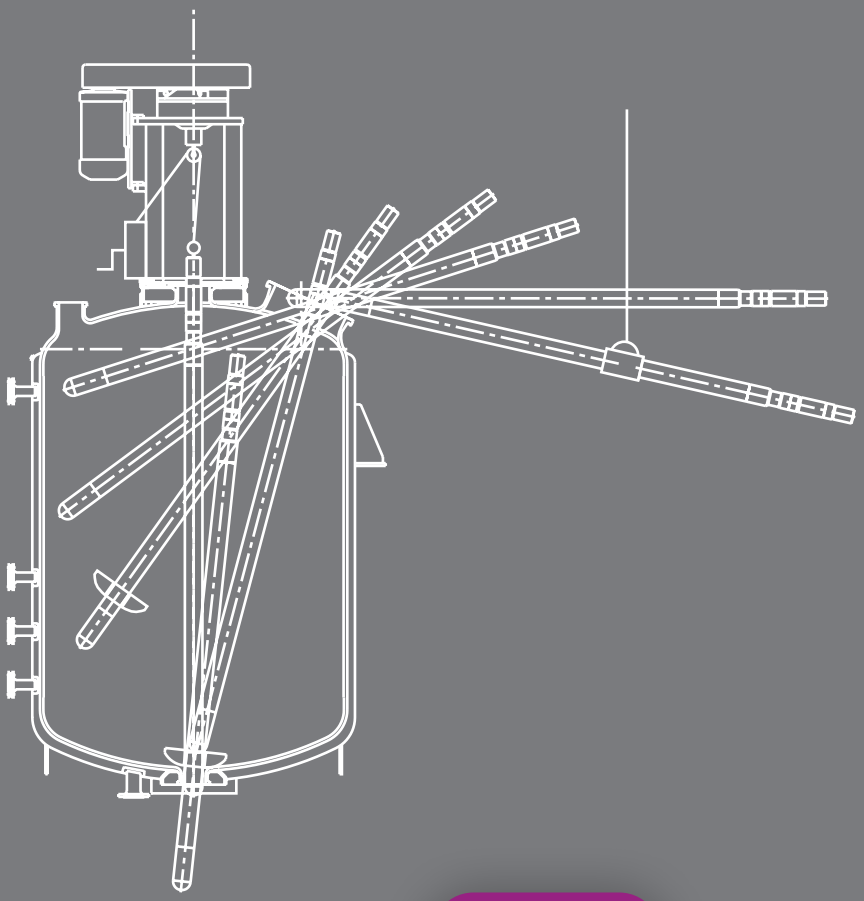
A fully glasslined reactor shaft is strongly cooled with nitrogen (-196 °C). By this process, the shaft shrinks, so that an equally fully glasslined agitator can be fitted to the shaft. Once both parts have warmed up to ambient temperature again, they are firmly joined by a nonpositive connection. The entire process can be reversed. Once it has been cooled down again, the agitator can be removed without causing any wear and replaced by another one – e.g. if a different agitating process is chosen.

Freedom of shape

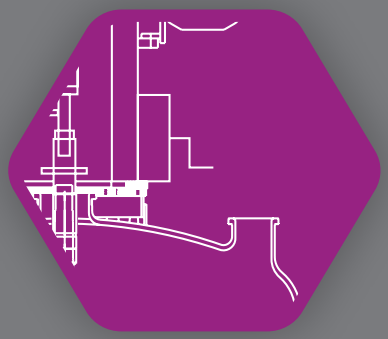
In many cases, the effect of a single agitator step is not sufficient for agitating the entire reactor contents. Cryo-Lock® provides for individual agitator designs. Several agitators of any size and shape can be coupled to a single shaft. This possibility provides for extremely customized agitator assemblies for different applications and processes. Our engineering plant will be pleased to assist you with the design and optimization.

