Original Instructions

Installation, Operation & Maintenance Manual

Sentry W7950 Degassing Sparger

Single Line Conditioning Module

S-SW-IOM-00721-0 10-20

COMPANY WITH
QUALITY SYSTEM
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= ISO 9001 =

SENTRY

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Do not install, maintain, or operate this equipment without reading, understanding, and following the appropriate Sentry Equipment Corp instructions. Otherwise, injury, damage, or both may result.

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Note

The information contained in this document is subject to change without notice.

Safety Information

Please read the entire manual before attempting to unpack, set up, or operate this product. Pay careful attention to all Warnings, Cautions, and Notes. Failure to do so could result in serious personal injury and/or equipment damage.

Use of Hazard Information

If multiple hazards exist, the signal word corresponding to the greatest hazard shall be used.

Definitions

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to personal injury.

➲ NOTE

Information that requires special emphasis.

➲ TIP

Alternate techniques or clarifying information.

SHALL: This word is understood to be mandatory.

SHOULD: This word is understood to be advisory.

General Safety Precautions

Product Selection, Installation, and Use

⚠ WARNING

Improper selection, installation, or use can cause personal injury or property damage. It is solely the responsibility of users, through their own analysis and testing, to select products suitable for their specific application requirements, ensure they are properly maintained, and limit their use to their intended purpose.

Follow proper local, state, and federal regulations for proper installation and operational requirements.

Always use caution and common sense when working with any chemical. Read the product label and Safety Data Sheets (SDS) carefully and follow the instructions exactly.

Specification

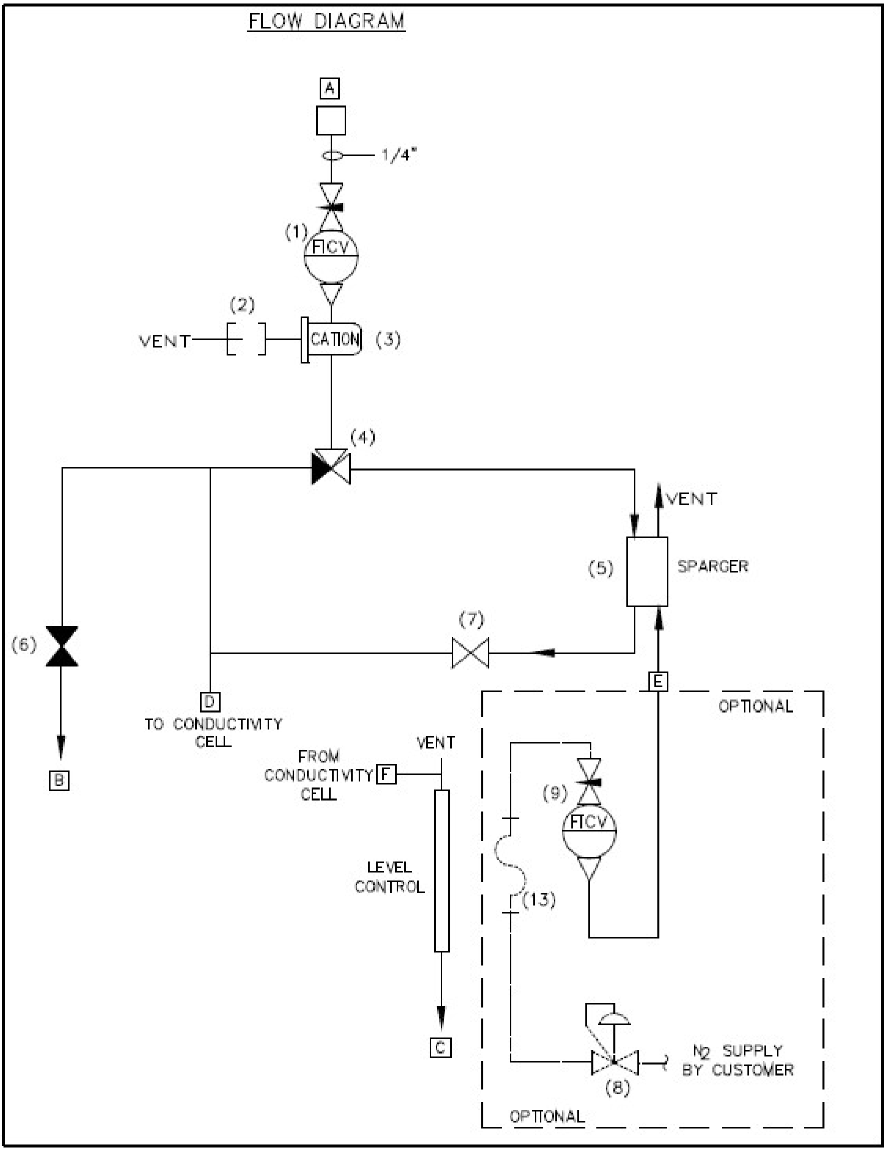
Sentry® Single Line W7950 Degassing Sparger is a completely self-contained unit, including a cation resin column with a vent and auto shut-off quick disconnects for easy resin change out.

