

# Precise Control of Dissolved O<sub>2</sub> and N<sub>2</sub> in Semiconductor Applications Using 3M™ Liqui-Cel™ Membrane Contactors

Semiconductor manufacturers increasingly want precise control of O<sub>2</sub> and N<sub>2</sub> concentrations in ultrapure water. Specifically, the polishing loop of a semiconductor plant needs to control dissolved O<sub>2</sub> to low levels of 1 ppb or 5 ppb while simultaneously controlling the dissolved N<sub>2</sub> between 8–12 ppm.

When it comes to total gas control, 3M™ Liqui-Cel™ Membrane Contactors are able to remove dissolved O<sub>2</sub> down to 1 ppb and then add N<sub>2</sub> 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<sub>2</sub>/N<sub>2</sub> 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<sub>2</sub> and N<sub>2</sub>.

The first Liqui-Cel membrane contactor establishes a base level of O<sub>2</sub> and N<sub>2</sub> in the water. The second Liqui-Cel membrane contactor is then used to re-dissolve gases into the water. A saturation level can be

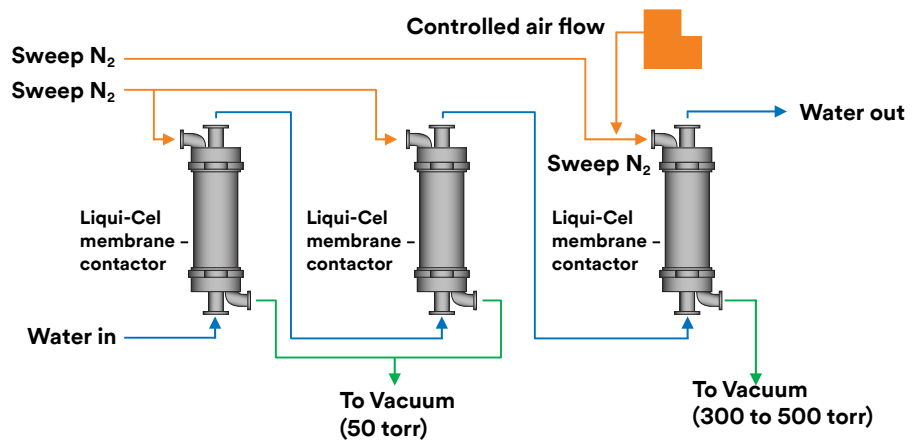


Figure 1. Controlled air flow to introduce trace O<sub>2</sub> in N<sub>2</sub> sweep

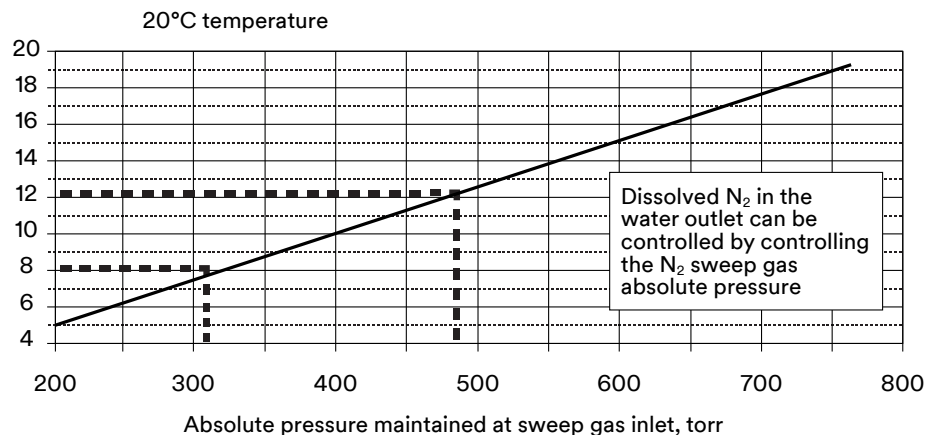


Figure 2. Projected dissolved N<sub>2</sub> concentration in water as function of sweep gas pressure (vacuum level)

## Technical Brief | Precise Control of Dissolved O<sub>2</sub> and N<sub>2</sub> in Semiconductor Applications Using 3M™ Liqui-Cel™ Membrane Contactors

achieved by controlling the vacuum and the O<sub>2</sub>/N<sub>2</sub> gas ratio. To achieve 8-12 ppm dissolved N<sub>2</sub>, we use N<sub>2</sub> 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).

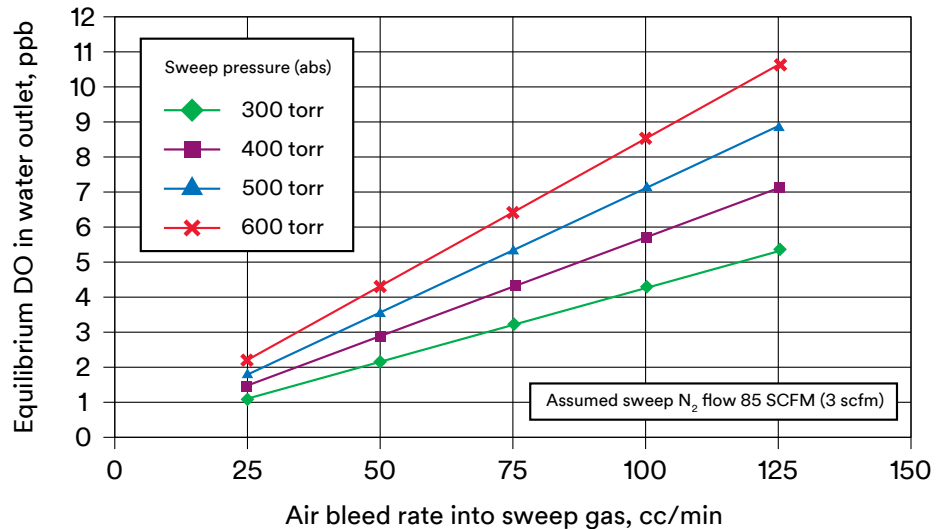
The control of both O<sub>2</sub> and N<sub>2</sub> can be achieved as follows.

Regular N<sub>2</sub>-combo mode is used in the first 3M™ Liqui-Cel™ Membrane Contactor with fairly deep vacuum to reduce both the O<sub>2</sub> and N<sub>2</sub> concentrations in the water.

A second Liqui-Cel membrane contactor is used in N<sub>2</sub>-combo mode with a low-grade vacuum to increase the N<sub>2</sub> concentration by blending in a very small controlled amount of air into the N<sub>2</sub> sweep. (See Figure 1 on the previous page.)

The amount of air needed for blending can be calculated based on the equilibrium dissolved O<sub>2</sub> concentration depicted in the chart (Figure 3) to the right.

Maintaining the vacuum level in the module will control the dissolved N<sub>2</sub> concentration, whereas adjusting the



**Figure 3.** Projected dissolved O<sub>2</sub> concentration in the water outlet as function of air bled into the N<sub>2</sub> sweep gas

flow rate of the air that is bled into the N<sub>2</sub> sweep will control the dissolved O<sub>2</sub> 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

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](http://3M.com/Liqui-Cel).

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LC-1067  
70-2016-0232-6

Rev. 02/2021

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