ROBUST.

AND SENSITIVE.

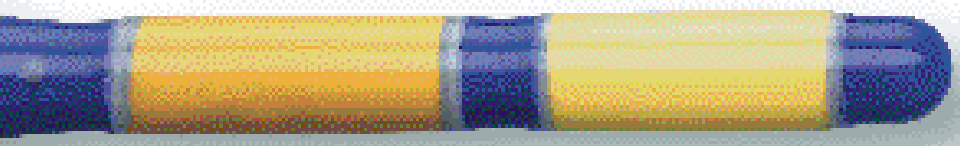
ANALYTICAL
MEASUREMENT
TECHNOLOGY
FROM PFAUDLER

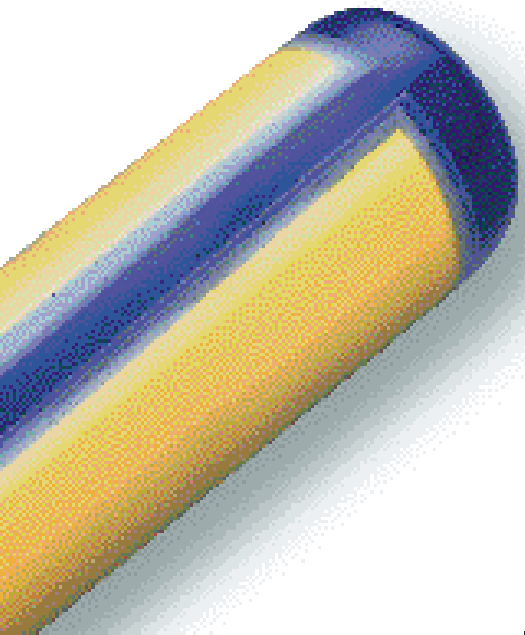
PFAUDLER
REACTOR SYSTEMS

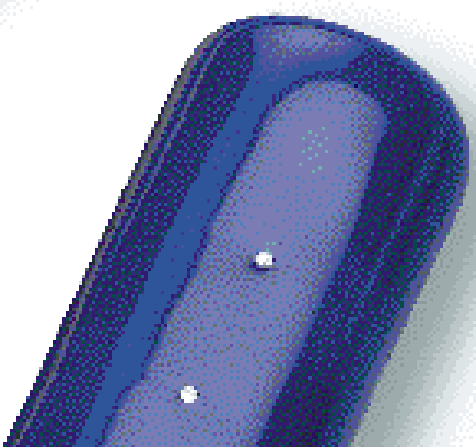
641-2e

EVERYTHING UNDER CONTROL

WITH PFAUDLER:







The Pfaudler measuring probes. Simple - but tough.
In many processes, things can get rough - a problem for most sensors. When other measuring systems have long ceased to work (with all the unpleasant consequences you know only too well), our measuring probes are still going strong. They deliver faultless and precise test readings wherever they are used - whatever the conditions.

A strong combination: Enamelled steel
What makes Pfaudler measuring probes so different? Answer: We use enamelled steel. This makes light work of resisting attack, physical or chemical, and goes on doing so for a long time.

The steel makes our measuring probes impervious to physical influences such as high flow rates in reactors and pipes, sudden pressure surges and pressures up to 100 bar.

The Pfaudler enamel used, along with the pH enamel, provide the measuring probes with an effective protective shield against attack by chemicals. The enamel remains absolutely neutral during the process with no catalytic or biological effects.

Where others give up, our measuring probes keep on going. The technology employed is robust making process monitoring possible for the first time in many areas. Pfaudler enamel is known all over the world for its tremendous chemical resistance.

OUR PH, RH AND LF MEASURING PROBES

Robust -
but precise and very, very sensitive
Pfaudler measuring probes are as sensitive in delivering measured values as they are robust in use. You can rely on this vitally-important sensitivity. Every time.

Positiones “where the action is”
Our measuring probes work where it really happens. That means right inside the reactor or in the main flow line, permitting measurements that are direct, precise and immediate.

After all, why should your measuring be complicated when it can be so simple? Our measuring probes don’t need pumps, shut-off devices and by-pass pipes. And there’s a bonus: you save money and gain on safety.

With precise and immediate test readings at your fingertips, you can react swiftly and raise your product quality. End result: you’ve made savings all round.

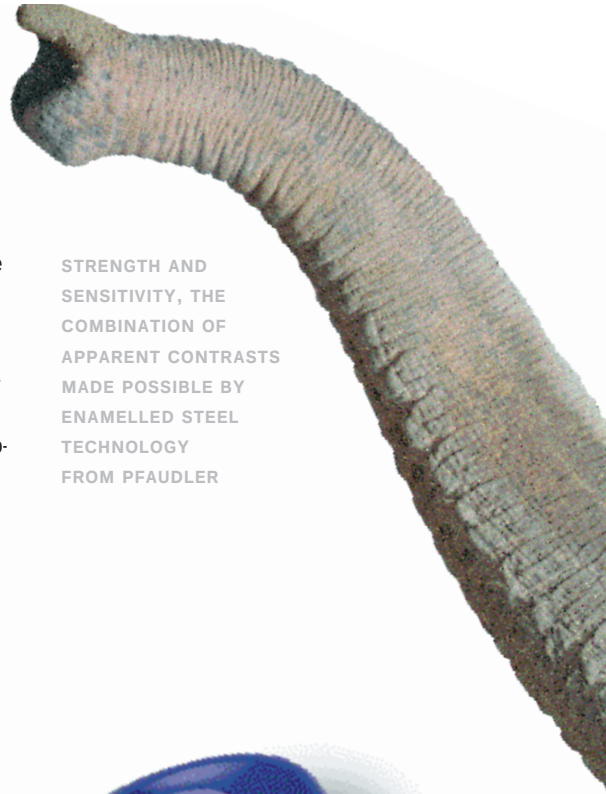
Fit it - then forget it
for a long time
It isn’t just the material that was chosen for a long life. A lot of thought went into the design, too. We wanted measuring probes which would have a wider range of uses than had previously been the case and which would increase productivity.