Sparging gas can be obtained by using portable cylinders, or more economically by electing the continuous nitrogen generator option. Add an on-line conductivity analyzer for full function.

The assembly is mounted on a plate and is designed to be wall-mounted. Optional custom units can be supplied mounted on a unistrut floor stand, or mounted on a hand truck for portability.

Sample Inlet	**Pressure:** 100 PSIG Design Pressure (Recommended regulated sample pressure to 10-20 PSIG) **Temperature:** 125°F Maximum **Sample Flow:** 100-200 cc/min, 150 cc/min optimal
Sparging Gas	Nitrogen or helium, 600-800 scc/min (Gas Regulator, Braided SS Hose, Nitrogen Flowmeter, and Nitrogen Generator are available as options with each unit.)
Power	Depends on Analyzer (optional), typically 120/240VAC, 50/60 Hz, ≤100W

Flow Diagram and Typical Operation



A typical flow diagram is shown above. The sample enters at the top, through a valved sample flowmeter, and then through the cation resin column.

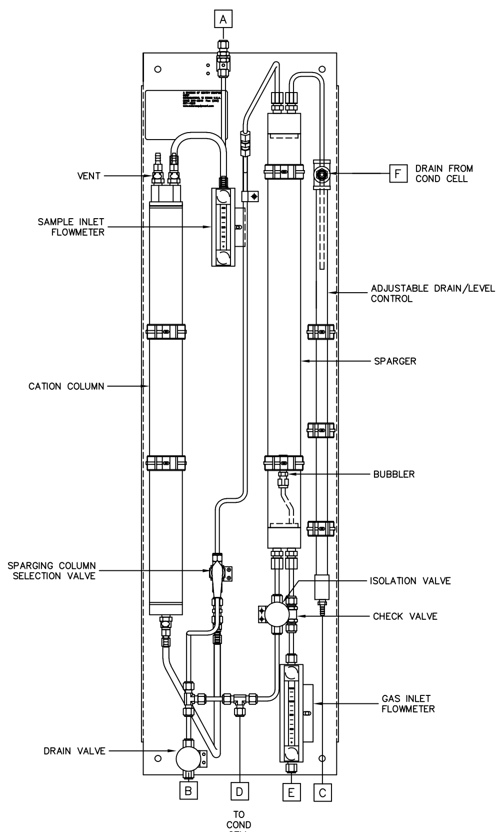
Downstream of the resin column is a three-way valve, which allows the sparging column to be bypassed. This allows a measurement of the cation conductivity without degassing it.

The sparging gas is connected to a valved flowmeter beneath of sparging column, and will vent out of the sparging column at the top along with any gases removed from the sample stream.

