GENIE® 133
Supreme Membrane Separator

Application Brief

Genie® Model 133 Supreme Membrane Separator™ protection in Continuous Emissions Monitoring Systems (CEMS)

Introduction

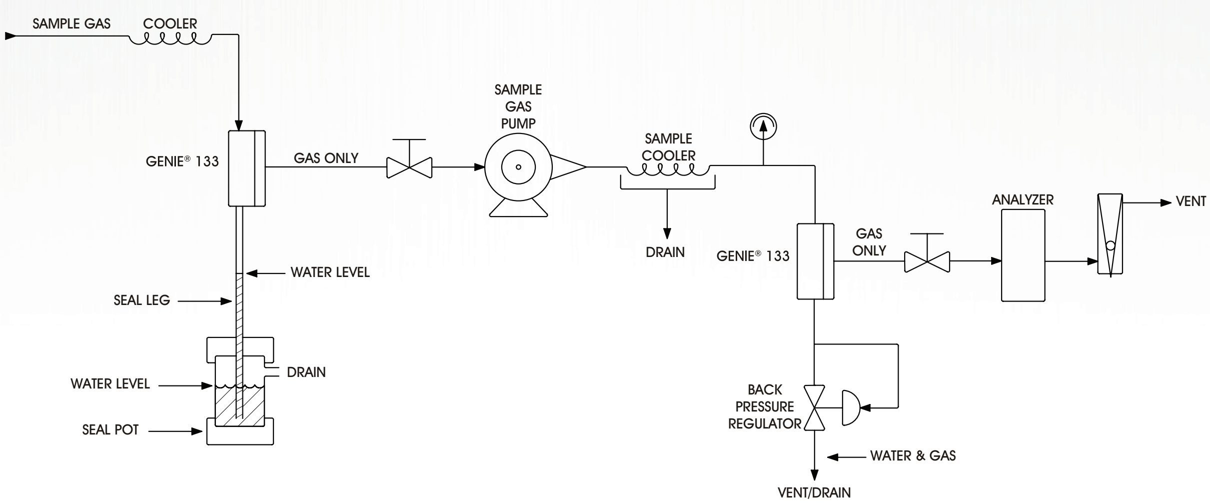
In various types of facilities, gases are emitted from stacks which prevent ground level air contamination in plant areas and aid in dissipation to the atmosphere. Governmental clean-air regulations require monitoring of stack gases. Continuous Emission Monitoring Systems (CEMS) provide the analysis required for this purpose.

The government mandates that CEMS analyzers maintain high accuracy and have minimal down time or heavy monetary fines are imposed. There are many obstacles in sampling stack gases, which can be challenging for many companies.

- The sample gas is often reactive, difficult to maintain in its original state and very hot with high water dew point temperatures.
- The sample gas may often contain sulfuric acid which slowly accumulates on the analyzer optics and can cause analysis errors and require analyzer maintenance. Maintenance results in downtime and downtime results in profit loss.
- The components to be analyzed are usually present in low parts per million (PPM) concentrations.
- Sample point locations are difficult to access, generally high above ground level and so long heat traced sample lines are required.
- The presence of particles and liquids in the sample gas often require special sample probes which may be heated or blown back with compressed gas to clear them.

Design and operation of a CEMS sample system can be a major challenge for even those skilled and experienced individuals. Our focus is at ground level portion of the sample conditioning system near the analyzers.

Typical CEMS Configuration



In the typical CEMS configuration shown above, Genie 133® separators provide protection to the sample gas pump against liquids upstream of the pump and protection to the analyzer against liquids and sulfuric acid aerosol upstream of the analyzer.

Sample Gas Pump Protection

Hot, water-saturated gas that may contain sulfur compounds is being drawn from the stack via a vacuum pump. This gas is cooled before entering the pump, causing a portion of the water vapor to condense. Installing a Genie® Supreme Model 133 Membrane Separator™ upstream of the pump prevents diaphragm failure from liquid carryover entering the pump.

The sample flow path through this Genie® is such that gas and water enter via its inlet port where they are separated by the membrane. The water-saturated gas, free of liquids, flows through the membrane and exits from the outlet port. The liquid rejected by the membrane drains from the bypass port into the seal pot via the seal leg. See option 1 below for flow schematic.

Analyzer Protection

The pump increases the pressure of the water vapor saturated sample and causes water to condense. A second Genie® Model 133 separator installed between the cooler and the analyzer protects the analyzer against liquid which could be present at that point in the event of a sample cooler failure or excessive flow rate which could cause liquid carry over. Use of a back pressure regulator downstream of this Genie® bypass port provides a means for simultaneously removing accumulated liquid, bypassing to vent to reduce transport time and controlling system pressure.

