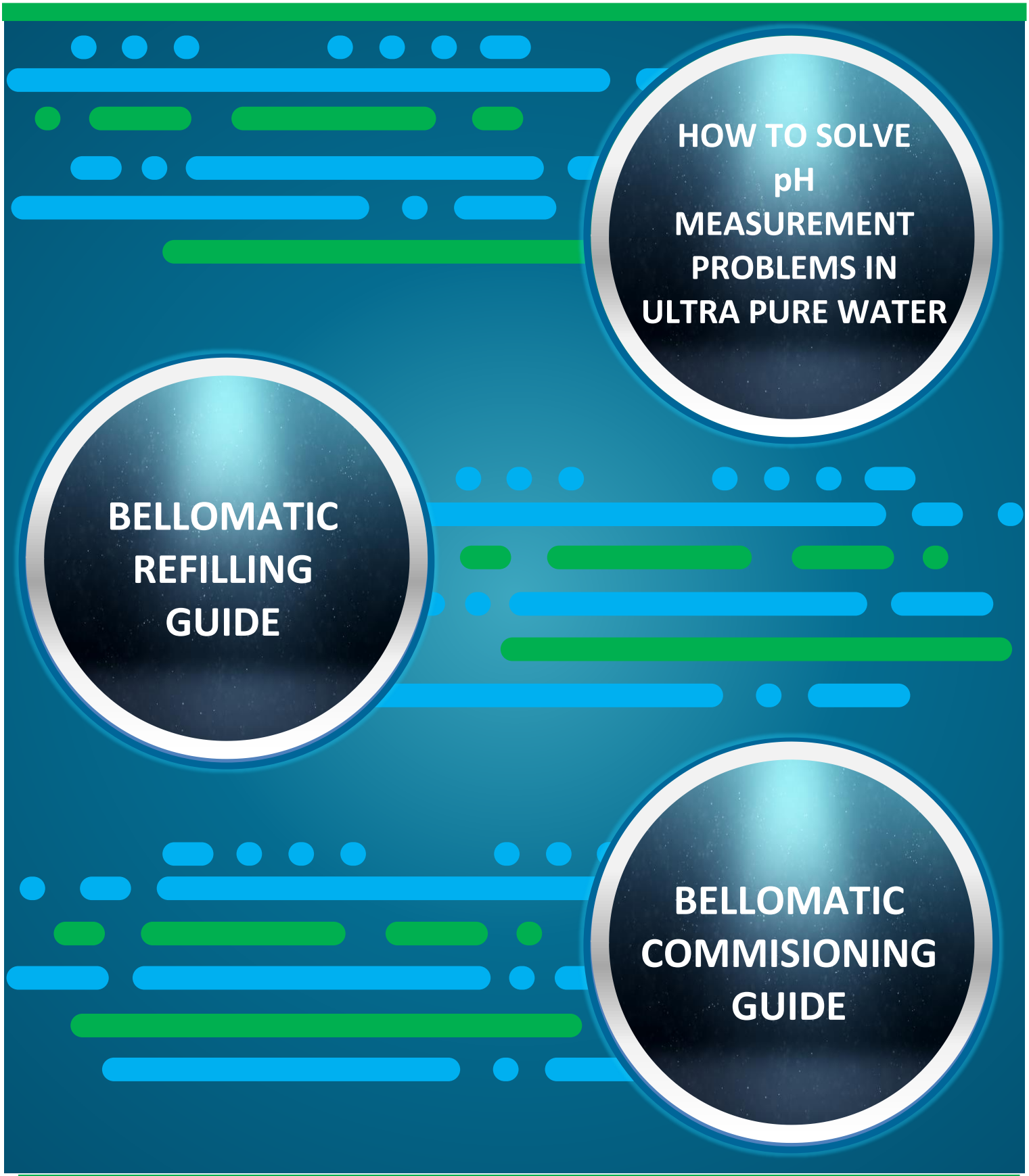
TECHNICAL INFORMATION

TI 12B06G00-00EN-P

pH

Bellomatic Guide

SR20-AC32 flowing type pH reference sensor



YOKOGAWA

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1. Introduction

1.1 Measuring problems in (ultra) pure water

Measurement of pH in high purity water is a difficult measurement at best. The low conductivity and limited buffering capacity of low ionic strength pure water can lead to 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 these properties could not be satisfactorily overcome and achieve the desired measurement accuracy and reliability. The areas most affected by their pure water properties include the reference electrode stability.

