



# Bubble Removal From Aqueous Streams Using 3M™ Liqui-Cel™ SP Series Membrane Contactors

## Introduction

Many manufacturing processes, analytical measurements, and other industrial processes that involve aqueous solutions are adversely affected by bubbles in the fluid stream. 3M™ Liqui-Cel™ SP Series Membrane Contactors provide a very simple, cost effective solution to help eliminate bubbles from such processes.

## Background

When liquids and gases are brought into contact with each other, mass transfer between the two phases will occur. The concentration of gas dissolved in the liquid will continue to increase until equilibrium is reached, after which the concentration remains. The liquid is said to be “saturated” at this stage, which is reached quickly under most conditions. Therefore, design engineers must assume that a liquid stream is saturated with any gas with which it has come in contact.

## Bubble Formation

Once a liquid process stream has become saturated with a given gas or gas mixture, the concentration of the gases in the liquid will remain constant until equilibrium conditions change. For example, an increase in system pressure will cause more gases to dissolve into the liquid stream, while a decrease in system pressure will cause gases to be released.

When gases are released, bubbles form in the liquid, creating potential problems for manufacturing processes. For example, if the liquid is used in a cleaning or coating process, bubbles can adhere to product surfaces and cause defects that significantly reduce yield.

## Bubble Prevention and Elimination

Liqui-Cel SP Series membrane contactors offer a cost-effective and simple way to prevent and eliminate bubble formation. Listed below is one example that demonstrates the effectiveness of Liqui-Cel SP Series membrane contactors for yield improvement.

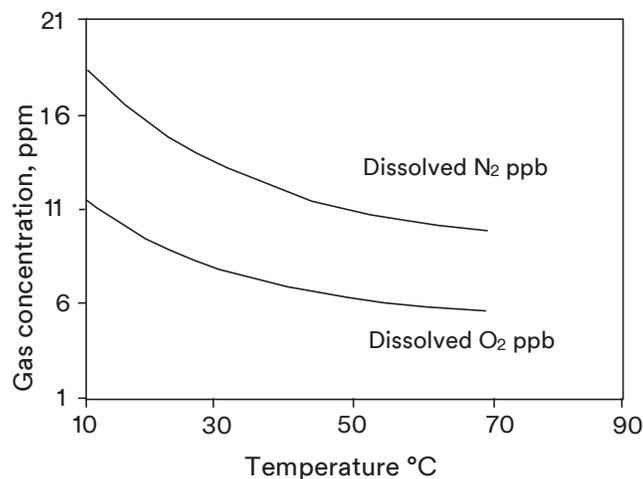


Figure 1. Dissolved gas concentration in water at atmospheric pressure

## Application:

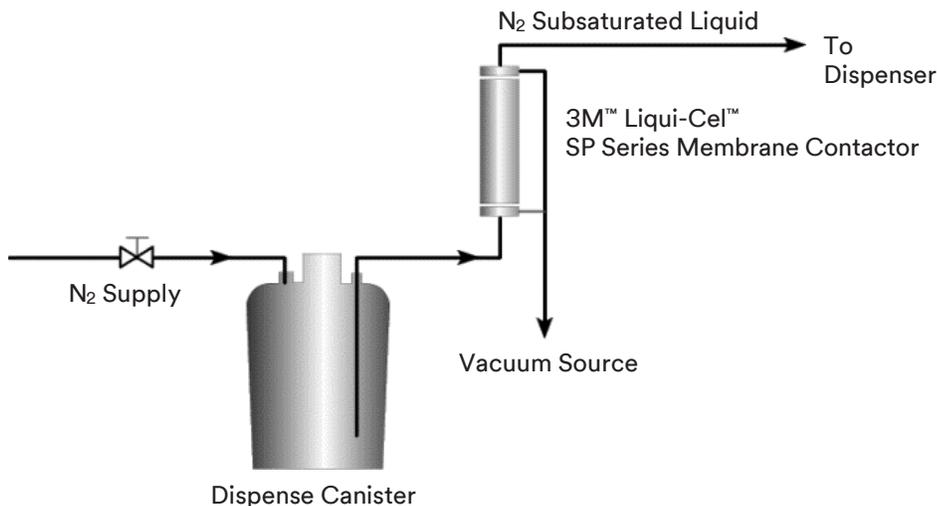
A customer is processing a coating solution that is prepared at 20°C and then heated to 60°C prior to application. The heating step causes significant offgassing of the solution.

Venting the solution removes some excess gas, but is ineffective at maintaining dissolved gases at a consistent level during manufacturing runs. As a result, product yields vary over time.

## Solution:

The difficulty with simply venting excess gas is that the coating solution is still saturated with gases. Any further pressure reductions and/or temperature increases create additional bubbles. Placing a 3M™ Liqui-Cel™ SP Series Membrane Contactor inline before the heater minimizes any bubble formation. Figure 1 shows the gas content of the liquid at 20°C and 60°C. By knowing the gas concentration of the fluid at 60°C, a Liqui-Cel membrane contactor system can be designed that reduces the gas concentration well below any process condition where gas could develop. This can completely eliminate the possibility of bubble formation. Due to the high efficiency of Liqui-Cel SP Series membrane contactors, a single membrane contactor will be adequate to reduce the gas concentration to satisfactory levels. In Figure 2, a process flow schematic of a typical system designed to eliminate bubbles is shown. Bubble removal systems utilizing Liqui-Cel SP Series membrane contactors offer several distinct advantages over existing technologies.

**Modularity.** Membrane contactor systems are inherently modular, which means that they can be easily and economically adjusted to accommodate process changes.



**Figure 2.** 3M™ Liqui-Cel™ SP Series Membrane Contactor flow schematic chemical delivery system

**Small footprint.** Liqui-Cel SP Series membrane contactors can be packaged into compact configurations. In addition, systems can be custom designed to fit into existing space constraints. Point-of-use systems can also be designed.

**Ease of operation.** With almost no instrumentation, Liqui-Cel SP Series membrane contactors are very simple to operate.

**Consistency.** Gas content in liquid process streams can be maintained very precisely even with simple process control systems.

For more information on bubble removal in process streams, please contact your 3M representative or visit [3M.com/Liqui-Cel](http://3M.com/Liqui-Cel).

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