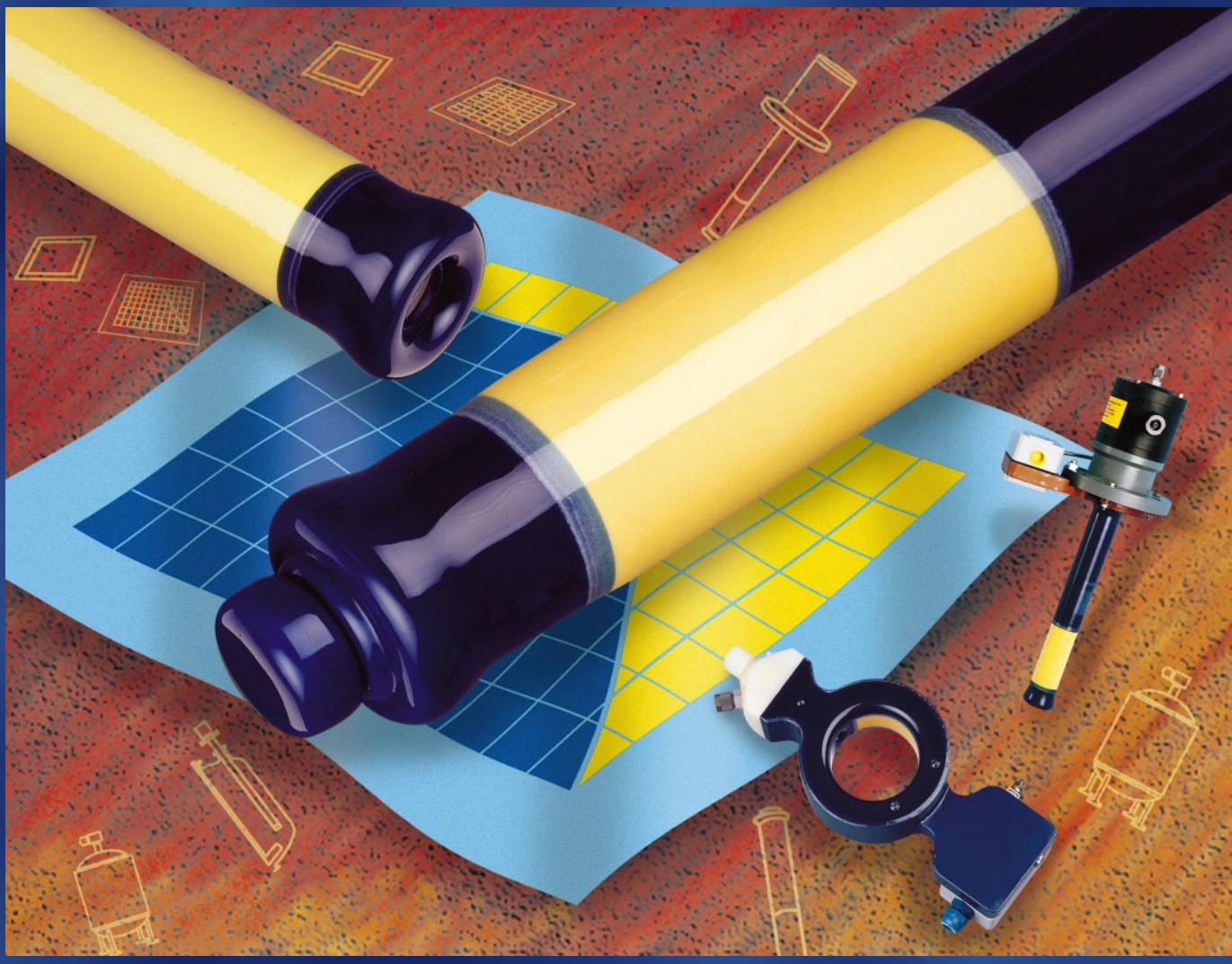
pH Measuring System



PAUDLER, Inc.

A Unit of Robbins & Myers, Inc.

