



Precise Control of Dissolved O₂ and N₂ 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 gases in a single system design.

Liqui-Cel membrane contactors connected in two stages or two in series can achieve any combination of O₂/N₂ 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 O₂ and N₂.

The first Liqui-Cel membrane contactor establishes a base level of O₂ and N₂ in the water. The second Liqui-Cel membrane contactor is then used to re-dissolve gases into the water. A saturation level can be

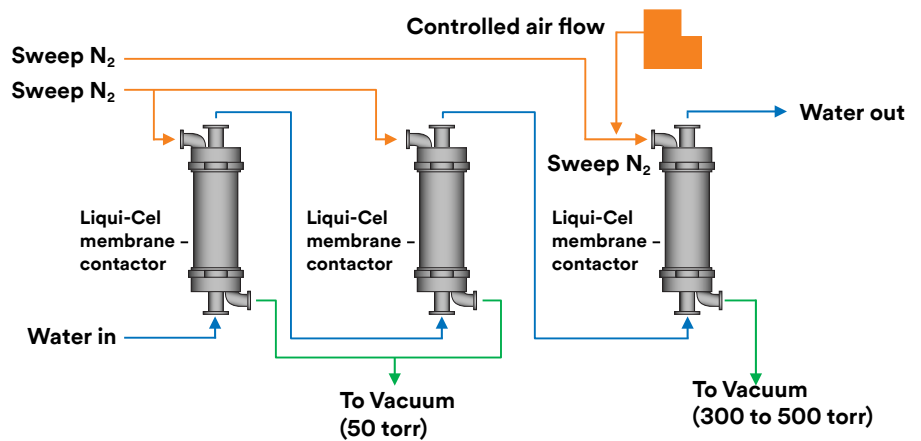


Figure 1. Controlled air flow to introduce trace O₂ in N₂ sweep

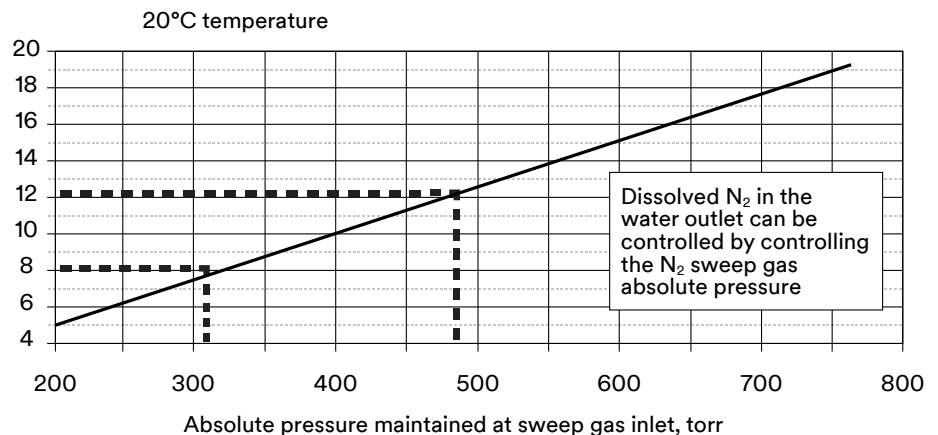


Figure 2. Projected dissolved N₂ concentration in water as function of sweep gas pressure (vacuum level)

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achieved by controlling the vacuum and the O₂/N₂ gas ratio. To achieve 8-12 ppm dissolved N₂, we use N₂ 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 O₂ and N₂ can be achieved as follows.

Regular N₂-combo mode is used in the first 3M™ Liqui-Cel™ Membrane Contactor with fairly deep vacuum to reduce both the O₂ and N₂ concentrations in the water.

A second Liqui-Cel membrane contactor is used in N₂-combo mode with a low-grade vacuum to increase the N₂ concentration by blending in a very small controlled amount of air into the N₂ sweep. (See Figure 1 on the previous page.)

The amount of air needed for blending can be calculated based on the equilibrium dissolved O₂ concentration depicted in the chart (Figure 3) to the right.

Maintaining the vacuum level in the module will control the dissolved N₂ concentration, whereas adjusting the

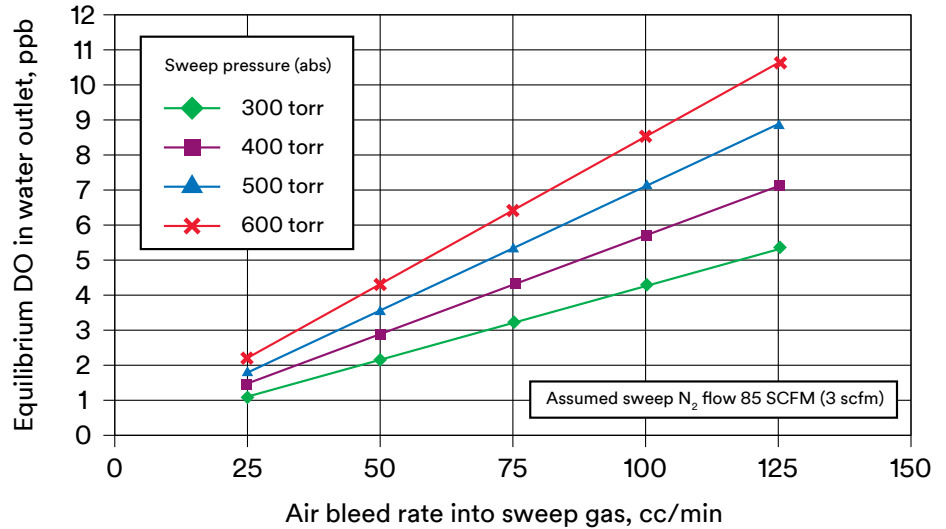


Figure 3. Projected dissolved O₂ concentration in the water outlet as function of air bled into the N₂ sweep gas

flow rate of the air that is bled into the N₂ sweep will control the dissolved O₂ concentration.

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

gases 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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Separation and Purification Sciences Division
13840 South Lakes Drive
Charlotte, North Carolina
28273 USA
Phone: +1 980 859 5400

3M Deutschland GmbH
Separation and Purification Sciences Division
Öhder Straße 28
42289 Wuppertal Germany
Phone: +49 202 6099 - 0
Fax: +49 202 6099 - 241

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