Providing you with gaseous chlorine dioxide solutions for your decontamination needs

Application Note 13: Electron Microscope Decontamination

Uses:

An electron microscope is sometimes used for studying dangerous biological organisms. Occasionally the organism can be sucked into the internals of the microscope making it hazardous to repair the microscope for concern of the organism causing health problems for the repair technician. To mitigate the concerns, decontaminating the inside components of the microscope can be accomplished using gaseous chlorine dioxide.

Benefits:

Quicker cycles with Chlorine Dioxide (CD) Gas than Vapor Phase Hydrogen Peroxide (VPHP)

1.5 to 3 hours depending on desired level of kill and sensitivity of components vs. 8 to 12 hours for VPHP.

No cycle development required for CD gas

CD: 1 mg/liter for 2 hours.

VPHP: Cycle parameters must be developed for every specific application. If ambient temperatures change, the cycle parameters most likely need to be changed.

Better distribution with a true gas like CD gas

CD gas is a true gas which naturally fills the space it is contained within, no matter the shape or amount of items inside the space.

VPHP is a liquid at room temperature and as such has limited natural diffusion. The small internal tubing diameters within the microscope are not large enough for vapors to flow and decontaminate the internals.

Better & Consistent Kill with CD gas

CD gas has better and more consistent kill. The standard error or variability for CD gas is much lower than all other methods of decontamination (see figure 1).

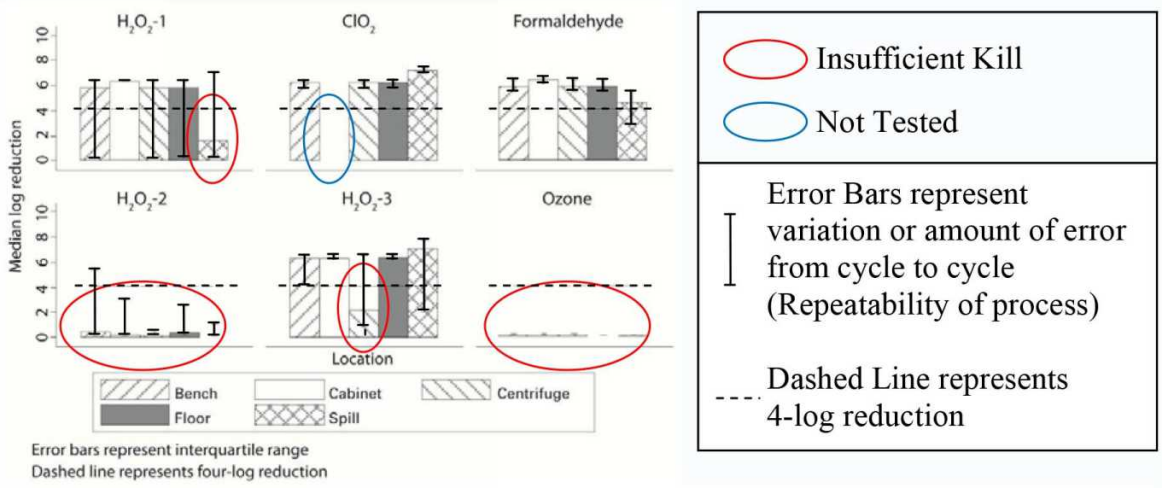


Figure 1: Observed median Log reduction by fumigation system and location

Ref. Beswick Alan J., et al, "Comparison of Multiple Systems for Laboratory Whole Room Fumigation", Applied Biosafety Vol. 16, No. 3, 2011.

CD gas is less harsh to electronics

Chlorine dioxide gas has a lower oxidation potential than ozone, peracetic acid, bleach and hydrogen peroxide, making it scientifically less corrosive than those other decontaminating agents (see Table 1).

Biocidal Agent	Oxidation Potential (volts)	Oxidation Capacity (electrons)
Ozone	2.07	2e–
Peracetic acid	1.81	2e–
Hydrogen peroxide	1.78	2e–
Bleach	1.49	2e–
Chlorine dioxide	0.95	5e–

Table 1: Oxidation Potential of various decontamination agents

Real-life testing performed by the US EPA confirms that CD gas is less corrosive on computers than hydrogen peroxide (see figure 2). Testing on electron microscopes found significant corrosion with VHP but only damage to a phosphorous screen with CD.