The liquid junction of the reference electrode tends to develop an appreciable diffusion potential because of the extremely large difference in ion concentration between the process and the electrolyte 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 offset in the pH value.

It will appear that there is a change in the pH of the process, but this change is caused by the junction potential. Depletion of the reference electrolyte occurs much more rapidly in high purity water, causing the reference potential to become unstable and the measurement unreliable.

For a reliable pH measurement, a conductive pathway is required between the reference electrode and the glass electrode. In high purity water, the ion concentration is too low to provide this pathway. A flowing type reference electrode like the Bellomatic, provides a continuous flow of ions thus creating a conductive circuit. If the reference electrode is depleted or the junction is blocked, the reference potential will drift, and the ion flow stop. As a result of the low fluid conductivity, no reliable measurements can be made.

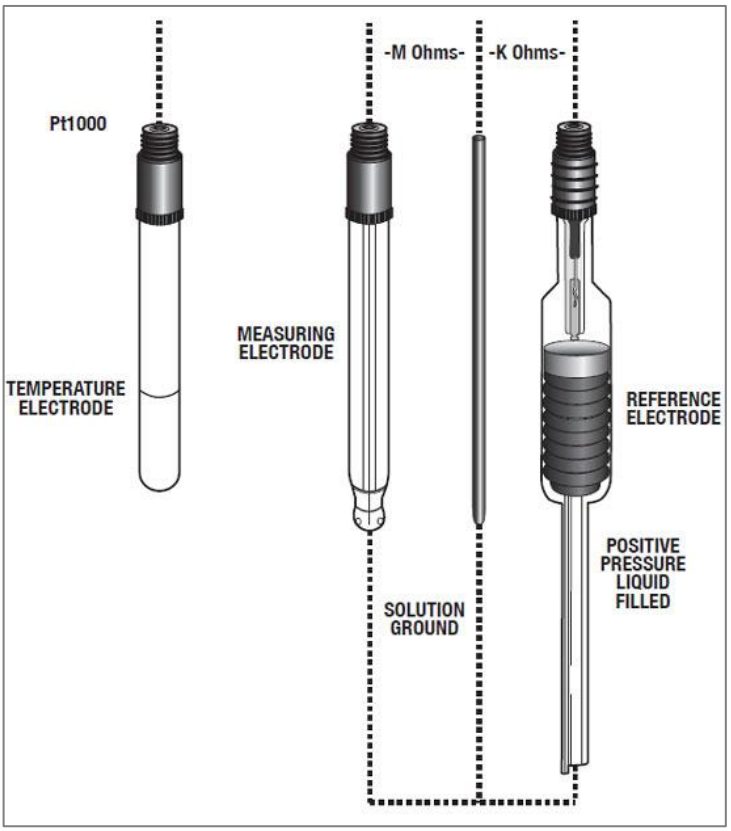


Figure 1: Typical Electrode Configuration for High Purity Water Applications

1.2 Measurement solution

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 reference electrode, the “Bellomatic,” has this feature (figure 1).

Utilizing a large refillable reservoir, the electrode provides a constant flow of reference electrolyte. This provides for a longer, more economical service life, than non-flowing reference electrodes can provide. In addition, the electrode is not affected by the variations in process pressure.

1.3 To flow or not to flow?

The question then is: The bellomatic (or other flowing type sensors) is only useful in (ultra) pure water, or also in other applications?

