How does the FU24 compare? What makes it a better solution?

Ultrapure water, UPW, high-purity water and deionized (DI) are all terms describing basically the same property. They refer to water which has been purified to the highest standards by removing all contaminants such as, organic and inorganic compounds; dissolved and particulate matter; volatile and non-volatile, reactive and inert; hydrophilic and hydrophobic; and dissolved gases. The purified water has very low conductivity which means it is high in resistance because all the conductive components have been removed. In low conductive solutions combined with its susceptibility to contamination and temperature effects makes accurate pH measurement very difficult.

The low conductivity and limited buffering capacity of low ionic strength pure water causes pH electrodes to drift, producing non-reproducible and inaccurate results. The common problems are large drift, unacceptable flow sensitivity and poor temperature compensation. Electrical noise and interference complicate matters further. Certain properties of pure water adversely affect the ability to obtain a reliable pH measurement. For many years it was believed that these properties could not be satisfactorily overcome in order to achieve the desired measurement accuracy and reliability. The areas most affected by the pure water properties include:

I. Electrical Noise:

Noise problems resulting from ground loop potentials are addressed by the design of the pH transmitter. Many pH transmitters utilize a single-ended amplifier design. This design allows current (leakage current) to pass through the reference electrode, giving an offset in addition to shortening the useful life of the reference electrode. With the differential amplifier design, this leakage current will flow through the solution ground, not the reference. Therefore, no offset occurs and the reference electrode is not adversely affected.

II. Special T.C. Requirements:

There are two major temperature effects that must be addressed in order to establish a truly accurate representation of pH in high purity water. The standard automatic temperature compensator only corrects for one of these, often referred to as the "Nernstian or electrode correction." The second effect is known as the "equilibrium or dissociation constant correction." While this effect is usually much smaller in magnitude, it can become significant.

III. Glass Electrode Response:

The low ion concentration of pure water appears to hinder the glass pH bulb's ability to detect hydrogen ions. This causes the electrode to have a low response speed. It is also possible that the alkali components of the glass measurement bulb may dissolve in pure water. If a low flow rate exists in the process, the result would be a pH reading that is too high.

To counter the low response speed and the effect of the alkali components of the glass electrode, special low- impedance S-glass electrodes were developed. They have a chemically resistant glass texture and very good response time due to their low impedance.

Since there are no conductive ions to speak of in high purity water, a physical path of conductive reference solution from the reference electrode to the glass electrode must be established in order for the measurement circuit to be complete. If there are no ions provided from the reference electrode (they have been depleted), there will be no stable reference from which to make the measurement.

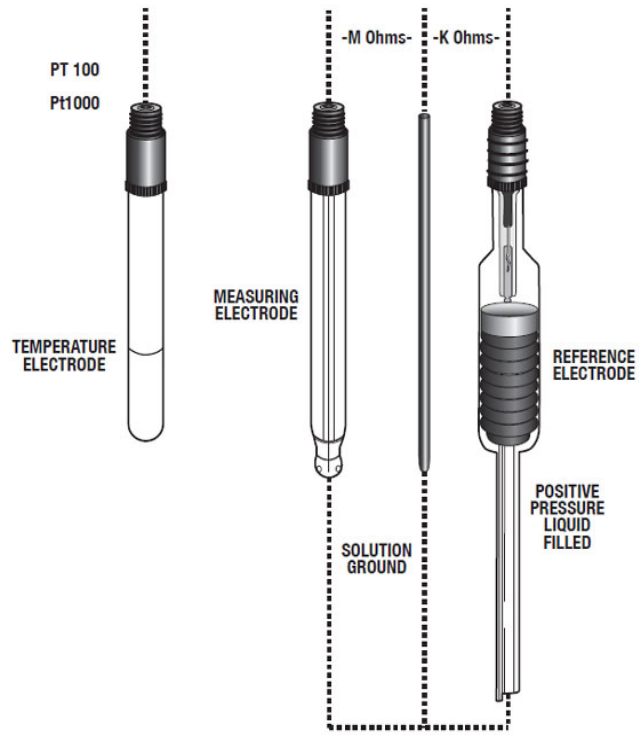


Figure 1: Typical Electrode Configuration for High Purity Water Applications

IV. Reference Electrode Stability

Previous Solutions:
A potential is developed at the reference junction when two different solutions come in contact with each other. This is called diffusion gradient. The reason for this unwanted gradient is transfer of ions at different rates because of flow variations. This may cause unstable reference potential and anomalous pH measurement. Process contamination can also generate these errors in pH measurement.

The liquid junction of the reference electrode tends to develop an appreciable diffusion potential as a result of the extremely large differences in concentration of ions between the process and the fill solution of the reference electrode.

The resulting junction potential can be as high as 20-40 millivolts (approximately 0.5 pH). Any change in this potential will show up as an erratic, drifting pH value.
It will appear that there is a change in the process pH, but this change is false since it is caused by the junction potential. Depletion or dilution of the reference fill solution occurs much more rapidly in high purity water, causing the reference potential to become unstable and the measurement unreliable.

Through years of experience and innovative design, Yokogawa has developed solutions for the problems previously discussed. The high diffusion potentials of the reference electrode can be overcome by using a positive pressure style electrode. One such electrode, called the "Bellomatic," was developed (figure 1). Utilizing a large refillable reservoir, the electrode provides a constant flow rate of reference electrolyte. This provides for a longer, more economical service life, than fixed reference electrodes can provide. In addition, the electrode is independent of the effects of process pressure. Therefore, the use of independent air pressure (as is used with a salt bridge) is not required.