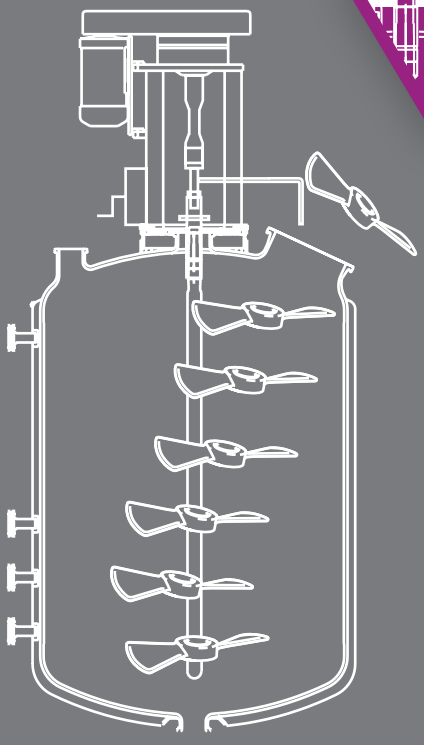
Advantages:

- Fully glasslined, liquid-tight connection between agitator and shaft
- Extremely short replacement times: shaft remains assembled, only the turbine is replaced. That means time and cost savings
- Suitable for reactors where the manhole is the largest opening (BE). More safety.
- New agitator shapes are possible according to Pfaudler standard or process specific
- No gaskets or connector elements required
- Identical hub diameter at all levels – reduced warehousing requirements
- Single- or multi-step

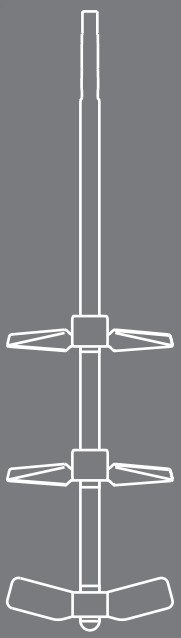


Cryo-Lock® agitator shaft: easy and quick installation





The turbine through the manhole. More safety less time and money.



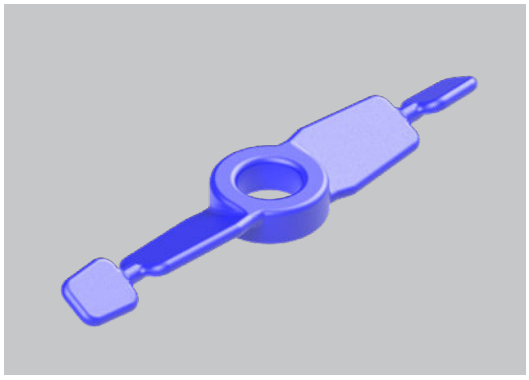
Multi-step agitator shapes can be easily implemented with Cryo-Lock®

The Turbine Shapes

Performance determined by the shape

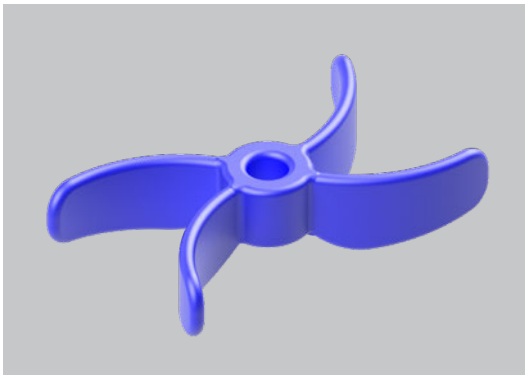
All benefits of glasslined components
Using the diversity of the Pfaudler agitators, you can equally benefit from the advantages of glasslined components and the capacity of ultramodern mixing systems made from metallic materials in any application area.

Cry-Lock® at its best
Depending on your requirements, you can choose the right shape with the most efficient function, while benefiting from the advantage of quick Cryo-Lock® agitator change.



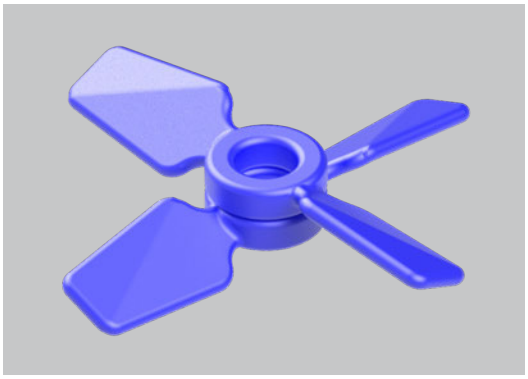
MSG, Multistep countercurrent agitator

- Can be used up to high viscosities (80000 mPas)
- Good thermal transfer
- Particularly suitable for homogenization, suspension
- Normally in multistep design, with or without a baffle