The flowing out of the reference sensor introduces ions into the process creating an electrical contact between the reference and the glass electrode. This ensures a good electrical contact between the two sensors, which results in a stable pH measurement.
Besides this, the flowing out will automatically clean the junction of any fouling or scaling. That makes flowing type reference sensors also suitable for applications sensitive to fouling.

In general, at a conductivity below 50 µS/cm the flowing type sensors should be used and above 50 µS/cm non-flowing type sensors can be used.

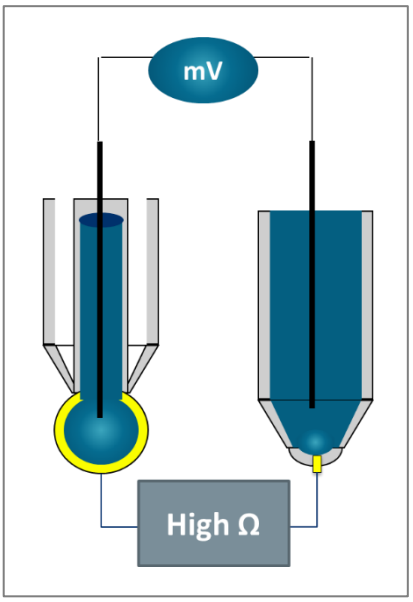


Figure 2: Schematic pH sensor in low ionic process

At lower conductivity levels, also the flow around the sensor must be kept minimal, otherwise the introduced ions will be washed away fast. This will cause the sensor to deplete faster and result in an unstable measurement. Experience shows that when the flow past the sensor is kept below 100 ml/min when the conductivity is 0.056 µS/cm with a flowing type sensor, a stable and highly accurate pH measurement can be achieved.

NON-FLOWING TYPE REFERENCE SENSORS

CONDUCTIVITY	APPLICATIONS:
> 50 µS/cm	General Purpose High Salt Concentration

FLOWING TYPE REFERENCE SENSORS

CONDUCTIVITY	APPLICATIONS:
< 50 µS/cm	(ultra) Pure Water Fouling and Scaling

2. Flowing type reference sensor: Bellomatic

In processes with low ionic strength (low conductivity) flowing type sensors are often used. Additionally, the flowing type sensor with build-in bellow (bellomatic) ensures a stable pH measurement in applications with frequent pressure variations.

In applications with pressure variations the composition of the electrolyte may change because of process liquid penetration into the electrode. This may cause a measuring error or even poisoning of the reference system of the electrode. To prevent this problem, an electrode with an integral pressure compensation system ("Bellomatic"-type electrode") is the best solution.

2.1 The bellomatic electrode function

The refillable reference electrodes have a positive flow of electrolyte to prevent junction fouling or poisoning of the reference system. To prevent penetration of the process liquid into the electrode the pressure in the electrode must be higher than the process pressure.

The electrolyte vessel of the bellomatic electrode contains a bellow which is compressed in the working position. The outside of the bellow is connected to process via the ceramic junction (**BLUE**) and the inside via the inner tube (**RED**).

The pressure inside the bellow equals the pressure outside, but the elasticity of the bellow itself causes the over-pressure which results in a flow of electrolyte (**BLUE**).

When the bellow is fully "expanded" the electrolyte flow stops and refilling is required. The bellow must be compressed before refilling.

The ceramic junction is suitable for most applications. In strong polluting processes a sleeve junction is preferable.

