BergerABAM
700 Northeast Multnomah Street, Suite 500, Portland, Oregon 97232-4120
503/872-4100 • 503/872-4101 Fax • www.abam.com

Technical Memorandum

Date: 11 September 2016

Subject: Zero Liquid Discharge Description

From: Dan Shafar, PE, Project Engineer

To: Brian Carrico, AICP, Senior Project Manager/Environmental Planner

Route to:

INTRODUCTION

In response to public comment received on the Draft Environmental Impact Statement (DEIS), NW Innovation Works Kalama, LLC, is evaluating use of a zero liquid discharge (ZLD) system for the disposal of process wastewater from the planned methanol manufacturing facility. The ZLD system is currently being evaluated by the engineering team for engineering and economic feasibility and regulatory acceptance. This memorandum summarizes the technical aspects of the ZLD system under evaluation. If implemented, the complete engineering report for the ZLD system would be submitted to appropriate regulatory agencies for review.

The wastewater stream resulting from the ZLD will be a high-quality distillate (purified water resulting from condensing the vaporized wastewater stream) and a solid salt cake. In the ZLD system, the waste stream is sent to a mechanical vapor recompression (MVR) brine concentrator and the blowdown from the brine concentrator is then sent to an MVR crystallizer. The crystallizer system removes the remaining water from the concentrated brine blowdown from the brine concentrator and creates a solids slurry that is transferred to a dewatering device to create a solid salt cake suitable for landfill disposal.

The ZLD would increase the facility's electrical demand. However, it would not affect the peak power requirements or the estimated air emissions for power generation. The only air emission from the ZLD includes a small vent that has negligible air emissions and, in the vendor's experience, has typically been permitted under the *de minimis* air emission standards. The following is a more detailed description of the ZLD system.

ZERO LIQUID DISCHARGE DESCRIPTION

The ZLD system is designed to handle approximately 404 gallons per minute (gpm) of wastewater produced during the methanol production process. The wastewater stream is made up of cooling tower blowdown based on the estimated cooling tower blowdown chemistry described in the engineering report (Appendix A to the EIS). The ZLD consists of two systems, a brine concentrator and a crystallizer, which work in combination to take the process wastewater and convert it to a reusable water source and solid waste (salt cake). The ZLD system is designed to operate at 100 percent treatment capacity for the methanol production process (Table 1).