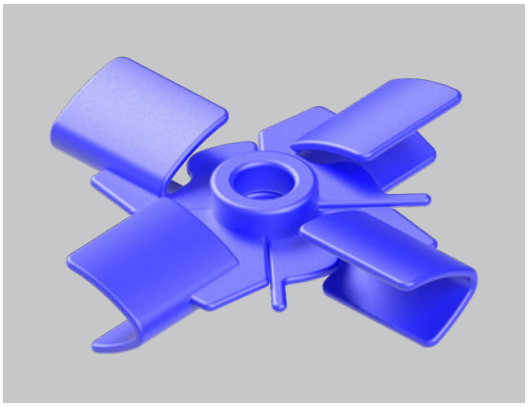
CBR, Turbine for residual quantities

- Agitating properties similar to CBT
- Turbine for residual quantities: dramatically smaller residual quantities can be agitated in connection with an extended shaft (e.g. reactor with a volume of 630l: Minimal agitating volume of approx. 3l)



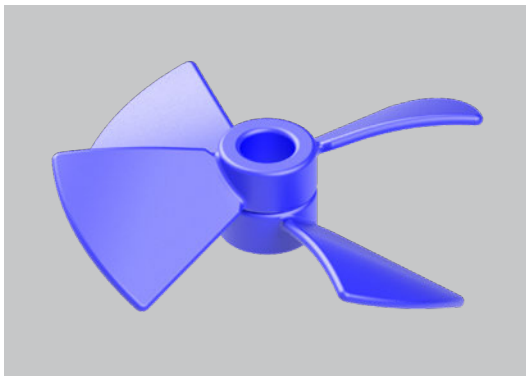
TBF, Turbofoil

- Produces mainly an axial flow with low shearing forces
- Suitable for all high-flow mixing processes for low-viscosity fluids, suspension and thermal tranfer tasks
- Low degree of disturbance required
- Low torques, low power input



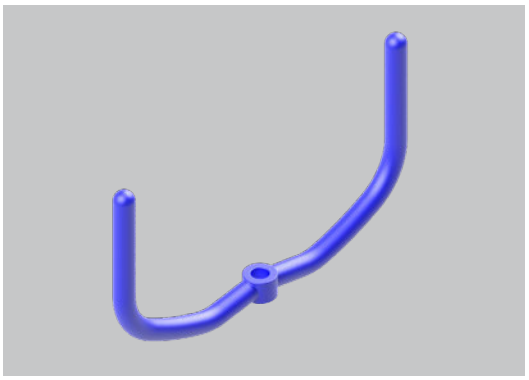
GST, Gas dispersion turbine

- Particularly suitable for mixing gases and fluids
- Superior homogeneity of the gas/fluid mixture
- Increase in transition regime rates compared to a disk-type agitator
- Gas/fluid mixing rates three times higher than with an impeller



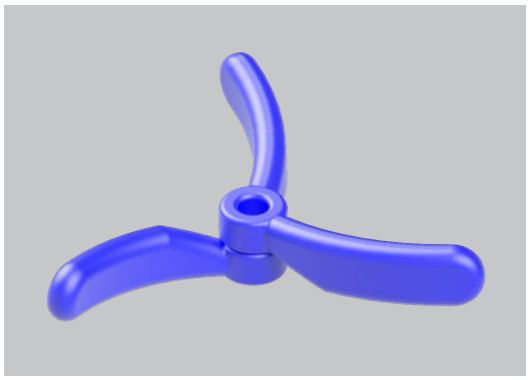
MXT, Maxflo Turbine

- High-performance agitator for mixing substance with a higher viscosity
- For agitating tasks that cannot be handled by conventional high-performance agitators (e.g. TBF)



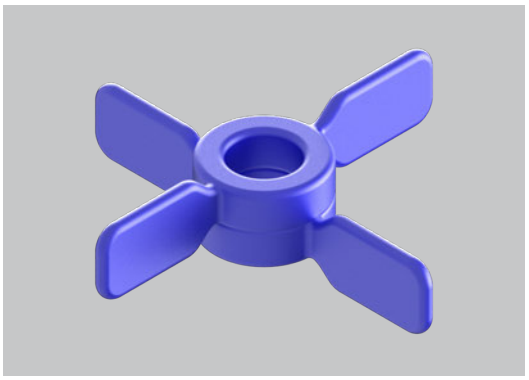
ANC, Anchor

- Produces maninly a tangential flow with low shearing forces
- Preferably used for thermal transfer and for agitating non-newtonian fluids
- High torque