Note: *the flow is highly dependent on temperature. When using the electrode continuously at temperature over 70°C (158°F) it is recommended to fill the electrode with a reference liquid having a higher viscosity, part number K1520VN (3.3 M. thickened KCl solution).*

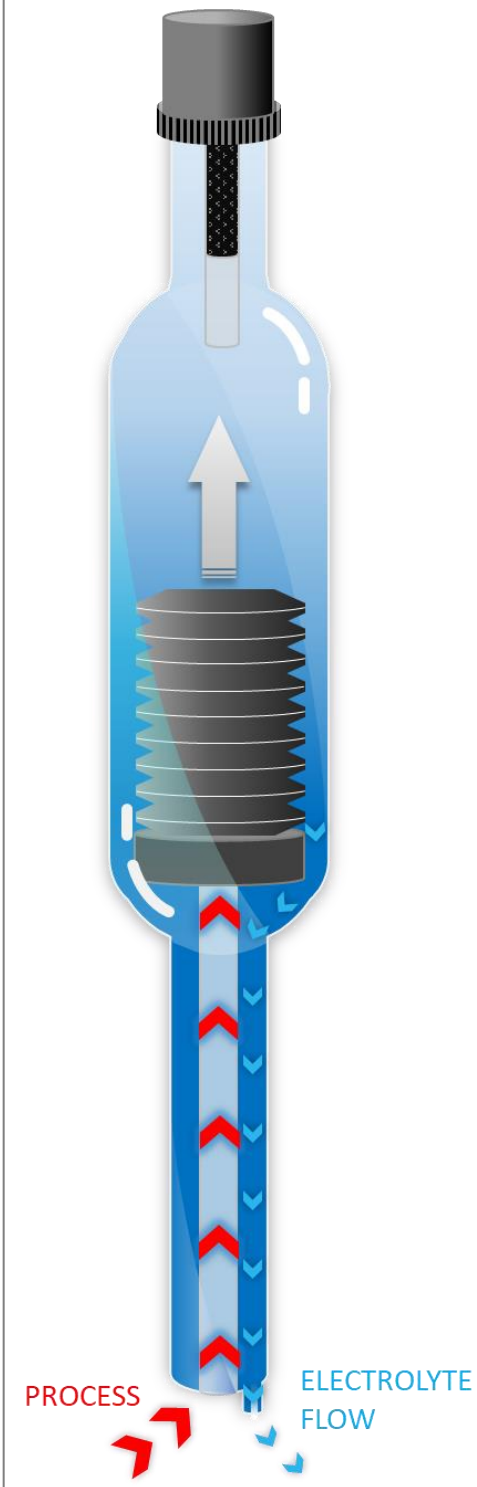


Figure 3: SR20-AC32 "Bellomatic" schematic

2.2 Fitting assembly for Bellomatic

The SR20D-AC32 “Bellomatic” needs a mounting kit (FS20-S13), to place it into our fittings. This kit provides protection against any mechanical impact to the sensor. It has holes on the side to show if the sensor needs refilling.

2.3 Specifications

The specifications of the materials for this fitting are:

Electrode mounting set:	Ryton R4
Body:	Stainless Steel (AISI 316)
Screw piece:	Stainless Steel (AISI 316)
O-rings:	Silicone
Rings:	Silicone
Weight:	Approx. 120 g

2.4-Dimensional drawing electrode mounting set (FP20-S13)