A separate shutoff valve is provided which can be used to drain the columns, or to obtain a grab sample.

The "level control" device shown on the flow diagram is used to adjust the water level inside the sparging column. A high level will allow some of the sample to be carried out of the sparging column with the venting gas flow. This will also reduce the speed of response by creating a large reservoir of sample. Alternately, a low sample level will reduce the efficiency of the Sparger by reducing the contact time between the sparging gas and the sample. By experimenting with the combinations of sample flow, sparging gas flow, and sparging column level, the optimum efficiency is achieved with a reasonably low consumption of sparging gas.

Previous testing indicates that the combination of a half full sparging column with a sample flow rate ≤ 150 cc/min and a sparging gas flow rate in the range of 600 to 800 SCCM will most likely produce the best results (greatest amount of CO_2 removal and therefore the lowest conductivity readings).



CONNECTIONS

A	SAMPLE INLET	1/4" TUBE
B	SAMPLE DRAIN	1/4" TUBE
C	LEVEL CONTROL DRAIN	1/4" BARB
D	TO COND CELL	1/4" TUBE
E	NITROGEN INLET	1/4" TUBE
F	FROM COND CELL	1/4" BARB

Module Preparation

Installing the Module

1. Anchor the unit to the wall or other suitable surface with 1/4″ bolts.

2. Connect the sample inlet line using 1/4″ OD tube. Try to keep the inlet line length as short as possible to minimize the lag time.

3. Connect the Nitrogen or Helium supply:
   a. Using a gas bottle:
      1. Install the regulator on the gas bottle. Technical grade gas seems to work fine for most power-plant samples; better grades will have lower backgrounds of CO_2 but are also more costly. For high purity work, we recommend that a CO_2 absorber be used at the cylinder rather than using high-purity gas, as the cost of the absorber is less than that of high purity gas.
      2. The regulator assembly should also include a valved flowmeter, preferably in the range of 0-1500 cc/min. Connect the discharge of the flowmeter to the inlet of the sparging column.

   b. Using a W7950 Nitrogen Generator:
      1. Anchor the unit to the wall or other suitable surface with 1/4″ bolts if the generator is not already integral with the Sparger.
      2. Connect the discharge of the generator to the valved flowmeter on the Sparger using 1/4″ OD stainless steel tubing.
      3. Leave drain lines on the filters unconnected to connect separately to a gravity drain. Do not combine filter drains with Sparger drain line.
      4. Run the drain (1/4″ Hose Barb) to a suitable gravity (non-pressurized) drain using Tygon or other flexible tubing.
      5. Connect the analyzer flow cell to the sample outlet (tee). Although Tygon tubing works well in many applications, Tygon is semi-permeable to CO_2, which can affect your results slightly. For high purity results a lined polypropylene, PVDF, or SS tubing should be used.
      6. Connect the analyzer flow cell discharge to the barbed fitting on the adjustable discharge pipe. Tygon is acceptable since this is flowing to waste.

NOTICE

The conductivity cell discharge must be connected to the return line on the drainpipe of the module. This height is used to control the liquid level in the sparging column.

Operating Instructions

1. Open the sample rotameter to start the flow of sample. The optimum flow rate through the cation resin column is around 150 cc/min; however good performance is seen anywhere from 100 to 200 cc/min.

2. Set the three-way valve to flow to the sparger, and open the valve downstream of the sparger.

3. Adjust the overflow tube to make the level in the sparger about 1/2 full.

4. Start the flow of Nitrogen or Helium.

   a. Open the flowmeter before opening the valve on the gas tank or Nitrogen Generator. This ensures that the valve on the rotameter will not create a dead leg.

   b. Using a gas bottle:

      1. Open the valve on the regulator to reduce the pressure as low as possible.

      2. Slowly open the valve on the gas cylinder, while watching the pressure to make sure it does not exceed 100 psi.

      3. Close the valve on the rotameter, and adjust the pressure regulator to 10-20 psig. Open the rotameter to achieve the desired flow rate. We recommend starting at 600 SCCM flow for the gas.

   c. Using a Nitrogen Generator:

      1. Slowly open the instrument air pressure regulator, while watching the pressure to make sure it does not exceed 100 psi.