Advantages of Pfaudler pH Systems

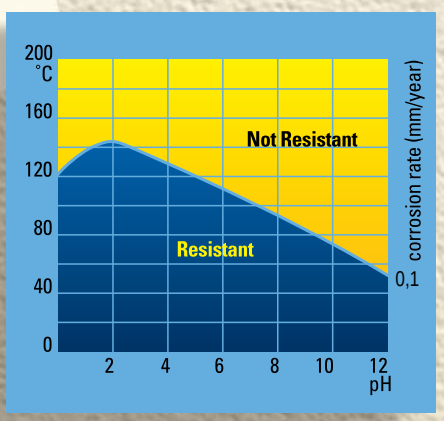
Limitations of Conventional pH Sensors:

- Fragile glass membrane.
- Short life span.
- Frequent maintenance.
- Low accuracy for in-line installation.
- Constant calibration required.
- Cannot be stored dry.

1 *Rugged design can be installed directly inside reactor vessel.*

2 *Operable under extreme conditions up to 135 psig and 285° F.*

3 *Large sensing area provides greater accuracy.*



Isocorrosion curve of the ion sensitive yellow glass (mean values)

4 *The fire-polished non-stick glass surface promotes self-cleaning, reducing maintenance.*

5 *No protective cage required, eliminating product buildup and inaccurate readings.*

6 *Infrequent servicing leads to continuous production, higher plant productivity and cost savings.*

7 *The probe remains in place during batch operation or shutdown and can be stored dry.*

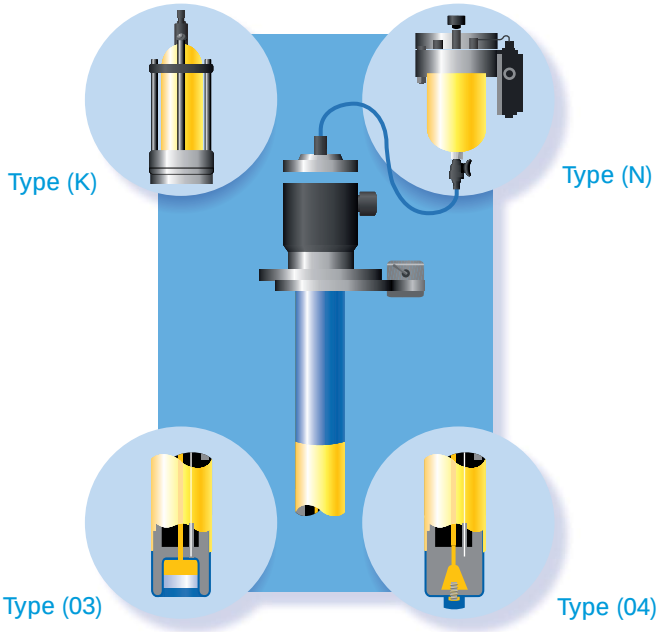
8 *Glasteel® construction offers a superior resistance against chemical attacks, see chart.*

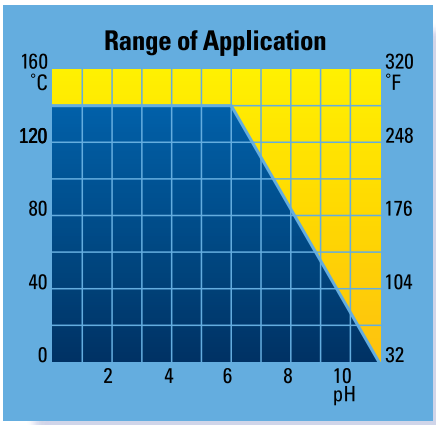
Longest Life, Lowest Maintenance System Available

The Pfaudler Glasteel® pH probe was developed for use in the severe, highly corrosive operating environments of agitated glassed steel chemical process reactors. The probe is placed inside the reactor and withstands the rigors of heat, pressure and dynamic agitation to provide continuous pH measurement. No protective cage is needed or used. The pH probe is ideally suited to situations where slurries are encountered, providing years of service with minimum maintenance.

Originally designed to complement Pfaudler Glasteel® reactors, pH probes are being applied to many processes where pH measurement is difficult, maintenance intensive, or thought to be impossible due to the severity of the operating conditions. Typical applications include: agitated reactors, pipelines with high flow rates, erosive and highly corrosive slurries, limestone recirculation lines, pulp and paper applications, pharmaceutical manufacturing, paint pigment manufacturing, fermentation, neutralization processes, etc.

All pH probes feature an exceptionally large measurement surface area, rugged construction, fire-polished surfaces, superior corrosion and erosion resistance.