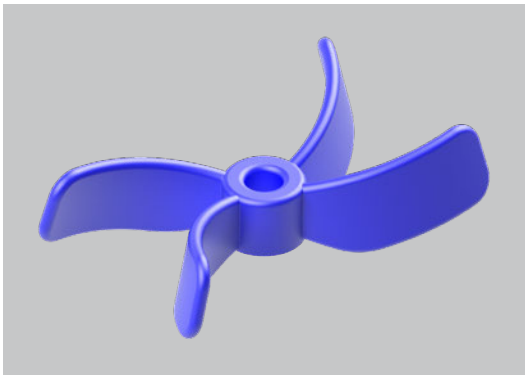
RCI, Retreat Curved Impeller

- Versatile universal agitator, produces a radial flow
- Insensitive to difference in viscosity
- Suitable for small filling levels
- Relatively high disturbing effect required



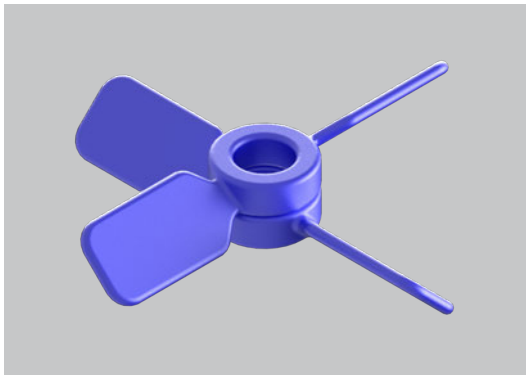
FBT, Flat Blade Turbine

- Produces principal flows in the radial direction with hight shearing forces
- Particulary suitable for mixing fluids and gases, low-viscosity fluids and for thermal transfer tasks



CBT, Curved Blade Turbine

- High shearing effect
- Creates a principally radial flow
- Suitable for mixing gases/fluids, low-viscosity liquids and thermal transfer tasks
- High disturbing effect required for low-viscosity media



PBT, Pitched Blade Turbine

- Produces an axial and radial flow
- Intermediate shearing effect
- Suitable for suspension, emulsifying, mixing low-viscosity fluids and for thermal transfer tasks
- Relatively high speeds

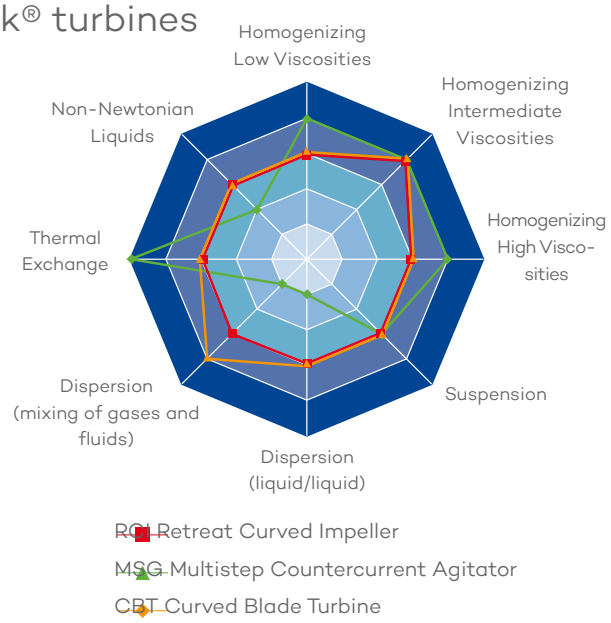
For Different Processes

The suitability of the Cryo-Lock® turbines

Wich agitator for which task?

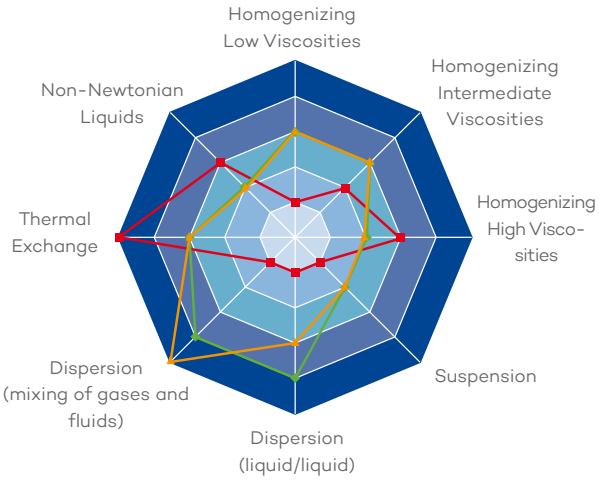
This page is designed to provide an overview of which agitator may be used for which task. Our complete range offers fundamental advantages for all process requirements:

