



**Liqui-Cel™**  
Membrane Contactors

# Kirin Beer Uses 3M™ Liqui-Cel™ Membrane Contactors for CO<sub>2</sub> and O<sub>2</sub> Removal to Prevent Pipe Corrosion at Three Japanese Breweries

In the food and beverage industry, there is a growing awareness of environmental considerations wherever chemicals are used. In response, companies are trending towards alternative systems that operate with less chemical usage.

Kirin Beer has been successfully using 3M™ Liqui-Cel™ Membrane Contactors for CO<sub>2</sub> and O<sub>2</sub> removal in their Okayama, Hokuriku, and Kobe Japan facilities. The contactors successfully prevent corrosion of pipes that feed the boiler without using high volumes of neutralizing amine chemicals that negatively impact the environment.

Carbon dioxide is formed when water containing dissolved salts, such as sodium bicarbonate, is heated in a boiler. This process is illustrated in the diagram below. The carbon dioxide dissolves into condensed water in the pipes; this creates an acidic environment that will attack the inner surface of the pipe. O<sub>2</sub> is another known corrosive element in water used to feed the boilers.

Kurita Water Industries Ltd. incorporates Liqui-Cel Membrane Contactors in their Oxyace® System which they installed to remove the CO<sub>2</sub> and O<sub>2</sub> in front of the boiler at Kirin Beer to prevent pipe corrosion.

## Method of Carbon Dioxide Removal

In order to prevent the formation of carbon dioxide in the steam, sulfuric acid can be added to the feed water. The sulfuric acid reacts with the sodium bicarbonate and forms sodium sulfate, carbon dioxide and water. This is illustrated in the chemical equation below.

Membrane contactors are unique devices that are designed to remove dissolved gasses from water. In this system, they remove dissolved carbon dioxide and oxygen that are present in the water.

The Oxyace® system includes: a Softener, Filtration, pH control (M-Alkali control), 3M™ Liqui-Cel™ Membrane Contactors and a vacuum pump. With system

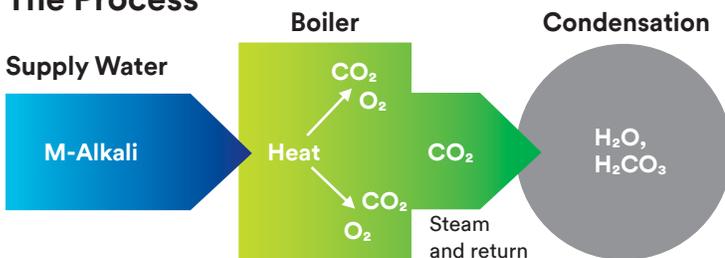


automation and a feed back signal, the soft water is controlled to a pH of 5.0 with sulfuric acid. Caustic soda is added daily to inhibit bacteria growth. Very minimal chemical usage is required to control the pH.

To date there are 14 Oxyace® systems operating in Japan. All of these systems utilize Liqui-Cel membrane contactors for degassing.

For additional information, please contact your 3M representative or visit [3M.com/Liqui-Cel](http://3M.com/Liqui-Cel).

## The Process



## Chemical Reaction



pH 5.0 adjustment

CO<sub>2</sub> removal by 3M™ Liqui-Cel™ Membrane Contactors



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System Summary	
End user	Kirin Brewery
Water Flow	70 m <sup>3</sup> /h (308 gpm)
Number of Contactors	Four configured 4 in parallel with 1 in series
Purpose of system	Primarily CO <sub>2</sub> removal with bonus of O <sub>2</sub> removal
Inlet gas	30–32 ppm CO <sub>2</sub>
Outlet gas	8–10 ppm CO <sub>2</sub>
Operating mode	N <sub>2</sub> sweep with vacuum combo
Boiler	Small steam pressure boiler of 16.6 kg/cm <sup>2</sup> (236 psi)

Outlet Summary	
The contactors reduce the CO <sub>2</sub> concentration from 30 ppm down to 10 ppm. This reduces the corrosion rate from 50 mdd (mg/square decimeters/day) down to 22 mdd. This chemical free alternative is equivalent to the reduction in corrosion rate that can be observed with neutralizing amines.	
<b>Note:</b> Corrosion rate = (Weight of test sample before immersion in mg) – (Weight of test after immersion in mg) / Surface area (100 cm <sup>2</sup> ) / Test days.	

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