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

Range and Accuracy of Measurement

Accuracy is within ± 0.1 pH in the blue shaded area as shown in the chart above.

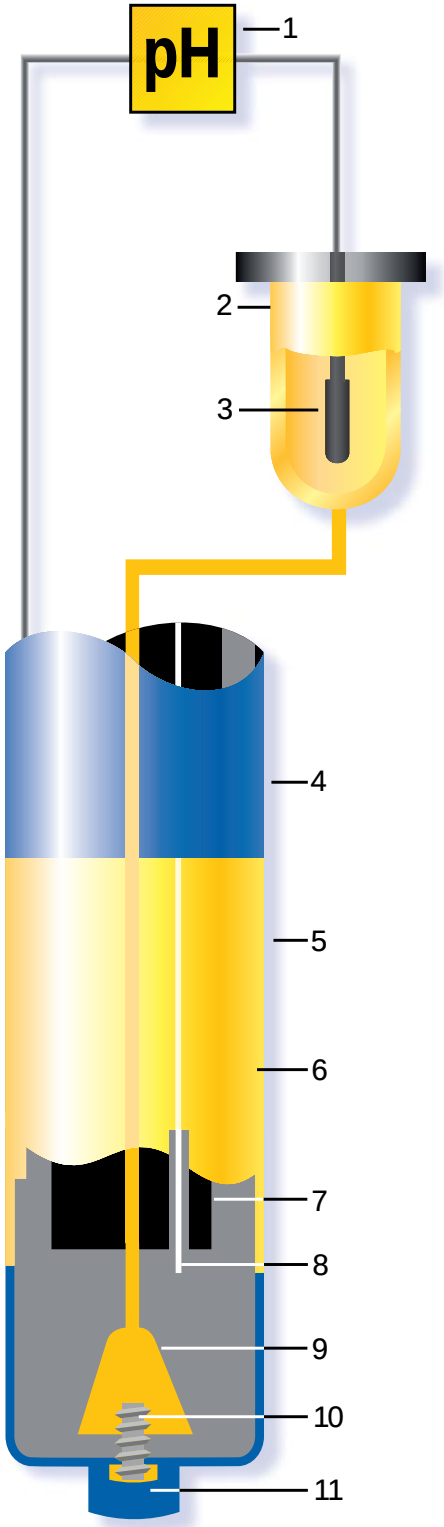
Measurements up to pH 12 are briefly possible. In this region, alkali error results in a deviation of more than ± 0.1 pH.

Design and Measuring Principle

The measuring electrode consists of a band of hydrogen-ion sensitive yellow glass fused on to the probe which replaces the fragile glass membrane used on a conventional pH electrode.

The potential developed by this measuring electrode is conducted to the pH transmitter via a strip of metallic foil permanently implanted in the cobalt-blue glass.

The pH measuring electrode provides a measuring surface area of 15 square inches to 50 square inches, depending on the length and diameter of the probe selected (versus a surface area of less than one square inch on conventional electrodes).



pH sensor, type 03

1. pH Transmitter
2. Electrolyte Reservoir
3. Reference Electrode
4. Glasteel® Body
5. Measuring Electrode
6. Embedded Signal Conductor
7. Steel Substrate
8. Resistance Thermometer
9. Electrolyte
10. Glass Plug
11. Electrolyte Leakage Path

Reference Electrode

The reference electrode silver/silver acetate in the pH sensor is separate from the measuring electrode and is encased in its own electrolyte reservoir. A flexible hose connects the electrolyte reservoir to the pH probe (Type N), or the reservoir may be mounted directly on the probe body (Type K).

The electrolyte contacts the process via a controlled leakage path between a solid glass disc (Type 03) or threaded glass plug (Type 04) and the Glasteel® body at the base of the probe. The reference electrode, therefore, establishes a liquid junction with the process to be monitored via the electrolyte.

Contamination of the reference electrode and electrolyte is prevented by maintaining a positive pressure in the electrolyte reservoir. This positive pressure prevents product from blocking the leakage path and continuously flushes the junction. The reservoir can be pressurized up to 150 psig allowing the pH probe to operate in process environments up to 135 psig (a 15 psig positive pressure differ-ential is recommended).

Electrolyte

The reference electrode operates with Pfaudler electrolyte type K_2SO_4 or KCl. With a positive pressure of 15 psig in the electrolyte reservoir, a loss of 0.2 ml/hr of electrolyte can be expected.