Their direct and problem-free location in the midst of a turbulent process, together with the smooth enamel surface of the measuring probes, prevents product deposition. The probes are thus self-cleaning. Measurement errors are prevented, while costly and time-consuming cleaning processes are a thing of the past.

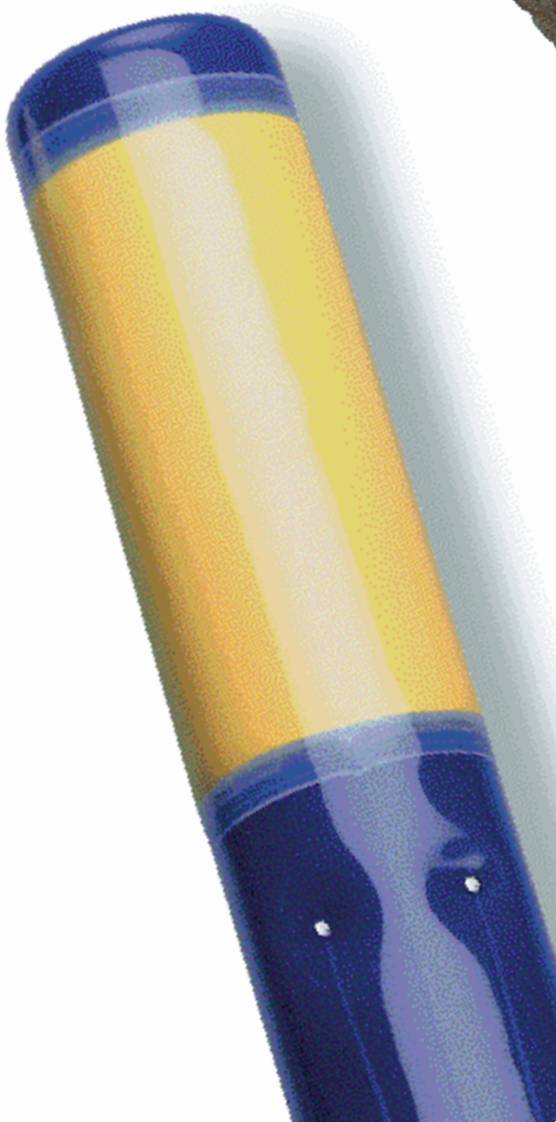
Service intervals:
Often a whole year
Infrequent servicing means continuous production, raised plant productivity and a saving on expensive service downtime - all in all, greater economy in product manufacture.

There’s a completely different but equally important consideration, too: having to interrupt hard-earned leisure time at the weekend because of operating faults is more than a nuisance to all concerned. Our robust, sensitive measuring probes are worth investing in - in every way.

You install them and forget about them for a long time. That’s what we call reliability.



STRENGTH AND SENSITIVITY, THE COMBINATION OF APPARENT CONTRASTS MADE POSSIBLE BY ENAMELLED STEEL TECHNOLOGY FROM PFAUDLER

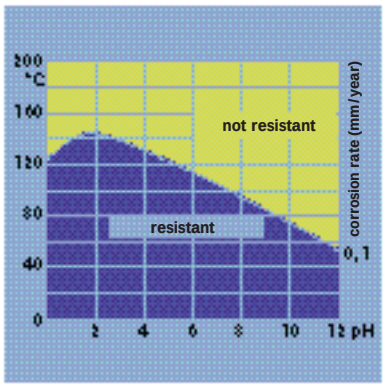


PFAUDLER

PH-MEASURING PRECISION

Chemical attacks
It's mainly thanks to the materials we use that virtually nothing affects our measuring probes. The probe carrier is protected by Pfaudler enamel - extremely resistant to corrosion.

Vital for the resistance of the measuring probes as a whole is the yellow pH enamel of the measuring electrodes. The diagram on the right shows the resistance of this enamel at given temperatures to acids, water and alkalis. The isocorrosion curve 0.1 mm/year constitutes the limit of the guarantee. The corrosion curve for the pH enamel was determined gravimetrically. In practice, deviating values can occur as a result of changed product volume/



Isocorrosion curve of pH enamel (Mean values)