CD Gas Features:

- Sterilization at ambient temperatures
- short cycle times
- precise concentration monitoring
- Uses a true gas
- excellent distribution into hard to reach areas
- simple to validate
- detailed cycle reporting
- no liquids in process
- does not require tight control of dew point
- quick aeration (can literally be minutes)
- non-carcinogenic
- non-flammable
- no measurable residuals
- does not condense out or breakdown during the process

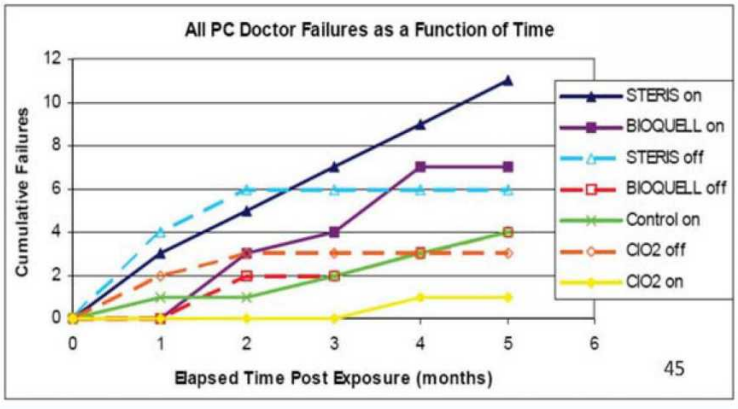


Figure 2: Computer Failures as reported by US EPA

Snyder, Emily, "Indoor and Outdoor Decontamination" Presentation at EPA Region 9 / ORD Homeland Security Research Workshop, July 14, 2011 San Francisco, CA. Accessed from http://www.epa.gov/osp/presentations/homesec11/hs_Snyder1.pdf . Accessed on 1-10-2013.

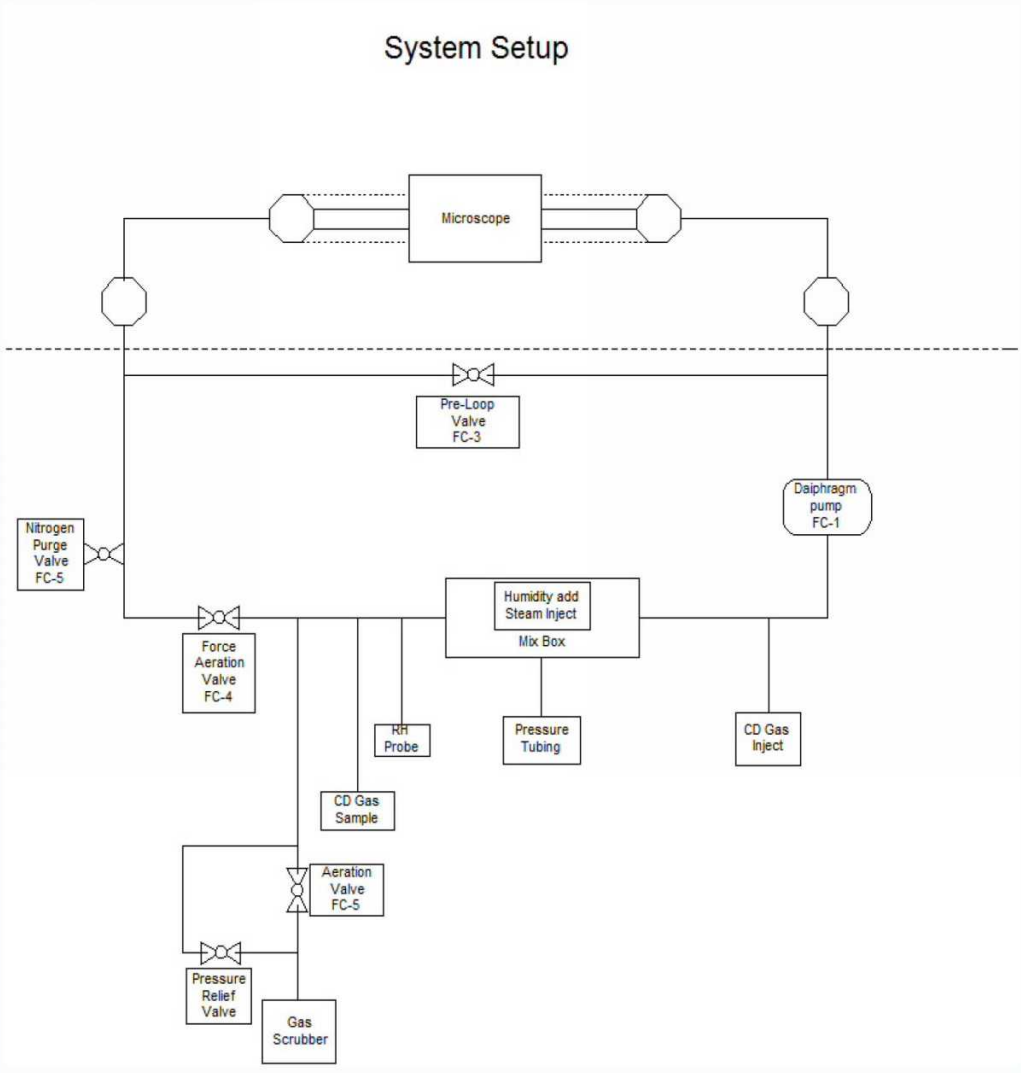
Equipment Required:

