Introduction
Controlling dissolved oxygen (DO) levels during beverage production is vital for ensuring consistent product quality and shelf life. This is particularly true for canning, where high DO levels can cause breakdown of the can lining, corrosion and even leaking – which in turn can result in product waste and customer dissatisfaction. In some cases, can supplier warranties have exclusions for high DO levels.

According to the Craft Brewers Association, cans have increased their share of craft beverage packaging from 2% in 2011 to 10% in 2014. It’s no surprise, then, that craft beverage producers are looking for ways to combat DO during the canning process.

The Process
Vermont Hard Cider, maker of the well-known Woodchuck brand of ciders, began experimenting with canning in 2012 at their Middlebury, Vermont facility. In 2014, the company decided to ramp up production of canned cider, but recognized that uncontrolled DO levels posed a threat to a consistent, high-quality product.

Many steps throughout the cider canning process allow for dissolved oxygen pick-up (Figure 1). While some oxygen may be present after fermentation (~50 ppb) with additional pick-up occurring during aging and filtration (500 ppb), the majority of DO is introduced during blending and tank transfer. Additionally, beverage producers using an in-line filler may also see significant DO pick-up in the final canning step unless very careful DO prevention measures are in place.

The Problem
Most manufacturers of cans void their warranties if DO levels are above 1,200 ppb in a canned product. Vermont Hard Cider noticed that even though DO concentration in the bright tank was within specifications at 200-500 ppb, they would occasionally experience DO levels above 1200 ppb in their canned products. The company determined that these DO levels were higher than anticipated because cider does not undergo fobbing (foaming), which is commonly used in beer canning to prevent excess oxygen pick-up.

The Solution
Vermont Hard Cider searched for a solution that, starting with fully oxygenated liquid (8,000 ppb) at a flow rate of 25 gallons per minute, consistently delivered cider with <200 ppb at outlet. After research and speaking with other industry brewers, the company approached Quantum Flow Technologies, which designs and builds deaeration skids with 3M™ Liqui-Cel™ Membrane Contactors.

“We needed a simple and effective solution for handling oxygen pick-up that was designed around our process needs. 3M™ Liqui-Cel™ Membrane Contactor technology helped make this possible.”

- Ben E. Calvi, Cider Maker, Vermont Hard Cider Company
**3M™ Liqui-Cel™ Membrane Contactors** use a microporous hollow fiber membrane to facilitate degassing of liquids. The micropores in the wall of the hollow fiber membrane provide a massive surface area that allows the contactor to be compact while efficiently deoxygenating large volumes of liquid. The small size of the membrane contactors enables compact systems that can be easily customized and scaled to meet various flow ranges and process configurations. Membrane contactors operate in-line for rapid degassing with low head loss.

The final skid design incorporated two stainless steel 3M™ Liqui-Cel™ EXF-8x20 Series Membrane Contactors before the bright tank so that oxygen removal took place as close as possible to the final canning step (Figure 2) in order to help reduce the opportunity for oxygen pick-up in downstream steps.

**Results**

The skid that incorporated Liqui-Cel membrane contactors was installed in 2015. Since then, Vermont Hard Cider has consistently achieved pre-canned cider with DO near 15 ppb, far exceeding the original target of 200 ppb. Moreover, the system functions the same under varying flow rates and is simple to operate and maintain.

To validate that the membrane contactors had little to no impact on the cider’s flavor profile, retention samples were evaluated at 0, 3, 6 and 12 months. Results showed that the taste profile was consistent with hard cider prior to installation.

As canning grows in popularity among craft beverage producers, flexible and easily managed DO control solutions will be more important than ever. Thanks to Quantum Flow Technologies and 3M, Vermont Hard Cider has a DO control solution that it can count on – and easily expand – in the years ahead.

**Contributors**


Amar Kapadia, Quantum Flow Technologies http://quantumflowtech.com

---

**Technical Information:** The technical information, recommendations and other statements contained in this document are based upon tests or experience that 3M believes are reliable, but the accuracy or completeness of such information is not guaranteed.

**Product Use:** Many factors beyond 3M’s control and uniquely within user’s knowledge and control can affect the use and performance of a 3M product in a particular application. Given the variety of factors that can affect the use and performance of a 3M product, user is solely responsible for evaluating the 3M product and determining whether it is fit for a particular purpose and suitable for user’s method of application.

**Warranty, Limited Remedy, and Disclaimer:** Unless an additional warranty is specifically stated on the applicable 3M product packaging or product literature, 3M warrants that each 3M product meets the applicable 3M product specification at the time 3M ships the product. 3M MAKES NO OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY OR CONDITION ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE. If the 3M product does not conform to this warranty, then the sole and exclusive remedy is, at 3M’s option, replacement of the 3M product or refund of the purchase price.

**Limitation of Liability:** Except where prohibited by law, 3M will not be liable for any loss or damage arising from the 3M product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.

3M and Liqui-Cel are trademarks of 3M Company. All other trademarks are the property of their respective owners. © 2017 3M Company. All rights reserved.