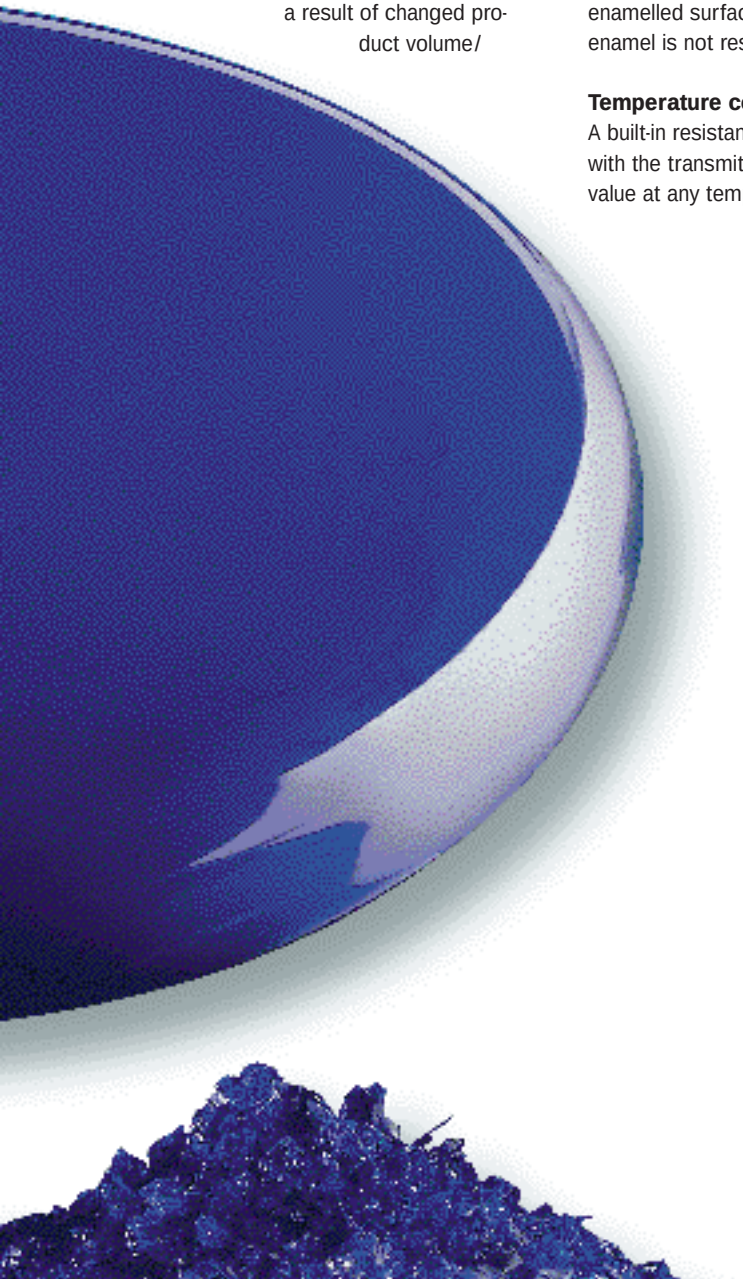
enamelled surface proportions. Like glass, enamel is not resistant to fluoride.

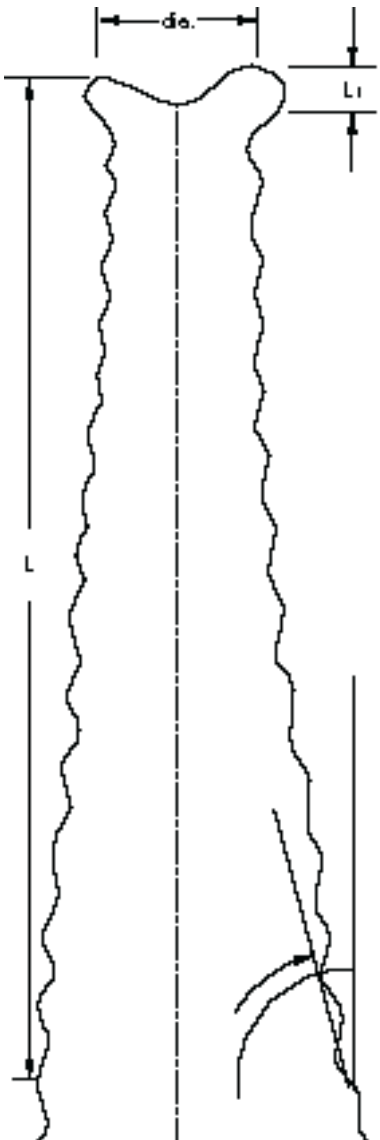
Temperature compensation
A built-in resistance thermometer, together with the transmitter, delivers a precise pH value at any temperature.

Consistency
Potential constant and consistency remain within a measurement accuracy of ±0.1 pH, even after operating intermissions. It is not necessary to dismantle the measuring probes. They can be stored dry.

Time taken to register pH changes
The Pfaudler pH measuring probes combine speed and robustness. pH changes are registered within seconds where and as they occur.

Electrical resistance
The resistance of the measuring electrode is max. 1,000 MΩ.





FROM A PURELY TECHNICAL VIEWPOINT...

Electrolyte
Our absolute instrumentation measuring probes operate with Pfaudler electrolyte. This is based on K_2SO_4 or KCl (pH <3).

Within the permissible pressure difference, max. leakage is 5 ml/h. At an overpressure of 1 bar, approx. 0.2 ml/h should be anticipated. This means barely 1 litre of electrolyte in six months of continuous use. Measuring probe and reservoir vessel together hold approx. 1.5 litres (N version) or 0.7 litre (K version).

Electrode slope
The enamel electrode guarantees values of more than 55 mV/pH at 25 °C. The effective value is documented in the test report.

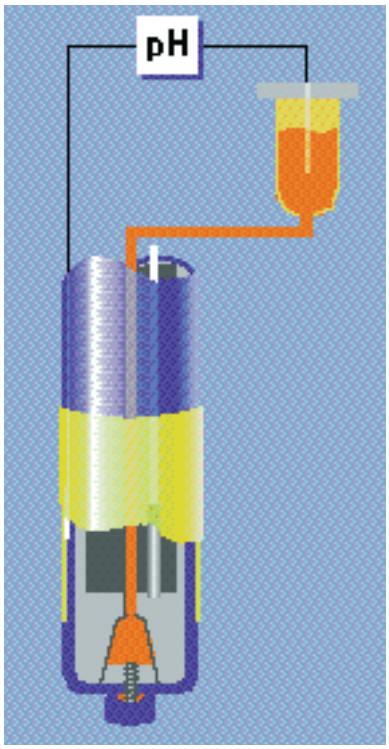
Chain zero-point
The measuring chain zero-point of the enamel electrode in combination with the Pfaudler AGA (silver acetate) reference electrode is pH 1.5 ± 1.

Temperature
The limits are dependent on electrode resistance, chemical resistance of the pH enamel and electrolyte vapour pressure.
The permissible range lies between 0 and 140 °C. Below 0 °C the pH display is sluggish. However, the measuring probe can stay in the reactor down to -20 °C.