      2. Close the valve on the gas flowmeter. Open the generator isolation valve and adjust the external air pressure regulator (not included with the generator) to between 80-100 psig. Open the sparging gas flowmeter to achieve the desired nitrogen flow rate. We recommend starting the sparging gas flow rate at 600 SCCM and increasing the rate of flow until the conductivity reading of the sample can no longer be lowered. This should take place between 600-800 SCCM.

         In order to produce up to 1 LPM of 99.5% pure nitrogen, the minimum operating temperature, pressure and flow rate for the instrument air feed line at the inlet to the separator is 75°F @ 80 psig and 10.5 SCFH with feed air dew point 65°F or less.

Principle Of Operation

Cation Conductivity

Positively charged ions are cations, negatively charged ions are anions. For example, sodium chloride (NaCl) dissolved in water results in the cation Na+ and the anion Cl-. The cation resin used in the cation resin column is a styrene-divinylbenzene polymer resin with the active (surface) sites saturated with hydrogen ion H+. The basic structure is R-SO3-H+. The cations in the sample are more strongly bound to the resin than the hydrogen ion, and so they replace the hydrogen on the resin and produce a weak acid from the equivalent neutral salt.

For example:

NaCl $R\text{-}SO_3\text{-}H^+ + Na^+Cl^-$ $R\text{-}SO_3^-Na^+ + H^+Cl^-$

Ammonia $R\text{-}SO_3\text{-}H^+ + NH_4^+OH^-$ $R\text{-}SO_3^-NH_4 + H_2O$

Since the acids have a greater conductivity than the neutral salts, the conductivity increases as it passes through the resin. This is used to increase the sensitivity to trace levels of neutral salts. However, ammonia is neutralized after cation exchange, therefore decreasing the conductivity. In power plants where ammonia is used for pH control, or where hydrazine is used as an oxygen scavenger, the amount of ammonia is considerably higher than the level of neutral salts. So passing the sample through the cation resin column reduces the conductivity.

Since CO_2 dissolves in water to form carbonic acid, which is a weak acid, it will be unaffected by the cation resin.

Gas Sparging

Gas sparging is a well-established technique for degasifying liquids. Typically it's used in larger industrial applications and where a large excess of dissolved gas is present. For example, pure water saturated with CO_2 can have a conductivity of 1µS, whereas pure water at 77F has a conductivity of .055 µS. The conductivity increase is due to the conversion of CO_2 in water to a weak acid (carbonic acid). The chemical formula is as follows:

$CO_2 + H_2O$ H_2CO_3 $H^+ + HCO_3^-$

In contrast with a gas such as CO_2, Nitrogen and Helium among others will dissolve in a sample but will not dissociate or react with the water. So a liquid saturated with an inert gas will not show an increase in conductivity.

In the formula above, the arrow symbol indicates a reversible reaction. A small amount of CO_2 dissolved in water will be primarily in the form of CO_2 gas. As more gas is dissolved, then the reaction proceeds to the right forming carbonic acid. If the CO_2 gas is removed from the liquid, the reaction proceeds to the left, reducing the amount of carbonic acid and eventually the dissolved CO_2 as well.

Gases are dissolved in water in the ratio corresponding to the partial pressure of the gases in contact with it. Since air is mostly Nitrogen and Oxygen, which will not react with water, only the CO_2 fraction contributes to the conductivity of a saturated solution. By sparging with Nitrogen free of CO_2 the CO_2 is driven off and the solution conductivity is reduced. This is the basic principle behind sparging. (In contrast, a reboiler heats the sample, thus reducing the solubility of gases in the liquid.)

