



**LAB &
PROCESS
GLASS**

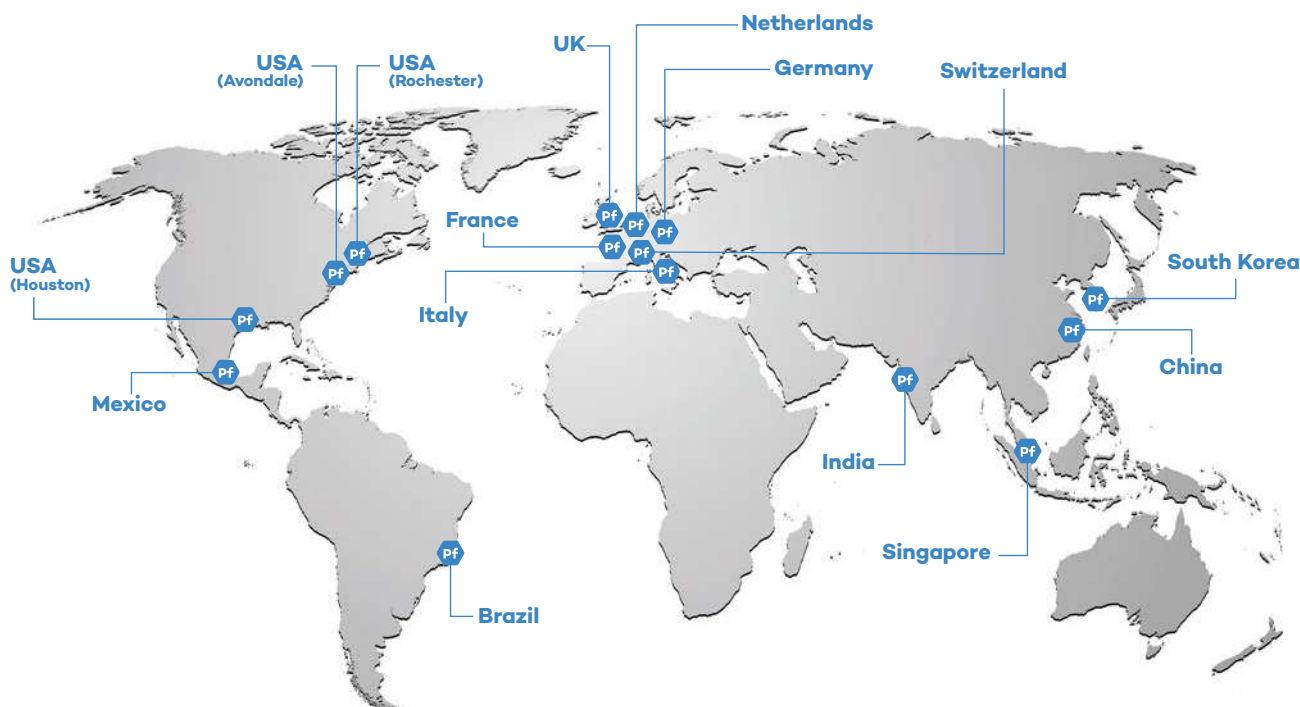


**HIGH
QUALITY
COMPONENTS**

**COMPONENTS
APPARATUS
& SYSTEMS**

Pfaudler International

One single source responsibility with access to all Pfaudler Technologies, Systems, Services worldwide



Pfaudler is a global Group offering a wide range of **corrosion-resistant technologies, systems** and **related services** for the **chemical, pharmaceutical** and **food industries**.

Edlon, Interseal, Montz, Mavag, Normag and **Pfaudler** are our Branded Product Lines.

These product lines are specialized and perfectly integrated to **meet the most complex Client needs**. We are in the position to offer a **complete turn-key package** for each of the critical aspects of chemical and pharmaceutical processing.

Technologies and process systems of our Group are installed in more than 100 countries and across six continents. Unique expertise and skills, **manufacturing capability**, targeted investments in strategic markets, innovation and competitiveness allow the Pfaudler group to be a landmark in the industry.

Around the world our Customers rely on the quality and performance of our supply to obtain efficient, reliable, profitable and safe chemical process systems.