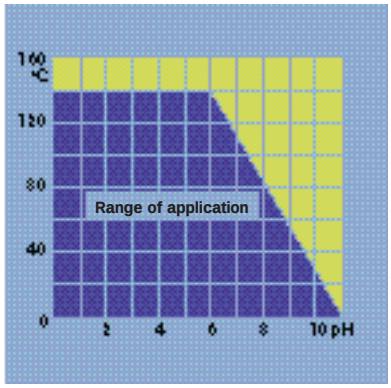
Pressure
The measuring probes may be used within the range -1 to +9 bar. Special versions operate in process pressures up to 24 bar.

It is sufficient to set the probe once in accordance with the highest pressure occurring during the process. In the event of sudden pressure-drop in the reactor vessel, function and operational safety are unaffected. No pressure compensation is necessary.

The pressure inside the reservoir vessel must be at least 1 bar above the maximum operating pressure. This ensures that the diaphragm is filled with electrolyte and prevents penetration by the product.



Measurement principle of Pfaudler measuring probes for absolute pH value determination



Range of application with measurement accuracy < ± 0.1 pH at 0.1 nNa^+

Range and accuracy of measurement
The linear range of the characteristic curve is from pH 0 to pH 10 at 25 °C. Measurement is accurate to below ± 0.1 pH.

Measurements up to pH 12 are briefly possible. In this region, alkali error results in a deviation of more than 0.1 pH. This rises as the pH value increases.

PH MEASURING PROBES

TYPES 03/04...

The compact Type 04 K, with electrolyte vessel mounted on the probe head

There are two versions available, covering all areas of application:

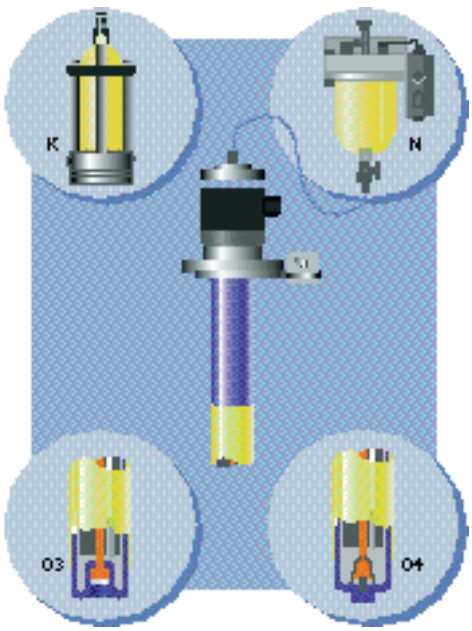
- pH measuring probe Type 04, the version for measurements in all areas, including explosion-hazard.
- pH measuring probe Type 03, the version for use in areas where there is no risk of explosion.

Design and measuring principle

A measuring electrode of pH-sensitive enamel, together with a reference electrode, make up the pH measuring probe.The measuring electrode fits round the lower end of the enamelled steel tube. The electrode has a large surface area and covers the whole of the lower end of the measuring probe. It is directly exposed to the product flow, without a protective cage or any similar device, and thus gives a direct and immediate pH reading.

The reference electrode is located in the eletrolyte vessel. It is in contact with the product to be monitored via the electrolyte and a ground diaphragm. An impedance transformer is connected downstream of the measuring and reference electrodes. Any commercially-available pH transducer can be connected to the impedance transformer.

The enamel measuring electrode is directly connected to its metal lead, thus eliminating the weak point at the inner buffer/by-pass electrode interface. The pH enamel is in contact with liquid on one side only, unlike the conventional glass electrodes.



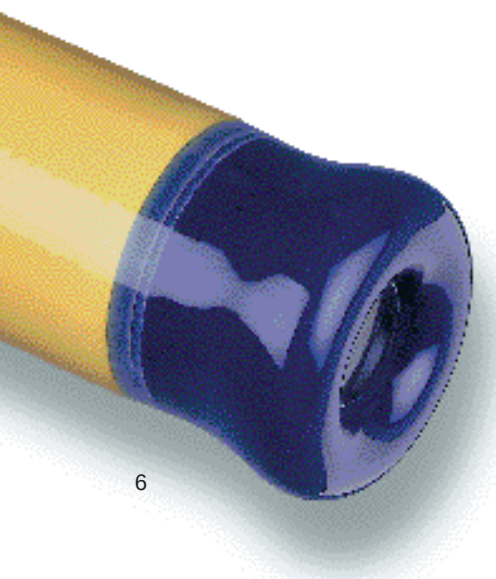
The reference electrode is located separately from the measuring electrode in an electrolyte vessel. The pressure in the electrolyte system is greater than the operating pressure in the reaction chamber. Product penetration through the diaphragm and via the long electrolyte line is not possible. The reference electrode is thus protected from any contamination.

Putting together the pH measuring probes

The modular design of the Pfaudler pH measuring probes means that you can assemble your own measuring probe to suit your operating conditions:

- two different electrolyte vessels: version K is compactly mounted on the head of the measuring probe, while version N is separate from the probe and connected to it via a flexible hose.
- two different diaphragms: in Type 03, this is a shrink-fitted glass disc for use in areas where there is no risk of explosion, in Type 04 it consists of two surfaces screwed together. This type is permitted in Zone 0 explosion-hazard areas in conjunction with downstream equipment as listed in Certificate of Conformity Ex 88.B.2125 X.

The pH continuous flow probes can be supplied in conjunction with a tee for installation in pipes of different materials.