The equipment required to decontaminate the inside of an electron microscope consists of:

- Minidox-M Portable CD Generator
- ClorDiSys Microscope Decontamination System
- Microscope Manufacturer Valve Sequencing System
- Electron Microscope

Equipment Setup:

The setup of the equipment is per the below diagram:



The setup shown allows the gas generator to cycle through the sterilization steps, described under "system operation".

All components below the dotted line are supplied by ClorDiSys.

The components above the dotted line is the microscope itself and also the microscope valve sequencing system which allow isolation of and sequencing specific column sections, etc. This has been done by the microscope manufacturer in the past, but can be done by ClorDiSys if desired.

Minidox-M Configuration:

The setup of the Minidox-M CD Generator is as follows:

Minidox-M Configurable settings

FC-1

Pump

This FC is connected to an AC/DC control box that turns on/off the pump that drives the loop
In the configurable parameters this is turned on in every step of the cycle.

FC-2

Signal to microscope

This is a signal that is sent to the microscope that tells it when we are in exposure and aeration. The microscope will then open vaIves to let the mixture into the system.
In the configurable parameters, this is turned on during exposure and aeration.

FC-3

Pre-Loop Valve

This creates a loop that allows the mix box to circulate the humidity and gas mixture before it is sent into the microscope.
In the configurable parameters this is turned on during pre-condition, condition, and charge.

FC-4

Force Aeration Valve

This valve is open during normal circulation but closes for pre-purge of nitrogen and aeration. (These two steps are the same vaIve sequences, but one is before the cycle and one is at the end.) When the valve is closed it will force nitrogen into the system and expel everything out through the scrubber. (FC-5 must be turned on for this to work.)
In the configurable parameters this is turned on during pre-condition, condition, charge, and exposure.

FC-5

Aeration Valves

Includes Nitrogen inlet valve and Scrubber Valve
During the nitrogen pre-purge and aeration these valves are opened to allow nitrogen to enter the system and to aIIow all the gasses to exit through the scrubber. (FC-4 should be off to disrupt the closed loop system. With FC-4 off the pump will pull the nitrogen in and force everything out through the scrubber.
In the configurable parameters this is turned on during leak test (we are using this step as the nitrogen pre-purge) and during aeration.