Our network organization is designed to:

- strengthen our local presence alongside Customers and markets;
- accelerate decision-making processes through a less-centralized management;
- improve Pfaudler's ability to attract new talent at the local level.

Normag is the lab & process glass expert.

Our product range includes **high quality components** and **units** made of **borosilicate glass 3.3** for reaction, distillation, extraction, filtration and absorption for laboratories, pilot plant and production.

Design, Production & Quality

Thuringia and especially Ilmenau have a strong relationship to the history and development of industrial glass forming. Glass has been blown for many generations in Ilmenau, the site of **NORMAG** Labor- und Prozesstechnik GmbH.

This competence in glass, the continuous improvement of our production methods and a close co-operation with the European chemical and pharmaceutical industries throughout years have pushed the development of our company.

The product range of **NORMAG** Labor- und Prozesstechnik GmbH reaches from high quality components to complete units for laboratory and processes and has been continuously developed together with our customers.

Design

- Standard and special components
- Feasibility studies
- CAD construction
- Documentation

Production

Based on Borosilicate Glass 3.3 - our production includes:

- Glass components and apparatus, manually or machine manufactured
- Glass grinding
- Surface coating
- Mechanical components for glass apparatus
- Electronics components for glass apparatus

Assembly

The assembly covers components and units

- Mechanical assembly
- Electrical assembly
- Commissioning
- Service

Quality & Certification

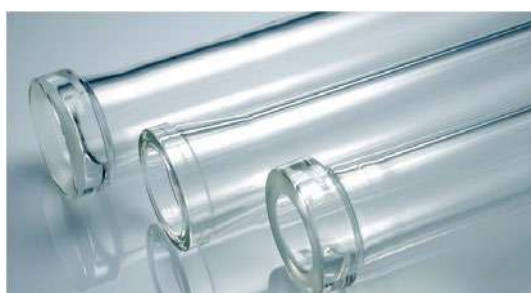
Quality is an integrated part of our production

- NORMAG-quality mark
- CE marking
- PED 2014/68 certificate
- TA LUF T certificate
- ATEX 2014/34 certificate (optional)
- FDA-Material certificate (optional)
- 2.2 material certificate (optional)

Components & Apparatus Lab Scale

All glass components are manufactured from Borosilicate glass 3.3, completed by the use of other highly chemical and thermal resistant materials.

Standardised components and apparatus are shown in our catalogue. Furthermore, we provide solutions for special applications and customer-specific components.



Tubes / Capillaries / Rods

Made of Borosilicate glass 3.3 according to DIN ISO 3585

- High precision in all dimensions
- Chemical and thermal highly resistant



Semi-Finished Products / Accessories

Based on Borosilicate Glass 3.3 - our production includes:

- High vacuum tight stopcocks
- Valves
- Grindings
- Hollow glass parts
- Different laboratory flanges and technical flanges
- Connections
- Frame work



Components

- Standard glassware
- Specialised glassware
- Standard components and specialised components Distillation components
- Reaction vessels
- Special components



MSR / Automation

- Sensors for all common measuring data
- Actors as pneumatic adjustment valves
- Measurement and control systems
- Software

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Glass Tubes

Made of Borosilicate glass 3.3 according to DIN ISO 3585

- High precision in all dimensions
- Chemical and thermal highly resistant
- Flanges, cylinders, spheres and tubes
- Calibrated tubes



Coupling System

- PF-System (safety pian flange / "QVF"-system compatible)
- KF-System (KF-system / "SCHOTT"-system compatible)
- Various other systems
- Adapters like KAMLOK, TRICLAMP, MILK PIPE or hose connection



Parts / Components

- Connections
- Piping
- Valves
- Vessels
- Instrumentation
- Framework



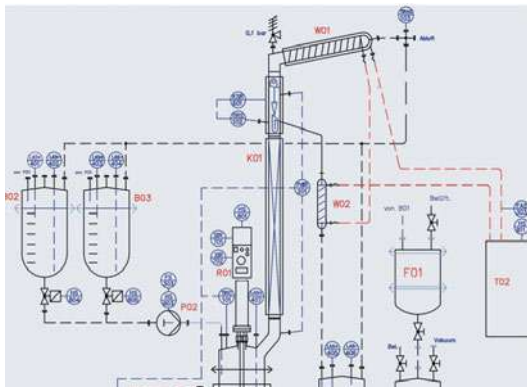
Equipment

- Mixer-Settler
- Nutch Filter
- Mixing vessel
- Evapora tor
- Condensar

Systems Lab Scale

The combination of our glassblowing skills, constructive and process-technical experiences enable us to built apparatus and process-engineering units. Due to the equipment of our apparatus and units

with measurement and control technology up to process visualisation we are able to supply customer specific solutions reaching from laboratory size to process.