- Improved efficiency of mixing systems
- Improved agitating efficiency of existing solutions through retrofits
- Reduced reaction and mixing times
- Minimized cost
- Optimized product quality, yield, and throughput
- Maximum energy efficiency

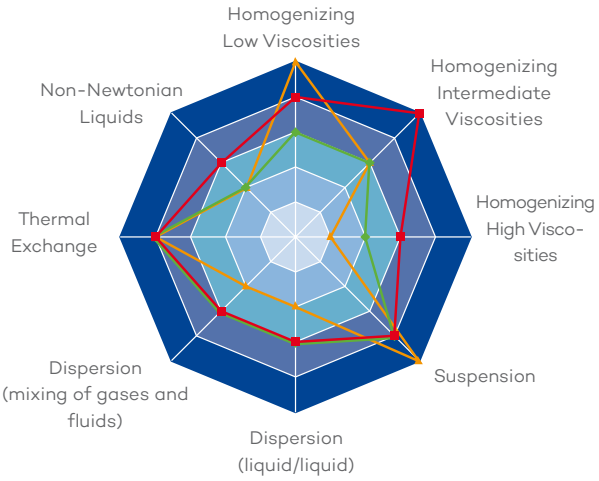


Agitating tasks	For low-viscosity media (e.g. water)		
Homogenization	CBT	MSG	TBF
Suspendieren	TBF	MSG	MXT
Thermalexchange	TBF	MSG	MXT
Crystallization	TBF	MSG	MXT
Dispersion liquid/liquid	FBT		
Dispersion liquid/gaseous	GST	FBT	
Polymerization	RCI		

well
suitable
little
not



ANC Anchor type agitator
FBT Flat Blade Turbine
GST Gas Dispersion Turbine



MXT Maxflo Turbine
PBT Pitched Blade Turbine
TBF Turbofoil

For intermediate-viscosity media (e.g. oils)			For high-viscosity products (e.g. syrup)		Agitating tasks
MXT	CBT	MSG	MSG		Homogenization
MXT	MSG		MSG		Suspension
CBT	ANC	MSG	ANC	MSG	Thermalexchange
TBF	MSG	MXT	MSG		Crystallization
FBT					Dispersion liquid/liquid
GST	FBT				Dispersion liquid/gaseous
RCI			RCI		Polymerization

Agitating Is One Thing

Baffling is another

Indispensable partners

The main funciton of the baffles is to convert the tangential flow produced by the rotation of the agitator, and thus of the reactor contents, into an axial flow and to avoid the formation of fluid spouts to the largest possible extent. This is the only way to achieve the desired flow patterns and mixing effects in the reactor.

Top performance: the C baffle

This new development made by Pfaudler is characterized by a considerably improved disturbing efficiency. The C_w value of is concave shape is approx. 75% higher than that of a conventian beaver tail baffle. Futhermore, the nozzle may still be used for introducing product, or as a vapor nozzle.

The BaffleRing – also available with temperature measurement and glass monitoring

One nozzle saved, and product can be introduced through the opening.

Pfaudler BaffleRing

Altough baffles are certainly important – with small, two-piece reactors they occupy one of the few large nozzles available which is no longer available for the process. The solution: the Pfaudler BaffleRing with 2 C baffles. It is inserted between the lid and the lower reactor body and fixed by the reactor clamps. The result: the nozzle remains free, plus an optimum agitating result due to a high degree of flow disturbance (corresponding to that of a reactor with 3 side-wall baffles). The BaffleRing may also be retrofitted to existing reactors.

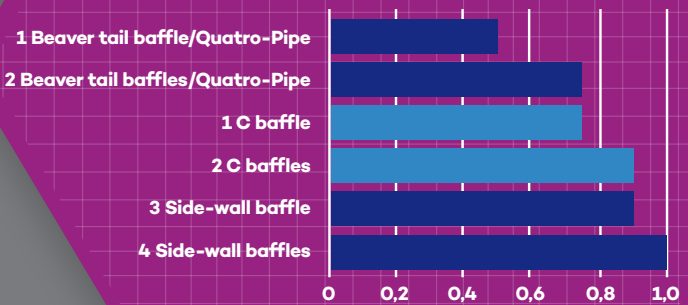
Beaver tail baffle

C Baffle with higher Cw value

The quatro-pipe up to four functions

DEGREE OF BAFFLING

(BE 4000 REACTOR)



Pf Technologies

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Defining the standard