Steam inject

Turns on Humidifier
Configurable parameter 3 (RHSP- X) is 15
Configurable parameter 4 (RH pause) is 120 seconds
Configurable parameter 6 (RH burst) is 20 seconds

Pressure Relief

Relieves pressure
Relief SP set to 600 (maximum)
High pressure alarm set to 1500

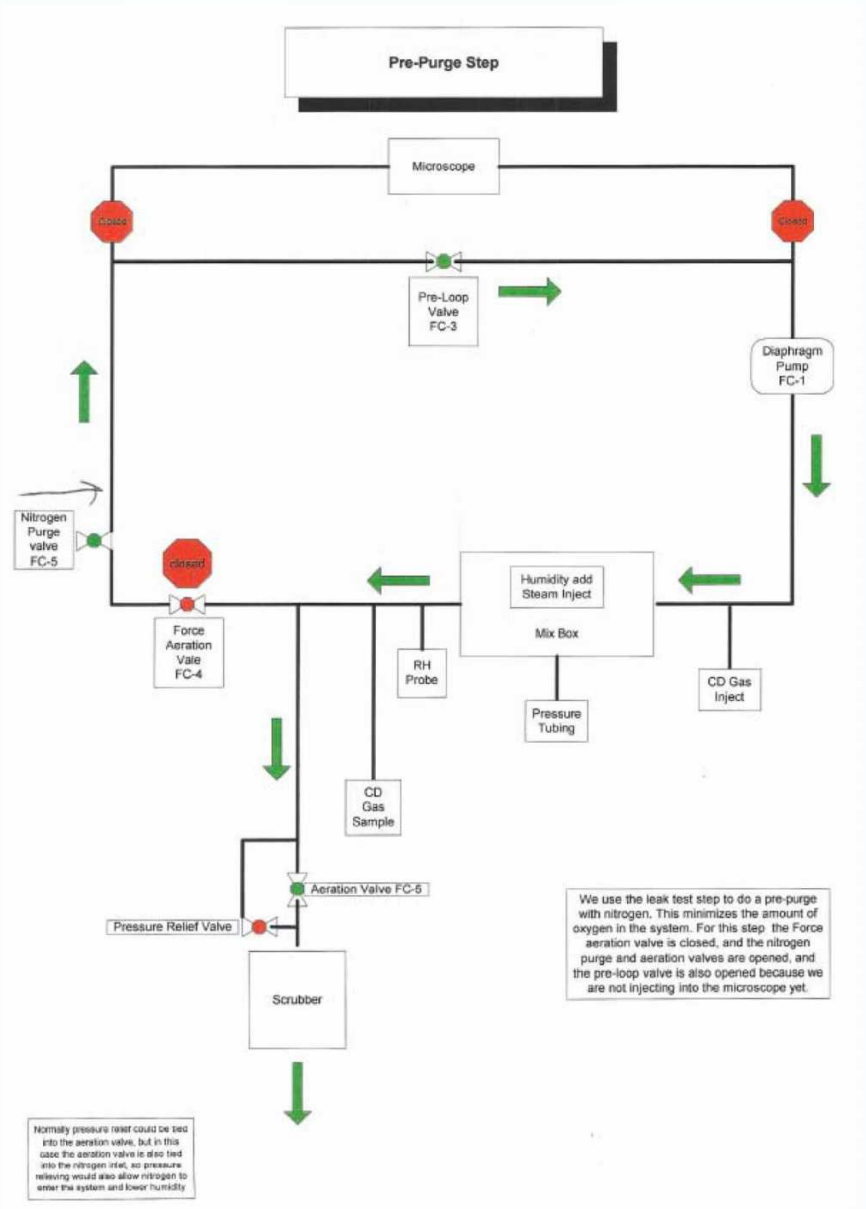
CD Inject parameters

Configurable parameter (CD pause) 120 sec
Configurable parameter (Charge CD Burst) 0.5 seconds
Configurable parameter (Exp CD Burst) 0.5 seconds

Equipment Operation:

The operation of the equipment is as follows:
The normal sterilization process is automated and consists of 5 steps:

1. Precondition: Raising of humidity to make spores susceptible to gas.
   This is achieved by using the RH probe in the loop to read humidity and then turning on the steam generator located in the mix box as needed to adjust the RH.
2. Condition: Holding of raised humidity level for spore softening.
3. Charge: Injection of gas into chamber
   This is achieved by injecting CD gas into the CD Gas Inject Tee until the photometer measures that the concentration is reached.
4. Exposure: Holding of gas concentration for the set amount of time.
5. Aeration: Expulsion of gas and humidity.