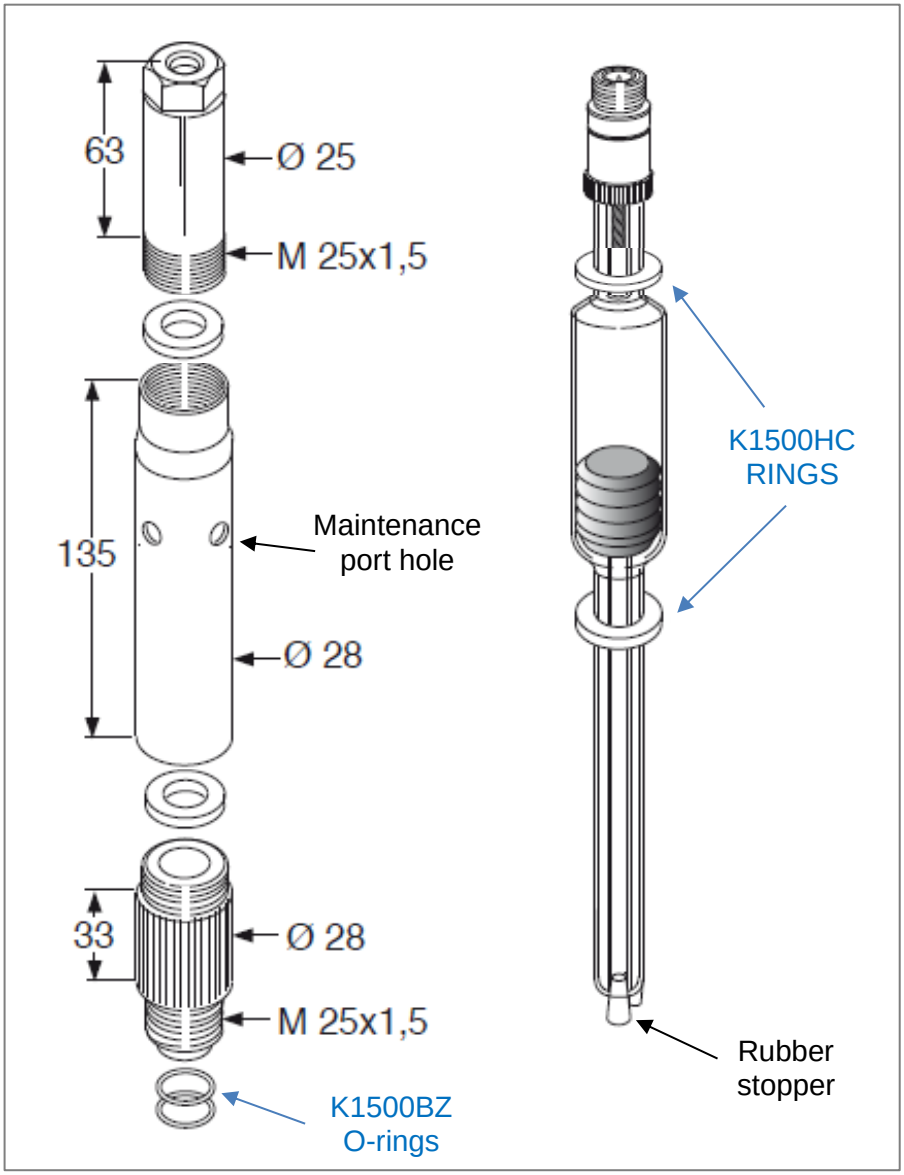


Figure 4: Mounting kit FP20-S13 for Bellomatic in subassembly (FS20), flow- or immersion fitting (FS20 or FD20)

3. Bellomatic refilling guide

PREPARATION

A new Bellomatic sensor is shipped with a rubber stopper inserted into the pressure port at the bottom of the sensor. This stopper must be removed before commissioning the sensor.
This stopper is re-used again when refilling the sensor with KCl solution. Thus, it is very important to keep it for later use.

WHEN TO REFILL?

The bellomatic is a flowing type sensor and needs to be refilled approximately once per month. During use the bellow will move upwards. Once it can be seen through the holes on the side of the fitting it is time to refill.

MATERIALS REQUIRED

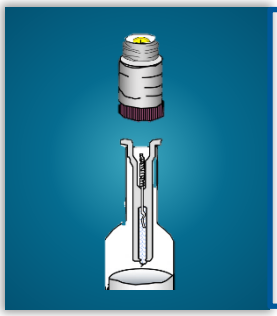
Materials needed: KCl Solution*, Rubber Stopper, Long object like a pencil or chopstick, paper towel or tissue to dry the top of the sensor.

STEP 1

Locate the rubber stopper and insert it into the pressure port at the bottom of the sensor.