New Solution:

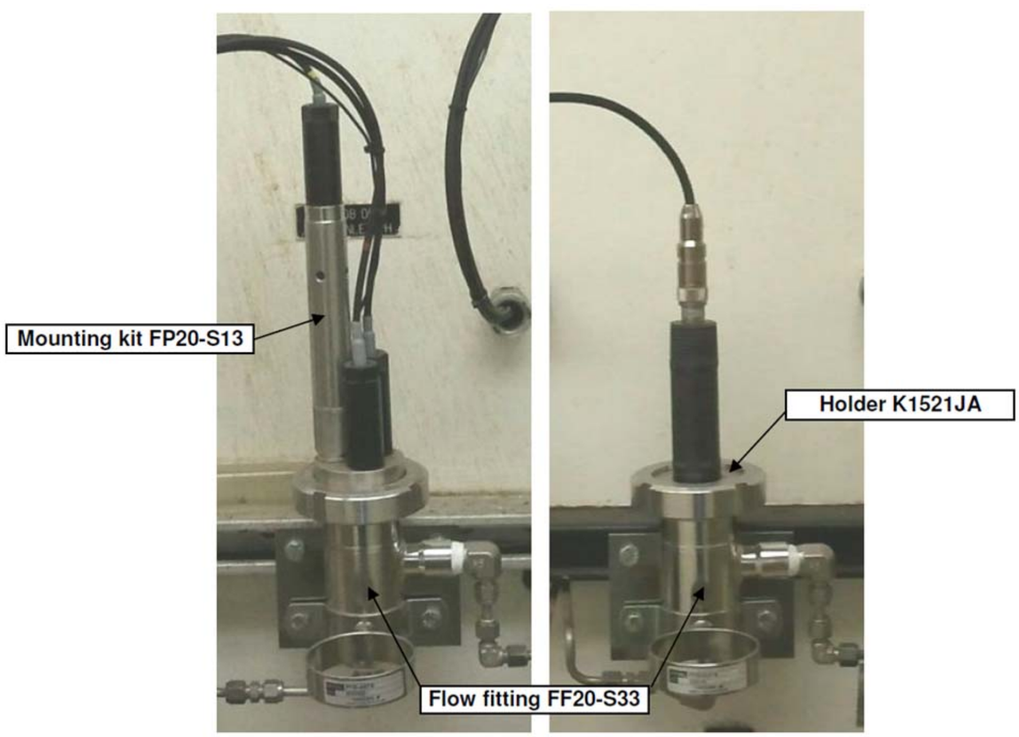
An alternative to a separate glass and reference electrode is a combination electrode with the capability to pressurize the reference portion. In addition to the benefits already stated, the close proximity of the two measuring elements helps insure electrode circuit continuity. The FU24 (figure 2) which incorporates the successful patented bellow system in an All-in-one body is the ideal solution.

Figure 2: FU24 All-in-One pH/ORP Combination Sensor

The FU24 was originally developed for harsh chemical applications were large temperature/pressure variations results in early depletion of the sensors reference chamber, subsequent signal drift and finally loss of functionality.

Designed with an internal bellow, large reference chamber and long-life reference probe, the expected sensor life time was calculated to be about 20 years at 20° C in demineralized water. Further lab tests and field tests indicate that the FU24 also performs very well in pure water applications. Results have been combined into one document TNA1502.

The FU24 has virtually no maintenance compared to the Bellomatic (SR20-AC32). This is due to maintenance time spent refilling and servicing the Bellomatic. For customers currently using the Bellomatic the FU24 can use the same installation holder with the simple change of the sensor adapter plate.



Pictures 1 & 2: 3-Sensor system (pH + Bellomatic Ref + Temp) vs FU24 combined sensor

Features of the FU24:
The FU24 sensor unique design features makes it the best choice for harsh applications involving severe temperature and pressure fluctuations. These features include 360˚mounting capability. Yes, you can mount it upside down if necessary.

The FU24 has a unique reference system that includes a ***SILVER-ION*** trap located directly below the Ag/AgCl reference element. This effectively provides a longer diffusion path between the Ag/AgCl element and the process and helps prevent the loss of Silver Chloride due to temperature variations. In addition, the system a “positive pressure” design comparable to the Bellomatic reference system, that keeps a continual over pressure on the reference junction, keeping in clean and flowing. These features significantly increase the electrode life in aggressive processes such as those containing sulfides or proteins and improve measurement accuracy at differing sample temperatures.

The chart below compares the FU20 and FU24 pH/ORP sensor to a variety of our competitor’s where they can be used as direct replacements:

	YOKOGAWA – FU20	YOKOGAWA – FU24	ROSEMOUNT- 3900	ROSEMOUNT- 396P	ABB – TBX551	ABB – TBX556	FOXBORO - DolpHin	E &H - Orbipac
Sub-Zero Temperatures -10˚C (14˚F)	• X	X	X					
Pressure Compensation	•	X			*	*		
Measures pH and ORP Simultaneously	• X	X						
360˚ Mounting	•	X						
Silver Ion Trap	•	X						
¾” Process Connection	• X		X		X	X	X	X
1” Process Connection	•	X	X	X	X		X	
Mim Conductivity Requirement	• X		Uknown	X	Uknown	Unkown	X	X
VarioPin Cable	• X	X	X	X			X	X
Chemically Resistant Polyphenylene Sulfide (PPS) Body	• X	X	X		X			X
Porous PTFE (Teflon) Junction	• X	X	X		X	X		
For Use in General Purpose Applications	• X		X			X		X
For Use in Harsh, Dirty Applications (Sourewater)	•	X		X	X		X	