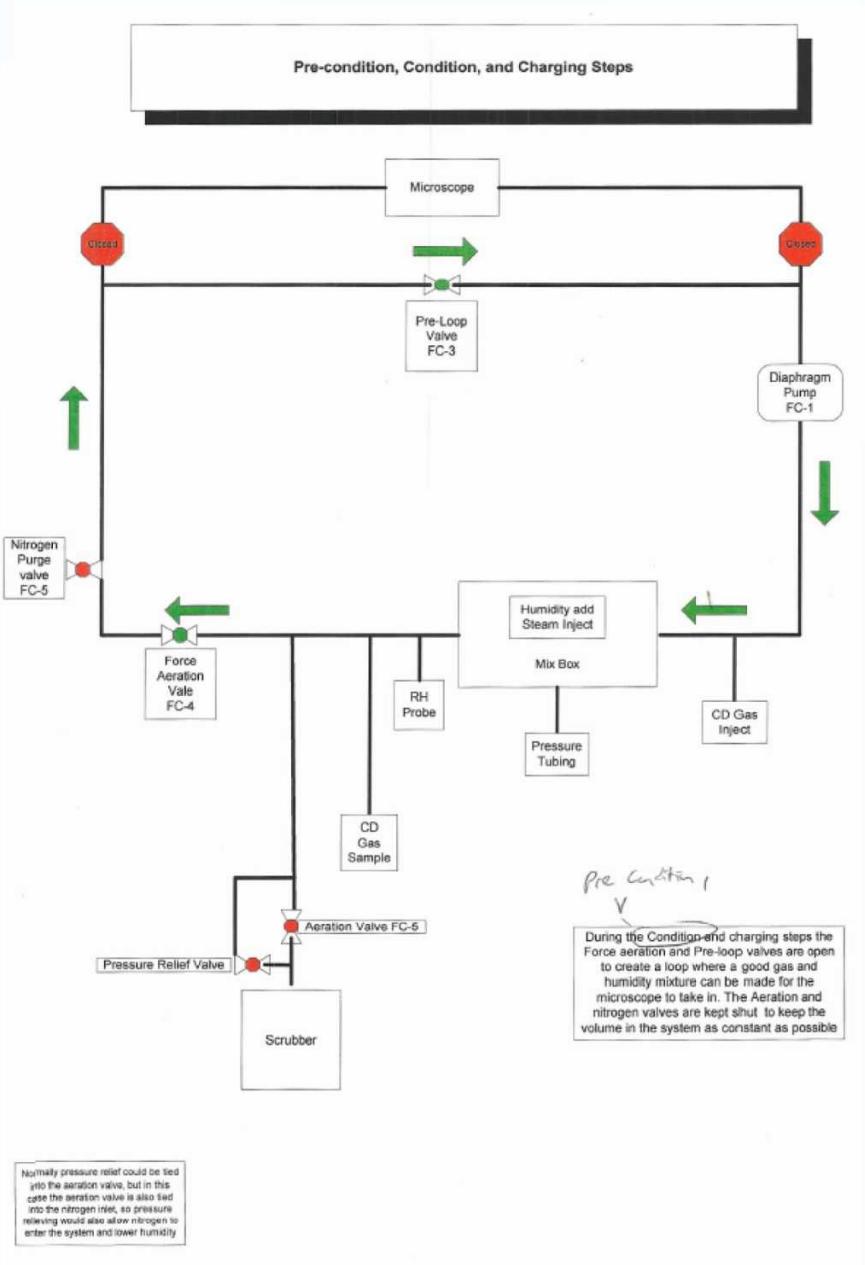


Some microscope manufactures add a sixth step which is a pre-purge of the system with nitrogen.