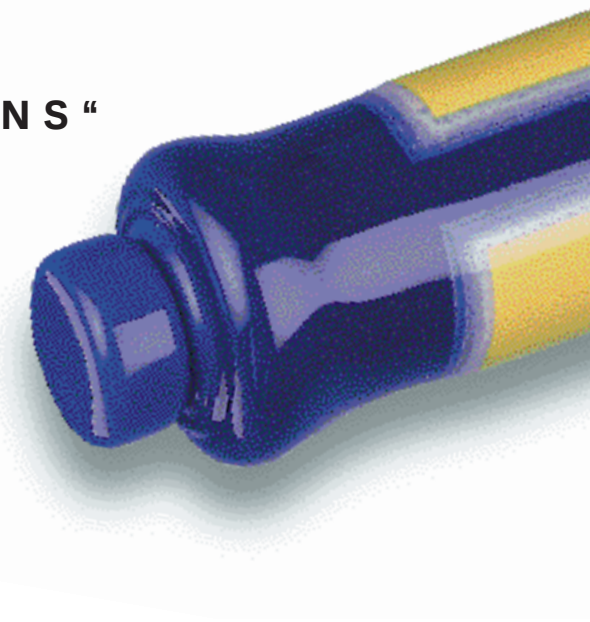


... AND THEIR

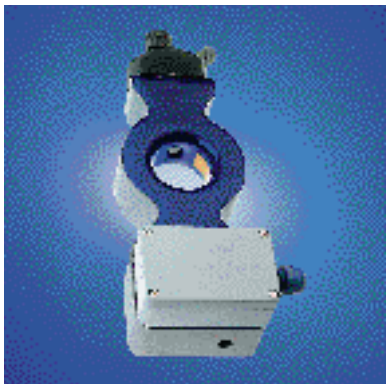
"CLOSE RELATIONS"

The pH measuring probe with two measuring systems
Fitting two identical pH measuring systems on one probe carrier means that self-monitoring through comparative measurement is possible.
Technical data are otherwise as for Type 04.

Doubly sure: the Pfaudler pH measuring probe with two measuring systems



The ring ph measuring probe
This version can be installed directly in pipelines. The smallest nominal size is DN 50. The enamel measuring electrode and the diaphragm are on the inside surface of an enamelled ring. Technical data are as for Type 03, Version N.



Takes up very little space: the Pfaudler ring pH probe for measurement in the pipeline

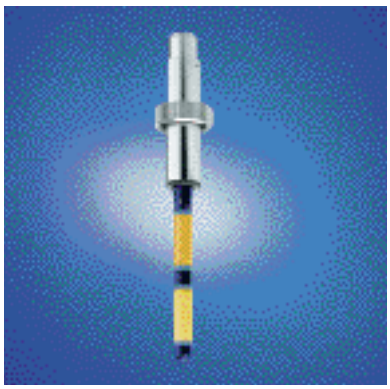
DIFFERENTIAL PH MEASURING PROBES TYPE 18/40

THE NEW WAY TO MONITOR PH

Relative simplicity:
Relative instead of absolute pH measurements
Unlike the pH measuring probes with constant reference system and absolute pH measurement, the differential pH probes deliver pH values which are measured to a product-dependent reference quantity - hence “relative pH”.

Since there are many known processes and all follow the same course, the reference quantity for a given process becomes the constant. This means that the “relative pH” is the real pH value.

Most processes in the chemical, pharmaceutical and food industries are repetitive manufacturing processes and run according to the same schematic. They are regulated or controlled to a set pH value in order to ensure consistency of quality.
In processes such as these, our Type 18/40 measuring probes are the right - and economically-sensible - choice. Their safe functioning principle, simple handling and robust construction, designed for uncomplicated long-term use, make an important contribution to safe and economical production.



Compact design:
The pH measuring probe Type 18

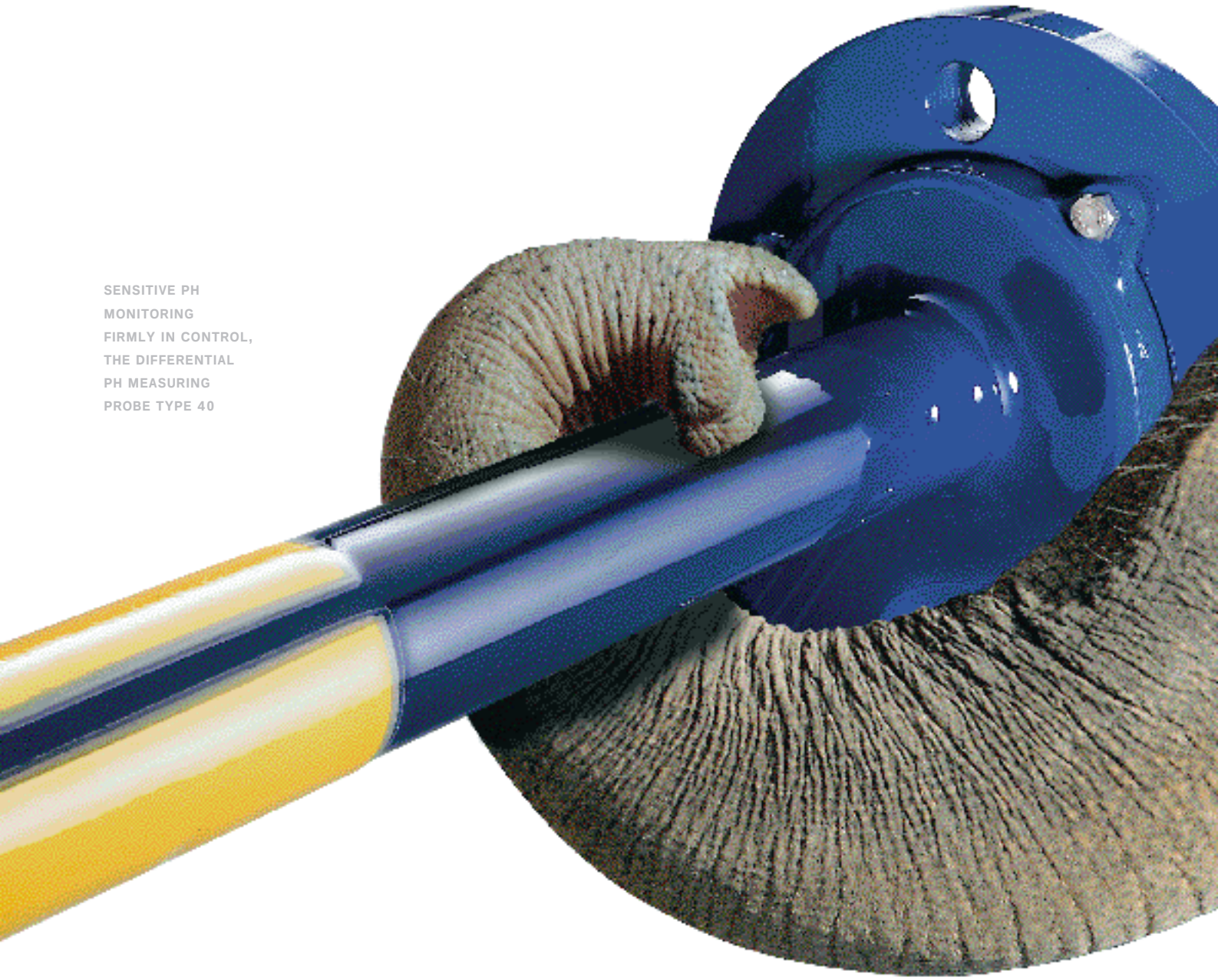
The measuring principle
Two separate ion-sensitive enamel electrodes are fused on to the end of the enamel probe carrier. In the zone pH 0 to 10, the pH enamel electrode responds to H^+ ions only. The reference electrode delivers a potential which is dependent on the concentration of dissolved salts and/or the product buffering. In Type 40 a rhodium central electrode embedded in the enamel serves to earth the product which is to be measured. Reference electrode, diaphragm and electrolyte line are not necessary. A resistance thermometer is built into the measuring probes to provide temperature compensation for pH value.