Engineering

- Individual customer co-ordination
- Process-technical support
- Construction
- Project management
- Assembly
- Commissioning
- Documentation



Apparatus

Specialised Apparatus

- Photo reactor
- Equilibration apparatus
- Solvent circulating apparatus
- Extractive steam distillation
- Solid-liquid extraction
- Liquid-liquid extraction
- Shortpath / Thin film / Falling film evaporator
- Nutch filter
- Scrubber



Units

Units made of Borosilicate glass 3.3 and other corrosion resistant materials for

- Reaction
- Distillation and rectification
- Extraction
- Absorption / Desorption
- Adsorption
- Crystallisation
- Filtration

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Units

Units made of Borosilicate glass 3.3 and other corrosion resistant materials for:

- Reaction
- Evaporation
- Distillation and rectification
- Extraction
- Absorption / Desorption
- Crystallisation
- Filtration



Processes

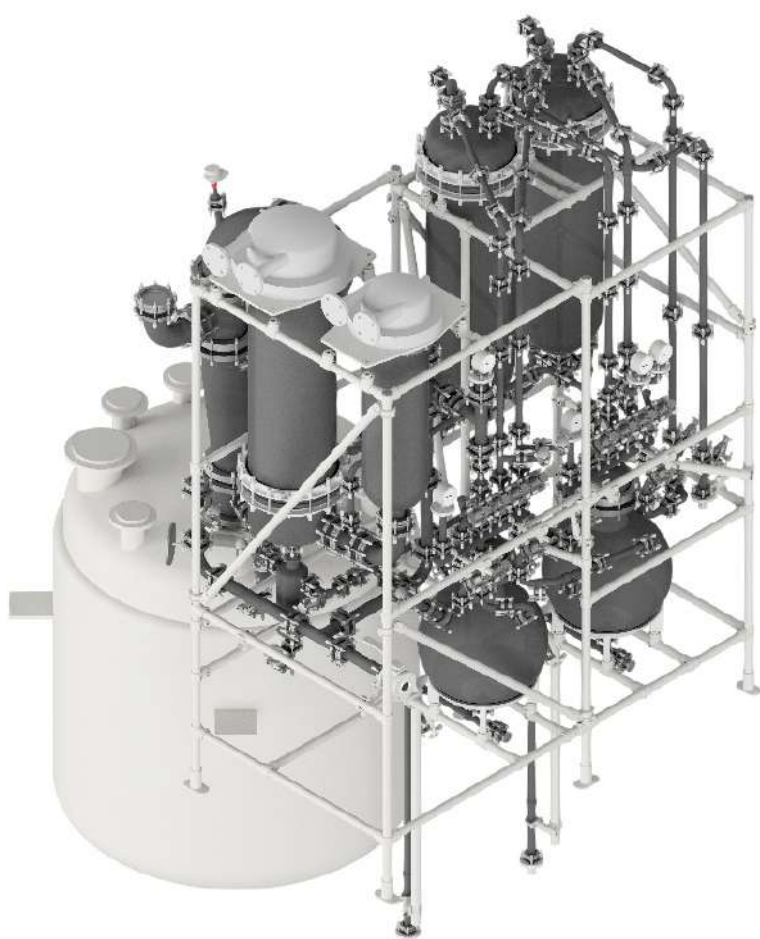
Process-specific systems for:

- Evaporation (various customer specific systems)
- Distillation (various customer specific systems)
- Rectification (methanol, ethanol, acetic acid, ...)
- Scrubber systems (HCl, NO_x)
- Acid concentration or dilution systems (HCl, H₂SO₄, HNO₃)
- Individual customer and process specific systems