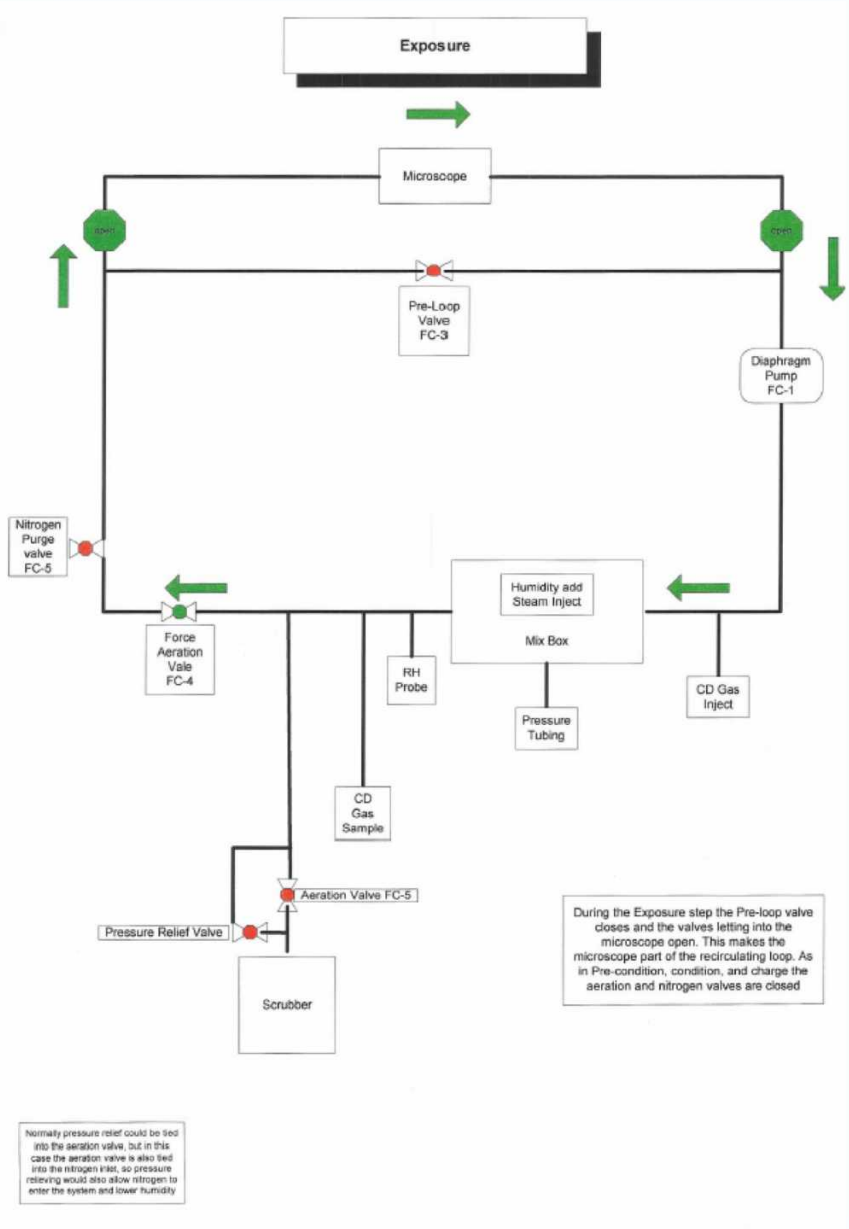
The sequencing of the valves are shown for the various steps of the cycle:

If a Pre-Purge step is used the valves shown are opened and nitrogen is passed through the system. This should not be a necessary step.