Other Gases Affecting the Conductivity

Other gases affect the conductivity as well. In a power plant the most notable are hydrazine and ammonia, both of which are used in chemical treatment. However, other gases and volatile compounds are present as well, and can include amines, resins, alcohols, and organic acids such as formic and acetic acid. Many of these are removed in the cation resin column (in particular ammonia and hydrazine) but others are weakly ionizing in water and are not removed by the cation exchange cartridge. However, the fact that these gases are weakly ionizing also means they do not contribute much to the conductivity, relative to the CO_2.

High Purity Water Samples

With extremely high purity samples (<0.2 µS) the relationship with dissolved gasses may not hold as it does with higher concentration samples. The same is true of a sample that is degassed down to a low conductivity. Since the dissolved CO_2 concentration is very low, the remaining volatile components may contribute as much conductivity as does the CO_2. Furthermore, some evidence suggests that these other components will be preferentially sparged off. For most power plant applications this is of technical interest only, because the true measurement desired is in fact the conductivity of the sample degassed of all volatile components, not just the CO_2.

High Purity Water Samples

Since the conductivity reading that is obtained with this method can always be reduced to some extent by increasing the sparging gas flow rate, it's important to understand the significance of the results. It follows that the actual degassed cation conductivity will ALWAYS be lower than the analyzer readings. For most applications this is sufficient, because the significance is to ensure that the degassed conductivity is always below a certain threshold value.

Once a baseline is established, then every test should be run under the same conditions of flow rate for both sample flow and sparging gas flow rate. In this way all samples can be referenced to that condition. Some experimentation should help determine what the optimal conditions are.

Maintenance

The Sparger Assembly has been designed for years of trouble-free service. Follow the instructions in this section to insure continued proper operation.

1. **Cation Resin –** the cation resin included with the resin column is a color indicating type resin, with the flow path from top to bottom. As the resin exhausts, it will change from purple to a yellow color, and the color change will proceed down the column. As a rule, the resin should be changed when the color change has progressed 2/3 to 3/4 of the way down the column. Keep in mind that as the resin exhausts, shedding

of entrapped ions will occur with increasing concentration over time. Depending on the accuracy required, the resin might need to be replaced more frequently, since completely fresh resin will produce the best results.

2. Correct any leaks promptly. A leak may appear to be leaking sample fluid out of the fitting or other device, but it could also be allowing in-leakage of CO_2. Even a small leak can affect the results significantly.

3. Perform scheduled calibrations on the conductivity analyzer to ensure accuracy. Most conductivity cells are calibrated at the factory, and some users purchase an additional conductivity cell to use as a reference. If attempting to calibrate with standards, be aware that low-level conductivity standards (<100µS) are extremely unreliable and change value rapidly on exposure to air. However, it may be possible to produce a stable conductivity standard using a water-propanol-salt solution developed by NIST. The benefit of this standard is that the propanol-water mixture does not absorb CO_2 and thus remains stable for extended periods of time.

   Ref: Yung Chi Wu and Paula A. Berezansky, J. Res. Natl. Inst. Stand. Technol. 100, 521 (1995).

4. **Rotameter –** inspect for evidence of leakage around the valve. If necessary, the tube can be cleaned per the manufacturer's instruction.

Troubleshooting

1. **High Conductivity Reading**

   a. **Air In-leakage:** If the probe is not threaded tightly into the probe holder, air can potentially leak into the cell. This would only occur if the discharge line were below the level of the probe holder, thus creating a siphoning effect. The design of the discharge (level control) tube does not allow the discharge to be below the level of the cell, thus preventing siphoning. Any customer modifications should take this into account.

   b. Resin column exposed to direct sunlight or UV light: If the resin column is exposed to direct sunlight, the conductivity reading will increase dramatically. Even with reflected sunlight, there could be a slight affect on the resin. If necessary, cover the column with dark paper or foil to see if this eliminates the problem.

   c. Resin channeling or exhausted.