In which processes can relative measurement be used?
Relative measurement is ideal for processes which are constantly repeated in the same format - e.g. continuous reactions (neutralisation), biotechnical processes and fermentation. It is also suited to high-purity processes in which the presence of electrolyte fluid is undesirable.

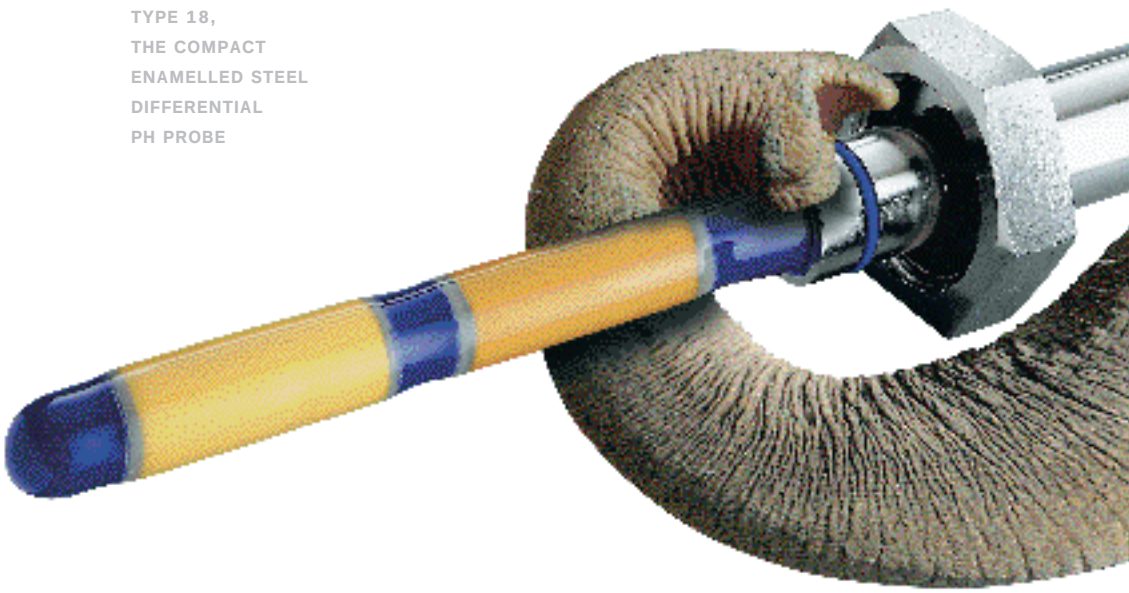
Are there any further advantages?
Well, of course enamelled steel is important here, too. The measuring probes are resistant to chemical and physical attacks. They are very compact, take up little space and can therefore be built into reactors and pipelines wherever desired.
No servicing is necessary and the function principle means that the measuring probes are highly reliable.