Components & Apparatus Lab Scale

Reaction units and distillation tops - Lab and process scale

- **Reaction Units and distillation tops for the chemical and pharmaceutical industry**
- **Units for experimental halls and production**
- **Customer and process specific design**
- **Reactors made of borosilicate glass 3.3, enamel or stainless steel**
- **Permissible operation conditions**
 - temperatures from -80°C to 200°C and
 - pressures from -1 barg to 0.5 barg or higher
- **Optional**
 - Phase separation liquid-liquid
 - solid dosage
 - glass coating
 - lifting device
 - N₂- and vacuum distributor
 - multistage distillation top
 - Tempering
 - Automation with PLC-system
 - GMP-design conformity for Pharma
 - EX-protected design
 - scale-up of units
 - skid-mounted units



Reaction units and distillation tops from NORMAG are used for various processes, e.g. production and separation of fine chemicals or pharmaceutical products. The typical requirements of each customer will be clarified right at the beginning of each project, e.g. liquid/gaseous feed, viscosity, phase separation, temperature/pressure range, as well as the material requirements, to engineer a specific customized unit. These specific units are based on our reliable solutions for each specific requirement - even for very specific requirements such as photo reaction or deep temperature - due to our long-term experience and cooperation with leading european chemical and pharmaceutical companies since many years. The illustrated pharmaceutical unit shows a 2.500 l enamelled reaction vessel. The vapour is condensed in two vertical enamelled and fully draining condensers. The distillate will be led into a phase separator and then back into the vessel or two graduated distillate glass receivers. For Dosage are two separate glass vessels integrated. The design is easy to operate from the front, very compact as well as fully draining and cleanable.

Components & Apparatus Process Scale

Reaction units and distillation tops - Options

Technical specification

R 01	Reactor	l	30	50	100	160	250	400	630	1000	1.600	2.500	4.000
	Material*	l	G	G/EG	G/EG	EG	EG	E	E	E	E	E	E
	Area	m ²	x	x	0,85	1,25	1,65	2,45	3,1	4,6	7,35	9,6	13,5
E 01	Spiral	m ²	1	0,7	1	1,5	2,5	4,0	-	-	-	-	-
	RBW-glass	m ²	-	-	-	-	2,5	4,0	8,0	12,5	16,0	20,0	25,0
	RBW-SiC	m ²	-	-	-	-	1,0	1,5	2,5	4,0	5,0	6,3	10
E 02	Spiral	m ²	-	0,5	0,7	1	1,5	1,5	-	-	-	-	-
V 01	Vessel	l	20	20	50	50	100	150	200	200	400	400	400
V 03/04	Distillate	l	20	20	50	50	100	150	200	200	400	400	400
PS 01	Phase sep	l	1	1	1	1	3	3	5	5	5	5	10
Vapour line		DN	50	50	50	80	80	100	100	150	150	150	200

* G = glass vessel & cover EG = Enamel/glass cover E = Enamel vessel and cover

Energies

Power	230/400 VAC, 50/60 Hz (others on request)
Cooling media	max. 3 barg
Instrument air	6 barg, dry

Regulations / guide lines

PED 2014/68EU*	1/+0,5 barg (product/glass mantle) -1/+3 barg (cooling media) -1/+6 barg (Enamel)
ATEX 2014/34EU	optional
TRGS 727	optional
TA-Luft "technical sealed system"	for connections and valves made of borosilicate glass 3.3
Seismic calculation	optional
Material certificate	optional

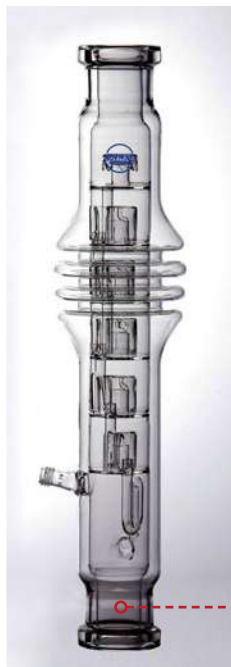
* Other perm. operation conditions on requests

Rectification from Lab to Process

Rectification systems from **NORMAG** have been developed since decades as central partner of the chemical & pharmaceutical for this process for lab scale units and scale-up to production scale and will be further developed together.