Temperature Compensation

A built-in resistance thermometer (pT100), plus the pH transmitter, function together to automatically compensate for temperature variations and deliver a precise pH value.

Slope and Zero Point

Output of the pH measuring electrode will be at least 93% of the theoretical slope. The zero point of the pH probe ranges between pH1 and pH3. Conventional pH electrode zero points are typically pH7.

Probe Response Time to pH Change

Readout delays encountered in by-pass measuring loops are eliminated. Since the pH probe is installed inside the reactor in direct contact with the product, response time for final readout is between 1 and 5 seconds, depending on the pH value being measured.

Probe Response Time to Temperature Change

The maximum readout deviation caused by a temperature change of up to 1.8°F per minute (1°C/min) is ± 0.1 pH.

The Pfaudler pH ring is excellent for pipe line measurements

Table 1 **Standard Size Glasteel® pH Probes**

Probe Type	Reservoir Style	Nominal Probe Diameter "D" (in.)	Mounting Nozzle Diameter "DN" (in.)	Immersion Length (in.)
03	N/K	1-1/2	2	11-7/8 17-3/4 26-3/8 31-1/2
			3	37-3/8
04	N/K	1-1/2	2	11-7/8 17-3/4 26-3/8 31-1/2
			3	37-3/8
		3	4	45-1/4 55-1/8 63 70-7/8 84-5/8
			6	78-3/4
		5	6	98-3/8 112-1/4 118-1/8
		7	8	106-1/4 126

Table 2 **pH Probe Selection by Reactor Size**

Vessel Type Nominal Volume (gal.)	Probe Length "L" (in.)	Reactor Nozzle Diameter "DN" (in.)	Adapter Height (in.)	Adapter Height "L1" with gaskets (in.)
RT-20	17-3/4	2	1-1/2	2
RT-30	17-3/4	2	4	4-1/2
RT-50	26-3/8	2	1	1-1/2
RT-100*	37-3/8	4	1-3/4	2-1/4
RT-200	45-1/4	4	–	–
RT-300	55-1/8	4	2-1/2	3
RT-500	84-5/8	4	4	4-1/2
RA-300	45-1/4	4	–	–
RA-500	70-7/8	4	–	–
RA-750	63	4	–	–
RA-1000	84-5/8	4	–	–
RA-1500	84-5/8	4	–	–
RA-2000	98-3/8	6	–	–
RA-3000	98-3/8	6	–	–
RA-4000	126	8	–	–

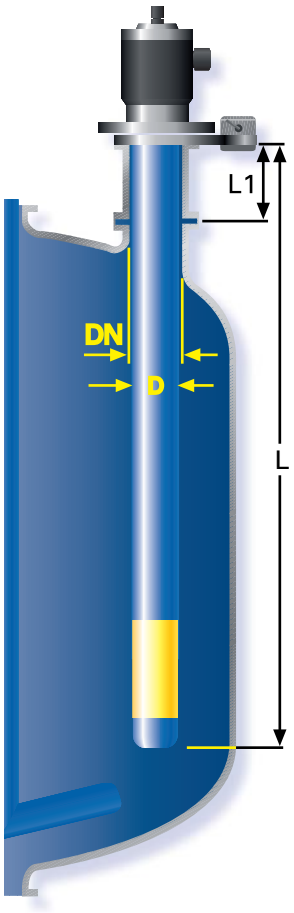
*RT-100 Adapter is a 4" x 3" reducing flange

Table 3 **Flow-Through pH Probes (Class 150 fittings)**

Tee Diameter Nominal "A" (in.)	Probe Length Nominal "L" (in.)	Reducing Flange (in.)	Tee Length "B" (in.)	Overall Length with gaskets "C" (in.)
2	11-7/8	–	9	11-7/8
3	11-7/8	3 x 2	11	13-1/4
4	11-7/8	4 x 2	13	15-1/4
6	17-3/4	6 x 2	16	18-1/4
8	17-3/4	8 x 2	18	20-1/4

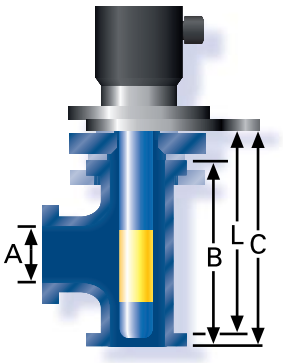
Reactor Probes

The standard pH probes are supplied in a flange mounted configuration and can be installed easily on the top head of any size Pfaudler reactor of 20 gallons or more. The overall length of the probes range from 1-foot to 11-feet as illustrated below and in Tables 1 and 2.



