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Precise Control of Dissolved O_2 and N_2 in Semiconductor Applications Using 3M™ Liqui-Cel™ Membrane Contactors

Semiconductor manufacturers increasingly want precise control of O2 and N2 concentrations in ultrapure water. Specifically, the polishing loop of a semiconductor plant needs to control dissolved O2 to low levels of 1 ppb or 5 ppb while simultaneously controlling the dissolved N2 between 8–12 ppm.

When it comes to total gas control, 3M™ Liqui-Cel™ Membrane Contactors are able to remove dissolved O2 down to 1 ppb and then add N2 in a second stage to the desired concentration. In comparison, vacuum towers are not used to remove and then add dissolved gasses in a single system design.

Liqui-Cel membrane contactors connected in two stages or two in series can achieve any combination of O_2/N_2 gas control. One of the advantages of using two membrane contactors is that you can eliminate complicated process controls that would normally be required to handle the concentration swings of the incoming O_2 and N_2.

The first Liqui-Cel membrane contactor establishes a base level of O_2 and N_2 in the water. The second Liqui-Cel membrane contactor is then used to re-dissolve gases into the water. A saturation level can be

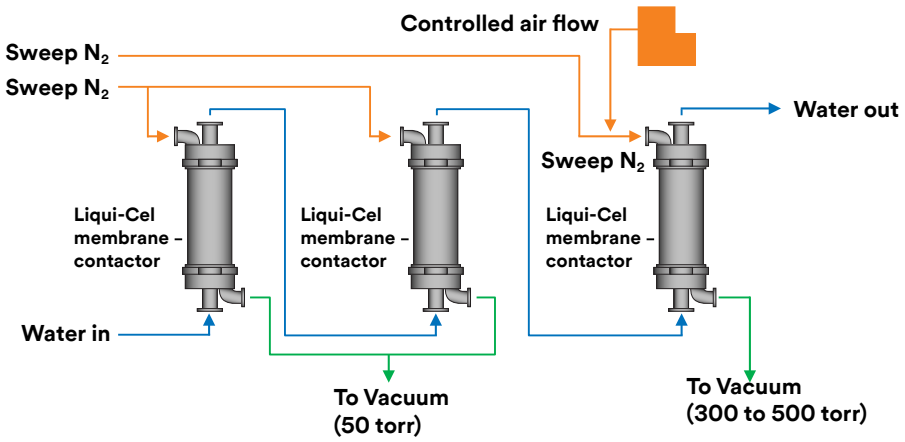

Figure 1. Controlled air flow to introduce trace O2 in N2 sweep

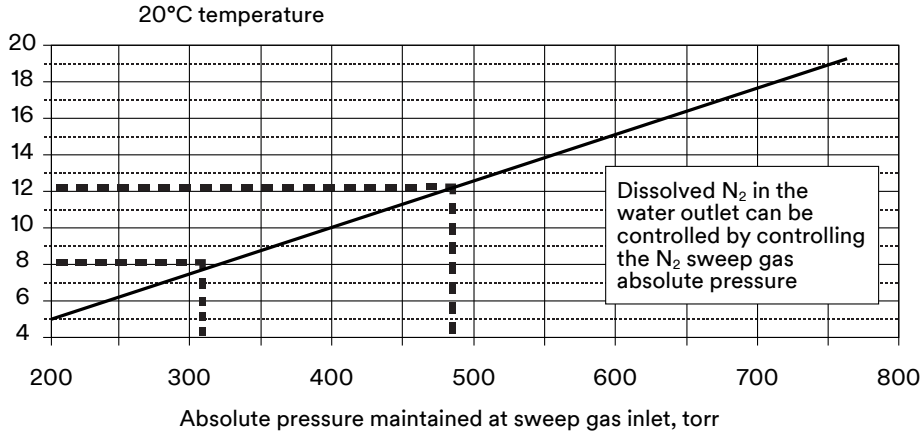

Figure 2. Projected dissolved N2 concentration in water as function of sweep gas pressure (vacuum level)

achieved by controlling the vacuum and the O_2/N_2 gas ratio. To achieve 8-12 ppm dissolved N_2, we use N_2 sweep in combination with vacuum. Gas Concentrations can be 'dialed in' by controlling the sweep gas absolute pressure, as shown in the equilibrium chart on the previous page (Figure 2).

The control of both O_2 and N_2 can be achieved as follows.

Regular N_2-combo mode is used in the first 3M™ Liqui-Cel™ Membrane Contactor with fairly deep vacuum to reduce both the O_2 and N_2 concentrations in the water.

A second Liqui-Cel membrane contactor is used in N_2-combo mode with a low-grade vacuum to increase the N_2 concentration by blending in a very small controlled amount of air into the N_2 sweep. (See Figure 1 on the previous page.)

The amount of air needed for blending can be calculated based on the equilibrium dissolved O_2 concentration depicted in the chart (Figure 3) to the right.

Maintaining the vacuum level in the module will control the dissolved N_2 concentration, whereas adjusting the flow rate of the air that is bled into the N_2 sweep will control the dissolved O_2 concentration.

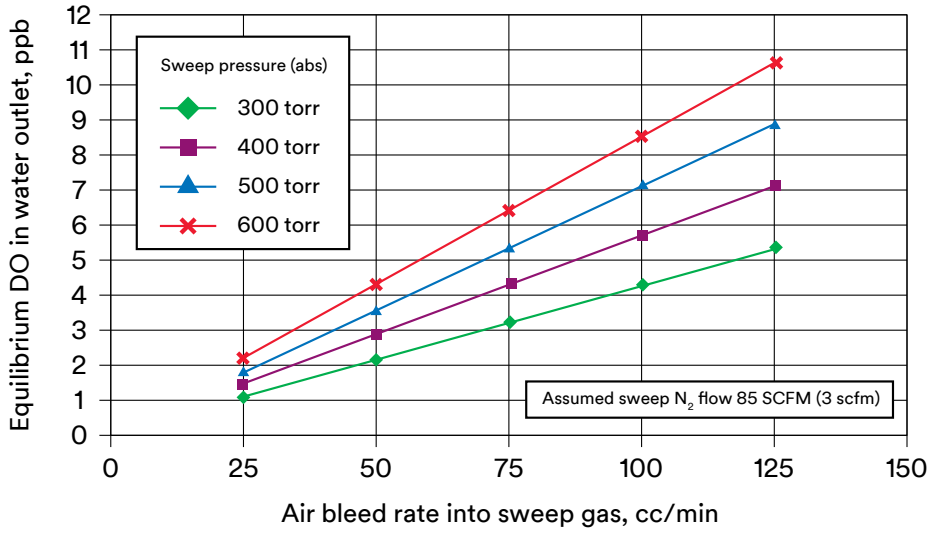

Figure 3. Projected dissolved O2 concentration in the water outlet as function of air bled into the N2 sweep gas

The system set-up described above is a less expensive option for controlling the gas concentrations in the degassing system. The control system is also less complicated and easy to adjust.

The benefit to the semiconductor plant is that they have complete control over the concentrations of gasses dissolved into the ultrapure water with a small and compact Liqui-Cel membrane contactor system.

We will work with you to provide a better understanding of the system economics for your situation.

For more information on using Liqui-Cel membrane contactors in your application, please contact your 3M representative or visit 3M.com/Liqui-Cel.

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