Complex function, simple design:
The pH measuring probe Type 40

SENSITIVE PH MONITORING FIRMLY IN CONTROL, THE DIFFERENTIAL PH MEASURING PROBE TYPE 40



TYPE 18, THE COMPACT ENAMELLED STEEL DIFFERENTIAL PH PROBE

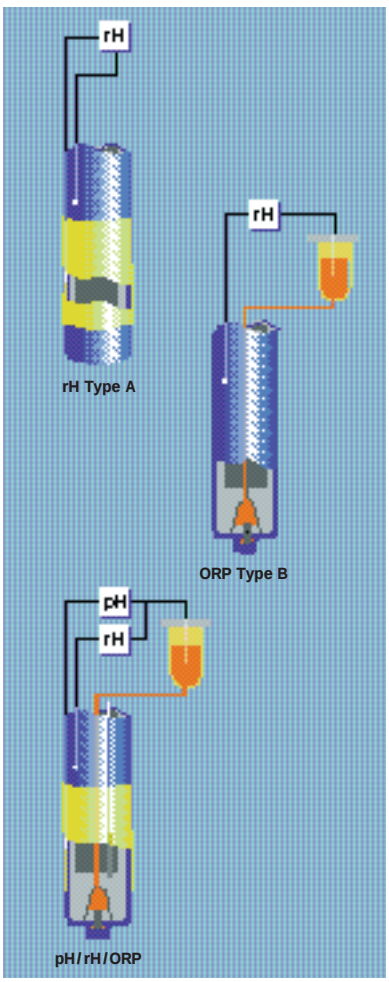


THE RH/ORP AND PH/RH MEASURING PROBES

The Pfaudler rH/ORP measuring probes
Several variants of our probes are designed for measuring redox potential. Like other Pfaudler measuring probes, these are robust and resistant to attack. Their function is to measure the redox potential arising in oxidation or reduction processes. This measurement is carried out with a noble metal electrode against a reference electrode. There are two different versions to choose from:

The rH measuring probe Type A

The rH measuring probe, Type A
In the case of Type A, the redox potential is measured between a rhodium electrode embedded in the enamel and a pH enamel reference electrode. The magnitude of the potential occurring at the reference electrode depends on the pH value of the product. Thus, a redox voltage is obtained which is not dependent on the pH value. The rH measuring probe is chemically highly resistant: the measuring electrode is made of rhodium, the reference electrode of pH enamel.



Operating principle

The ORP measuring probe Type B

The ORP measuring probe, Type B
In the case of Type B, the redox potential is measured between a noble metal electrode and an external reference electrode in the electrolyte vessel. The reference electrode is connected with the product via an electrolyte line and a screw type diaphragm (as with pH measuring probe Type 04). Through the constant reference potential, the measured redox voltage changes with changing pH value.

The combined pH/rH/ORP measuring probe

The combined measuring probe pH/rH/ORP
The combination of both measuring systems on one carrying tube makes possible the simultaneous measurement of pH value and redox potential. The technical data for this combined measuring probe are as for the pH measuring probe Type 04 and rH Type A.

TECHNICAL DATA

Type	03/04	Double pH	pH Ring	40	18
Measured value	absolute pH	2 x absolute pH	absolute pH	relative pH	relative pH
Reference system	Diaphragm + Reference electrode	Diaphragm + Reference electrode	Diaphragm + Reference electrode	Reference enamel	Reference enamel
Measuring range	0 - 10 pH	0 - 10 pH	0 - 10 pH	3 - 11 pH	3 - 11 pH
Slope (mV/pH)	> 55	> 55	> 55	50 - 57,5	50 - 57,5
Temperature (°C)	0 - 140	0 - 140	0 - 140	0 - 140	0 - 140
Temperature compensation	Pt 100	Pt 100	Pt 100	Pt 100	Pt 1000
Pressure (bar)	-1 ... +9	-1 ... +9	-1 ... +9	-1 ... +40**	-1 ... +15
Explosion protection zone 0	yes*	–	–	yes	–
Dimensions - Diameter - Lenght	see p. 13	see p. 13	≥ DN 50	see p. 13	ø 18 mm ET 150 mm

Type	rH Type A	ORP Type B	ph/rH/ORP	LF	LF ring
Measured value	Redox potential	Redox potential	Redox potential and absolute pH	conductivity	conductivity
Reference system	Reference enamel	Diaphragm + Reference electrode	Diaphragm + Reference electrode	–	–
Measuring range	–	–	0 - 10 pH	1 - 2000 mS/cm	1 - 2000 mS/cm
Slope (mV/pH)	–	–	–	–	–
Temperature (°C)	0 - 140	-20 - 160	0 - 140	-25 - +200	-25 - +200
Temperature compensation	–	–	Pt 100	Pt 100	Pt 100
Pressure (bar)	-1 ... +40**	-1 ... +9	-1 ... +9	-1 ... +40**	-1 ... +100
Explosion protection zone 0	yes	–	yes	yes	–
Dimensions - Diameter - Length	see p. 13	see p. 13	see p. 13	see p. 13	≥ DN 50

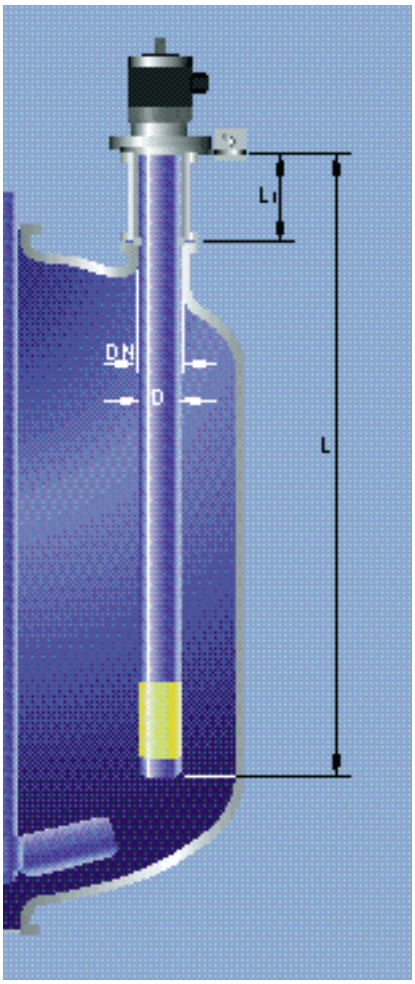
*not pH Typ 03

**Pressure of up to 100 bar possible

VESSELS AND MEASURING PROBE DIMENSIONS

Which measuring probe for which vessel?

This page shows you at a glance the types and dimensions of the Pfaudler vessels currently available. The probe sizes best suited to them are shown in the yellow area of the table. For further information re measurements, see drawing below.