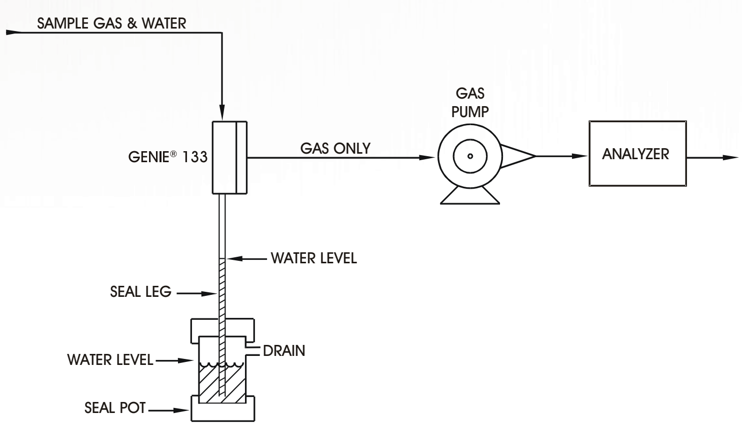
A second reason for having a Genie® at that point is to remove sulfuric acid aerosols that form when sulfur compounds, such as SO_2, react with Nitrogen Oxides (NOx) and water vapor that are present in the gas. The sulfuric acid forms slowly throughout the entire sample system (from probe to the analyzer vent) in submicron particles that cannot be seen. The accumulation of sulfuric acid on the optical system of analyzers such as infrared analyzers causes a shift in the baseline response (zero) and can also change the range (calibration). Both of these effects cause analysis errors and require maintenance and analyzer downtime.

Configuration of Genie® Bypass in Negative Pressure Application

The bypass port of a Genie® Membrane Separator™ under negative gauge pressure must be configured so that ambient air is not sucked in, yet the liquid rejected by the membrane can be drained from the separator. Outlined below are three possible options for doing so.

Option 1: Gravity Drain via liquid leg and seal pot

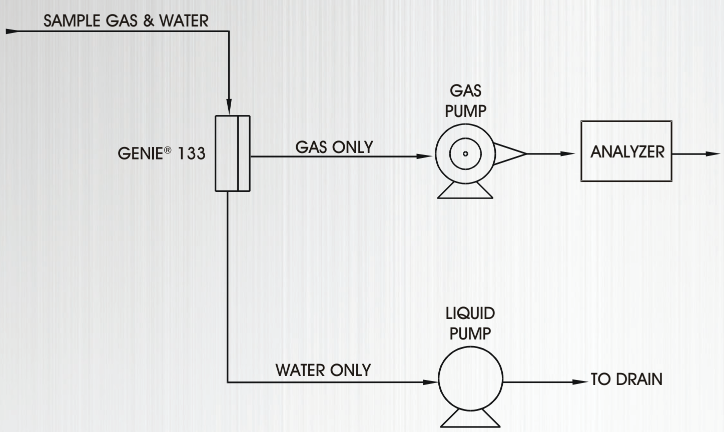
Sample gas and water enter the Genie® Membrane Separator™ via its inlet port where they are separated by the membrane. The gas (including water vapor) flows through the membrane, exits from the outlet port then on to the pump. The water drains from the bypass port into the seal pot via the seal leg.



The Genie® Membrane Separator™ should be located at an elevation of three feet or greater that will allow for sufficient seal leg height. The height of the water column in the seal leg will be dependent upon the pump suction pressure, which, in typical sample systems, ranges from approximately 10 to 24 inches of water column below atmospheric pressure.

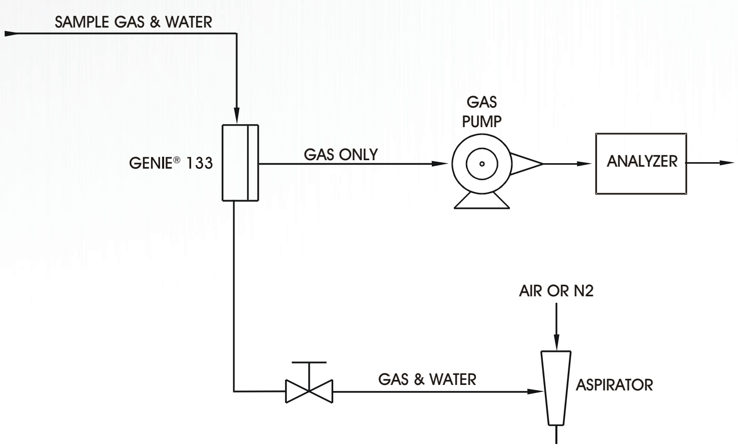
A seal pot of approximately 4" diameter by 4" high can be constructed from PVC pipe and fittings. It is important to provide a cap with a 1/8" diameter vent hole on the seal pot to prevent evaporation. Charge the seal pot with water when the sample system is first started up; otherwise ambient air will enter the pump along with sample.

Option 2: Gravity Drain via Peristaltic Pump



Sample gas and water enter the Genie® Membrane Separator™ via its inlet port where they are separated by the membrane. The gas (including water vapor) flows through the membrane, exits from the outlet port then on to the pump. Liquid water separated by the membrane gravity drains from the inlet cavity into tubing connected to a peristaltic pump. A timer can be used to periodically operate the pump.

Option 3: Liquid Expelled with Flowing Bypass



Sample gas and water enter the Genie® Membrane Separator™ via its inlet port where they are separated by the membrane. The gas (containing water vapor) flows through the membrane, exits from the outlet port then on to the pump.

An aspirator, or other vacuum source, provides motive for continuous flow of sample gas and rejected water through the bypass port.

A similar configuration would use a single vacuum source that is able to tolerate liquid to draw sample both though the analyzer and through the bypass port. The flow of the stream from the bypass port should be adjustable for timely sample transport.

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