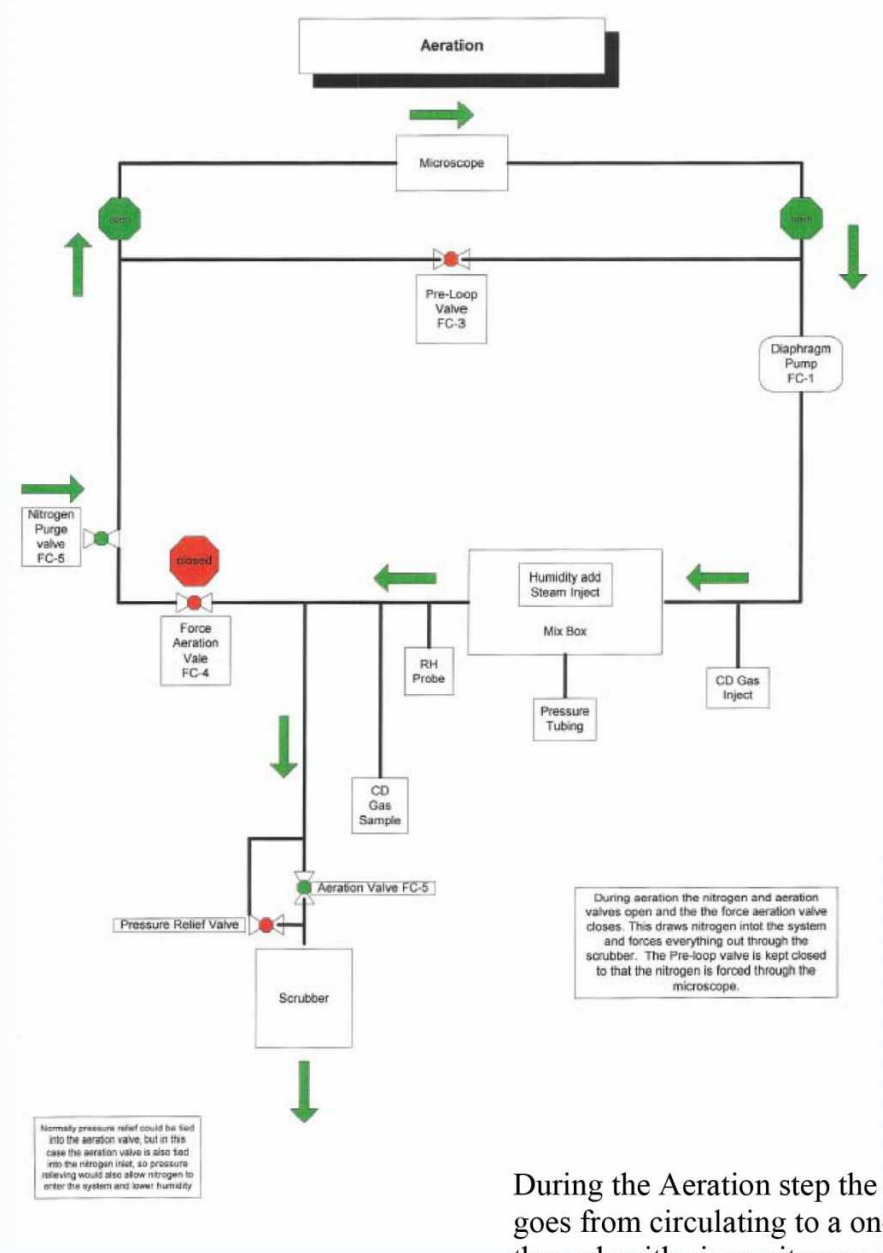
Note that the microscope is only open to the loop during the exposure and aeration steps. The microscope could be open during the Pre-Purge step if desired.



During the Pre-condition, Condition, and Charge steps the shown valves are opened. During these steps the microscope is not part of the loop. The reason for doing this is for some of the microscopes chambers there are small orifices that greatly restrict flow, so most choose to premix the humidity and gas to the desired amounts prior to sending the mixture into the microscope. When the volume of the selected microscope chamber is small relative to the volume of the mixbox and the rest of the loop, the adding of the microscope into the loop for exposure has little effect on the concentration levels of the mixture.



During the Exposure step the microscope's valves are opened to the loop. This loop is kept recirculating until the desired ppm hours are reached.



During the Aeration step the loop goes from circulating to a once through with air or nitrogen going into the system and the gas mixture leaving through a scrubber.

Microscope Valve Sequencing System Equipment Setup:

The setup of the microscope valve sequencing system equipment is per the below diagram. This system is the interface between the CD generation system and the microscope. The valves within this system are sequenced to both get and remove the gas from the microscope.