Pipe Line Installation

In addition to the Pfaudler pH ring (see adjacent page) the pH probe can be adapted for flow-through installations as illustrated below.



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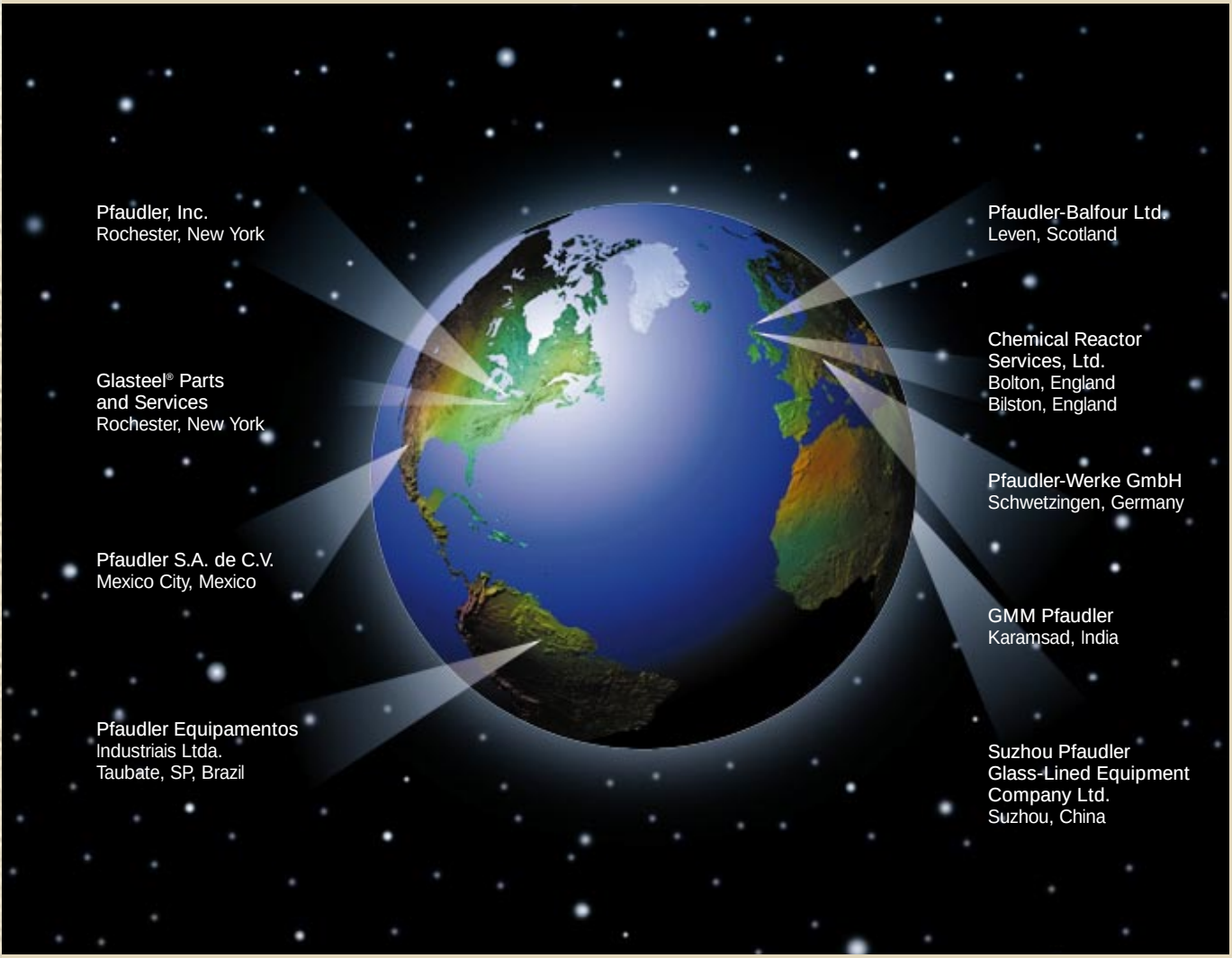

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