      1. Resin channeling occurs when the sample finds a small path through the resin, where the flow is not distributed evenly across the resin bed. The resin surrounding the channel becomes exhausted, thus increasing (typically) the conductivity reading. Remove the resin column and shake it gently to re-distribute the resin. In many cases this resolves the problem. If not, then the resin should be replaced with fresh resin.

      2. Some samples have high levels of particulates that can clog the pores between the resin beads; with the result that channeling is forced to occur. The only remedy is to replace the resin. Installation of a filter upstream of the inlet can prevent this, however, now the filter may plug up. Filters are not recommended, because the particulates in the filter can act as an absorber for the ions in solution, which affects the results slightly. For samples with a large amount

of particulates, adding a filter might be the only reasonable solution to the problem.

3. Check the color of the resin. If necessary, replace with fresh cation resin.

2. **Low Conductivity Reading**

   a. **Air bound cell holder:** Air bubbles trapped in the cell holder can affect the conductivity reading. The optional cell holder available for this system is angled to help prevent trapped air.

   b. **Dirty cell:** Clean the cell and, if necessary, recalibrate the analyzer.

3. **Slow response time:** The more sample in the sparging column the slower will be the response time. Keep the level as low as possible, but not so low that the results become affected due to insufficient sparging.

4. **Bubbler seems to be plugged:** The bubbler can be chemically cleaned in a strong solution of sulfuric acid, followed by a thorough rinse to remove the acid from the pores. If necessary, a replacement bubbler can be purchased from Sentry Equipment.

5. Resin changes color only on the outside surface of the resin column bed: Premature discoloration can be caused by sunlight or high levels of ambient light due to reflected sunlight. The interior of the resin bed retains the original color, indicating that the resin is still active. There are only 2 ways to prevent this,

   a. move the resin column to a different location

   b. wrap the outside of the column with a protective wrap.

   Leave a small slot in the wrap so that the resin is visible, located on the side of the column awayfrom the light source.

6. Sample discharges from the top of the sparging column.

   a. The level is too high. Lower the discharge pipe slightly.

   b. The flow of sparging gas is too high - verify that the flow is correct.

Parts List

ID	Description	Sentry Part Number
	Resin refill, 650 cc	W790110
	Gasket for resin and sparging column	WA170543
	Valved Rotameter, 0-1600 cc/min (Sparging Gas) Valved Rotameter, 0-450 cc/min (Sample)	WA171591 WA171578
	Resin Column, 1/4" NPT, for Cation Conductivity Analyzers, 1 charge resin included	W7901L44
	650 cc Sparging Column with SS diffuser	W7901SPG
	Teflon Hose, SS Overbraid, for sparging gas Supply Line	WD172145
	Valved quick-disconnect kit for W7901L/S resin column. Includes two fittings,each with hose barb ends to fit 1/4" ID flexible tubing.	WA070114
	Locking support clamp, non-corroding, for resin column models W7901L/S Set includes clamp and holder. Two clamps/holders recommended for each column.	WA171458

Customer Support

With proven sampling expertise since 1924, Sentry products and services provide business operations the critical insights to optimize process control and product quality. We deliver true representative sampling and analysis techniques to customers around the globe, empowering them to accurately monitor and measure processes for improved production efficiency, output, and safety. Standing behind our commitments, we are determined to tackle any application, anywhere.

We know that running an efficient operation isn't easy. It requires thorough, careful analysis of controlled, real-time data achieved through reliable, accurate, and repeatable process monitoring and measuring. By effectively conditioning, sampling, and measuring gas, liquid, slurry, powder, solids, steam, or water within their production environments, our customers obtain the critical insights they need to control and optimize their processes.

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966 Blue Ribbon Circle North, Oconomowoc, WI 53066 U.S.A. | +1-262-567-7256 | support@sentry-equip.com