Based on this long-term experience we can offer:

- lab & process scale rectification
- scale up
- Chemical Engineering design
- high skilled internals such as **NORMAG** bubble cap tray and **MONTZ** structured packing & distributors
- corrosion resistant materials incl. Boro 3.3, Glasteel or Fluorpolymers as Pfadler group materials optional combined with alloys according process requirements
- columns, units or complete process systems



Lab scale rectification for scale-up



Process scale rectification system

Absorption / Scrubber from Lab to Process



Lab scale mobile scrubber

Scrubber or absorption systems in general from NORMAG – either a fixed or flexible mobile unit – are provided since decades as central partner of the chemical & pharmaceutical for lab & process scale. Based on this long-term experience we can offer:

- lab & process scale fixed & mobile scrubber
- Chemical Engineering design & scale up
- high skilled internals such as **NORMAG** bubble cap tray and **MONTZ** structured packing & distributors
- corrosion resistant materials incl. Boro 3.3, Glasteel or Fluoropolymers as Pfaudler group materials optional combined with alloys according process requirements
- columns, units or complete process systems



Process scale two-stage mobile scrubber

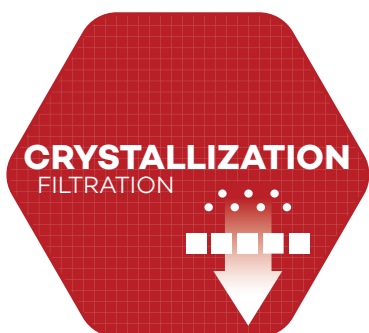
Filtration from Lab to Process



Lab scale nutch filter

Filtration in general from **NORMAG** – either as a fixed or flexible mobile nutch filter unit – are provided since decades as central partner of the chemical & pharmaceutical for lab & process scale. Based on this long-term experience we can offer:

- lab & process scale fixed & mobile nutch filter
- Chemical Engineering design & scale up together with **MAVAG**
- specific internals from **NORMAG** and **MAVAG**
- corrosion resistant materials incl. Boro 3.3, Glasteel or Fluoropolymers as Pfaudler group materials optional combined with alloys according process requirements
- filter, filter unit or complete filtration process systems



Process scale mobile nutch filter

Evaporation from Lab to Process



Lab scale evaporator system



Process scale WFE

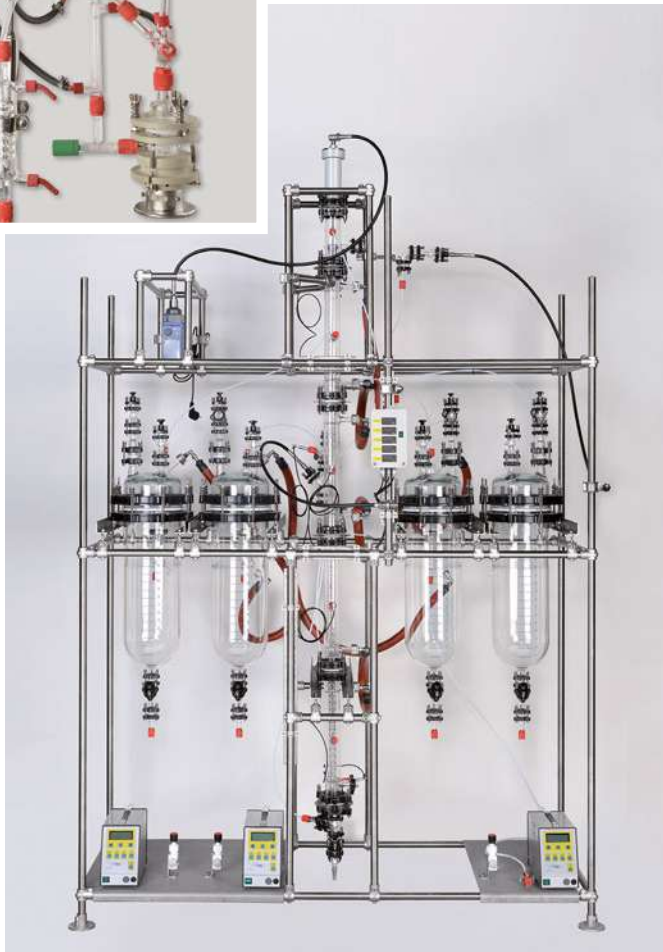
Evaporator from **NORMAG** are provided since decades as central partner of the chemical & pharmaceutical for lab & process scale.