STEP 2-1

Unscrew the connector from the top of the sensor and remove the Reference electrode from the top of the Bellomatic sensor.

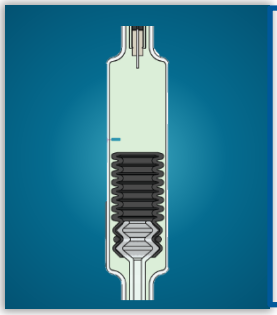


STEP 2-2

Occasionally the bottom part of the electrode will stick to the Bellomatic Assembly. If this happens, carefully remove the electrode from the top of the Bellomatic Assembly.

STEP 3

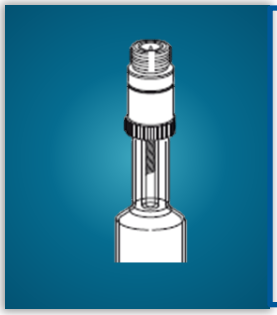
Use a damp paper towel to wipe and dry off the outside of the glass portion at the top to remove any remaining KCl from the area that connects with the neck. Reinsert the electrode into the connector and set it aside until you are ready for reassembly.



STEP 4

Hold the Bellomatic over a container or sink and remove the rubber stopper. some KCl may come out when the stopper is removed.

Use the pencil or chop stick and press down the bellow from the top until it is fully compressed. When holding the bellow in the compressed position, insert the rubber stopper back in the pressure port at the bottom of the sensor.



STEP 5

Pour out any remaining KCl and rinse a couple of times with a small amount of the new KCl solution.

Fill the chamber just to the bottom of the neck above the bellows chamber.

Dry off the top of the sensor where the electrode screws into the Bellomatic Assembly.

STEP 6

Reinstall the electrode carefully, making sure the KCl solution does not overflow out of the top of the sensor, otherwise clean and dry it again.

Remove the rubber stopper.

STEP 7

Once the top of the assembly is sealed you can remove the rubber stopper and place the Bellomatic Assembly back in service.

***Note:** The standard solution for this is the 3.3 Molal KCl solution (K1520VA). For temperatures > 70°C (158°F) it is advised to use the thickened 3.3 Molar KCl solution (K1520VN). This allows the KCl to flow at about the same rate at a high temperature as it would do at room temperature and keep the frequency of refilling still at about once per month.

4. Commissioning guide Bellomatic fitting

Add a silicone ring at the top and bottom of sensor.

For this the connector must be removed and after fitting the silicone ring screwed back on again.

Note: this only must be done at the commissioning stage, or when the rings need to be replaced

Place the body from the top and fit it around the bellomatic

Connect the cable to the sensor and screw on the (black) electrode mount which will protect the

Assemble the screw piece of the fitting by sliding it over the bottom part of the sensor and screwing it onto the body of the fitting

Slide the two (red) O-rings over the bottom part of the sensor.

This will properly seal the sensor into the fitting (FF20, FS20 or FD20).

5. Parts information

PART NO.	DESCRIPTION
FP20-S13	Mounting kit for SR20-AC32 (Bellomatic)
K1500BZ	O-rings Viton 11x3 (6 pieces)
K1500GR	O-rings silicon 11x3 (8 pieces)
K1500HD	O-rings silicon 11x3 (50 pieces)
K1500HC	Rubber Ring (10x)
K1500GE	O-rings (5x) for (inside) connector
K1520VN	3.3 Molal KCl solution (refill)
K1520VA	3.3 Molal thickened KCl solution for applications > 70°C / 158°C
K1520BA	Buffer Solution starter kit (pH 4.01, 6.87, 9.18)
K1520BB	Three bottles with NIST buffer 1.68 pH
K1520BC	Three bottles with NIST buffer 4.01 pH
K1520BD	Three bottles with NIST buffer 6.86 pH
K1520BE	Three bottles with NIST buffer 9.18 pH

General advice is to replace the O-rings once per year.

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