Vessel dimensions		Probe dimensions			
Type / Nominal volume	Diameter	D	L	Nozzle DN	Reducing flange Spacer block DN x L_1
AE 63	508	38	450	50	-
AE 100	508	38	670	50	-
AE 160	600	38	670	50	-
AE 250	700	38	800	50	-
AE 400	800	38	950	80	-
AE 630	1000	83	1150	100	-
AE 1000	1200	83	1400	100	-
AE 1600	1400	83	1600	100	-
AE 2500	1600	83	1800	100	-
AE 4000	1800	83	2000	150	-
AE 6300	2000	127	2500	150	-
BE 1600	1400	83	1600	100	-
BE 2500	1600	83	1800	100	-
BE 4000	1800	83	2000	150	-
BE 6300	2000	127	2500	150	-
BE 8000	2000	127	3000	150	-
BE 8000	2200	127	2500	150	-
BE 10000	2400	180	2700	200	-
BE 12500	2400	180	3200	200	-
BE 16000	2600	180	3200	200	-
BE 16000	2800	180	3200	200	-
BE 20000	2800	180	3200	200	-
CE 1600	1400	83	1400	100	-
CE 2500	1600	83	1600	100	-
CE 4000	1800	83	2000	150	-
CE 6300	2000	127	2500	150	-
CE 8000	2000	127	2850	150	-
CE 8000	2200	127	2500	150	-
CE 10000	2400	180	2700	200	-
CE 12500	2400	180	2700	200	-
CE 16000	2600	180	3200	200	-
CE 16000	2800	180	3200	200	-
CE 20000	2800	180	3200	200	-
DG 100	600	38	450	50	-
DG 250	800	38	670	50	-
DG 500	1000	38	670	50	-
DG 800	1000	38	950	50	50/80 x 45 [1]
E 1200	1200	83	1150	100	100 x 120
E 2000	1400	83	1400	100	100 x 100
E 3000	1600	83	1600	100	100 x 100
E 4000	1800	83	1800	100	-
E 6000	2000	83	2150	100	-
E 8000	2000	83	2150	100	-
E 12500	2400	127	3000	150	-
E 16000	2600	180	3200	200	-
E 20000	2700	180	3200	200	-
L 160	600	38	670	50	-
T 100	600	38	450	50	50 x 70 [2]
T 200	800	38	450	50	- [2]
T 300	800	38	670	50	50 x 30 [2]
T 500	1000	38	670	50	50 x 110 [2]
T 800	1000	38	950	50	50/80 x 45 [1] [2]

[1] Reducing flange in special version

[2] oblique nozzle

dimensions in mm

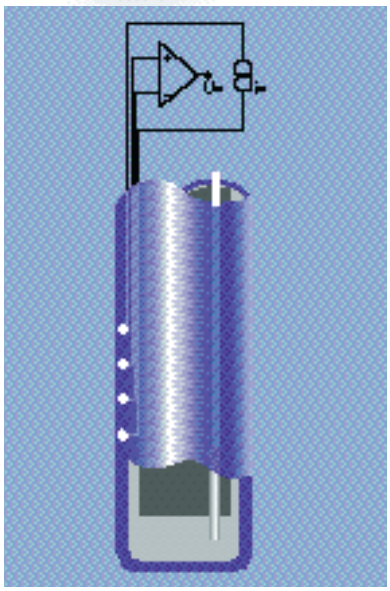
THE TYPE LF CONDUCTIVITY MEASURING PROBE

Probe design

In the LF measuring probe, four me (rhodium) electrodes are aligned lo nally and fused into the enamel coa the probe carrier. Thermometer tub baffles or spacer rings may be use probe carriers.

The cell constant is dependent on th metry and location of the probe and be predetermined. For this reason, a wire circuit is used. A constant alter current flows across the two outer e des and through the product. The re voltage drop is sensed by the two in electrodes and transmitted to a high dance measuring transmitter.

The LF measuring probe



The measurement principle

Calibration

It is possible to use transmitters which themselves determine the cell constant of the measuring probe where the conductivity of the product or of the calibration solution is known.

Please see folding page

ENAMEL

IS "OUR" MATERIAL

All roads lead to Pfaudler when it's a matter of using enamelled products in industry. We are known all over the world as the specialists in this material, as resistant as it is hygienic. Enamel is not an easy material to process: not everyone has the know-how, and experience and expert advice are very important. Pfaudler can offer both: we have worked with enamel for almost 100 years and have carried out our own thorough, efficient research in the interests of product advancement. What's more, we manufacture enamel ourselves and use it in a comprehensive range of apparatus and components. In addition to the measuring probes described in this brochure, we are able to supply the following:

■ **Agitated vessels**
DIN and other agitated vessels with enamelled surfaces, in different sizes from 4 to 40,000 litres capacity for different operating pressures and temperatures.

■ **Agitator drives**
in different versions, also bottom drive.

Agitator vessel that nothing can agitate! Enamelled by Pfaudler

Cryo-Lock© agitator system – everything revolves around safe mixing

■ **Cryo-Lock© agitator system**
The cost-saving agitator system: rapid, inexpensive assembly and increased safety. A wide range of agitator shapes is available for optimisation of your agitator processes.

■ **Quatro-Pipe**
Four functions in one connection piece: baffle, dip pipe, sensor tube and sampling tube.

■ **Pumps, pipes and valves**

■ **Enamelled columns and storage tanks**

Quality and service - of course!
Our organisation is certified in accordance with the requirements of DIN/ISO 9001. Customers using our products every day can be sure that our service team will be at their side if needed, bringing enormous experience and state-of-the-art knowledge on every occasion. Further, you can call on Pfaudler for any of the following services:

■ Testing and servicing
■ Replacement part service
■ Re-enamelling and updating of older vessels
■ Info-service: product information and applications technology courses.

Pfaudler Werke GmbH

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