Based on this long-term experience we can offer:

- wiped-film (WFE), falling film & short path evaporator and various special evaporators
- lab & process scale evaporator
- chemical Engineering design & scale up together with **PFAUDLER**
- specific internals from **NORMAG** and **PFAUDLER**
- corrosion resistant materials incl. Boro 3.3, Glasteel or Fluorpolymers as Pfaudler group materials optional combined with alloys according process requirements
- evaporator, evaporator unit or complete evaporation process systems



Extraction from Lab to Process

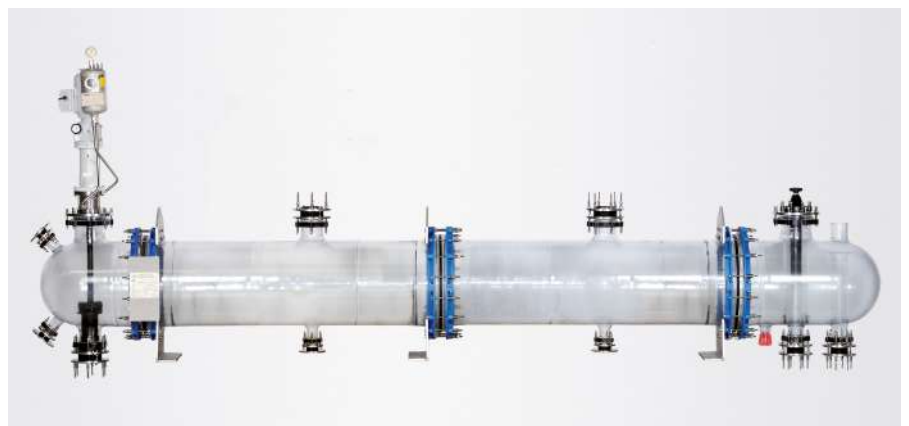


Lab scale mixer-settler & extraction column

Extraction systems from **NORMAG** have been developed since decades as central partner of the chemical & pharmaceutical for this process for lab scale units and scale-up to production scale and will be further developed together.

Based on this long-term experience we can offer:

- lab & process scale mixer-settler and extraction columns
- Chemical Engineering design & scale up together
- specific internals from **NORMAG**
- corrosion resistant materials incl. Boro 3.3, Glasteel or Fluoropolymers as Pfaudler group materials optional combined with alloys according process requirements
- mixer-settler & extraction columns, extraction unit or complete extraction process systems



Process scale
mixer-settler

Corrosion Resistant Systems from Lab to Process

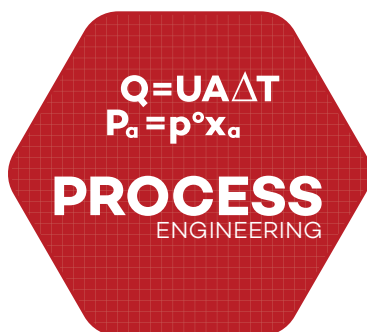


Lab scale units for testing at customers site or our test center

As a result of the various Technologies and corrosion resistant materials from **NORMAG** and the **PFAUDLER** group a variety of corrosion resistant processes can be provided:

- HCl, HBr, NOx and other scrubber systems
- Poly-Aluminum-Chloride systems
- Sulfuric Acid, Nitric Acid & hydrochloric acid dilution systems
- Sulfuric Acid, Bromic Acid & Nitric Acid concentration systems
- Nitric Acid, Ammonium hydroxide & hydrochloric acid electronic grade purification systems
- Precious metal Recovery systems
- Waste water Extraction systems
- Acetic Acid, Alcohol and other rectification systems

In addition specific evaporator, rectification & extraction systems are continuously developed together with our customers “from lab to process” and based on our “corrosion resistant material expertise.



Process scale sulfuric acid concentration system



NORMAG is part of the Pfaudler Group.

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