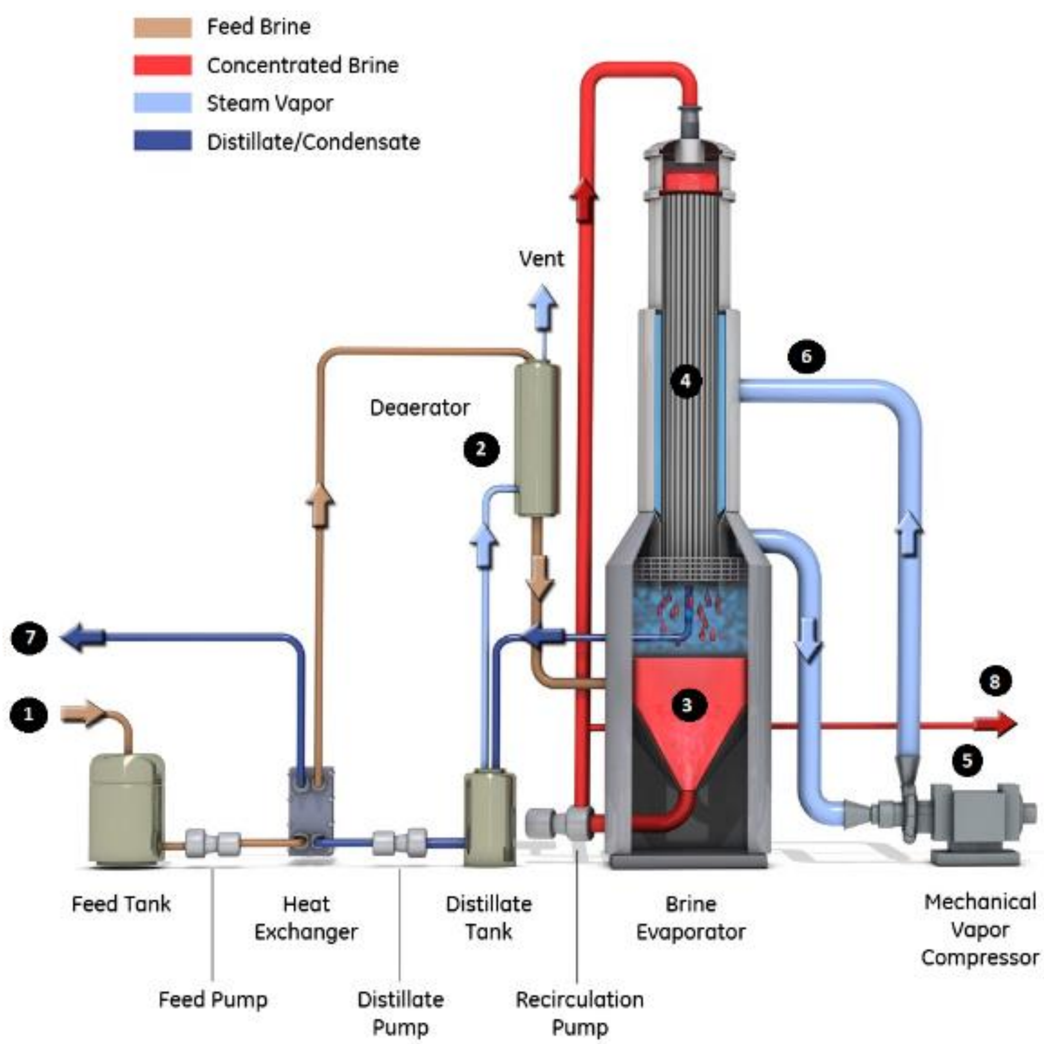
Table 1. ZLD System Performance Data

Description	Value
Brine Concentrator System	
Feed Flow	404 gpm
Distillate	395 gpm
Waste to Crystallization	9 gpm
Acid (100%) H2SO4	5 lb/hr
Antiscalant	2 lb/hr
Caustic (100% NaOH)	4 lb/hr
Electrical Consumption	1,700 kW
Startup Steam	2,400 lb/hr
Crystallizer System	
Feed Flow	9 gpm
Distillate	8 gpm
Antifoam	1 lb/hr
Electrical Consumption	135 kW
Solids Discharge	10 tons/day

The wastewater stream will be processed to high-quality distillate that is suitable for reuse in the methanol production process and to a solids salt cake suitable for normal landfill disposal. In the ZLD system, the wastewater stream is sent to a MVR brine concentrator, and the blowdown from the brine concentrator is then sent to an MVR crystallizer. The crystallizer system removes the remaining water from the concentrated brine blowdown from the brine concentrator and creates a solids slurry that is transferred to a dewatering device to create a solids salt cake suitable for landfill disposal.

The total electrical consumption necessary for the ZLD system is 1,835 kilowatts. The electrical load is within the total amount of connected load and on-site power generation assumed in the EIS. There would be no additional source power requirement for the facility if the ZLD system is implemented.

The brine concentrator is used to reduce the cooling tower blowdown wastewater volume and the wastewater from the facility is treated to maximize the ZLD system performance. Raw wastewater is pH-adjusted and dosed with scale inhibitor and pumped through a flat plate heat exchanger into a deaerator where carbon dioxide and other volatiles are removed. The adjusted, heated, and deaerated feed enters the brine concentrator sump where it is recirculated (Figure 1). Excess water is removed as steam vapor, which is collected and processed as a high-quality distillate for reuse in the methanol production process. The concentrated brine is passed to the crystallizer for further treatment (Figure 2).



❶ The wastewater enters a feed tank for deaeration and decarbonation. The wastewater is pumped through a heat exchanger that raises its temperature close to the boiling point.

❷ Wastewater passes through a deaerator counter-current to low-pressure steam, which removes non-condensable gases, such as oxygen and carbon dioxide.

❸ Hot feed combines with the concentrated brine in the sump. The concentrated brine is constantly circulated from the sump to a floodbox at the top of a bundle of heat transfer tubes.

❺ The vapor, created inside the tubes, passes through mist eliminators and enters the vapor compressor. Compressed vapor flows to the outside of the heat transfer tubes.

❻ Heat from the vapor (steam) is transferred to the cooler brine falling inside the tubes, causing some of the brine to evaporate. As the vapor (steam) gives up heat, it condenses as distillate (condensate).

❼ The distillate is pumped back through the heat exchanger, where it gives up heat to the incoming wastewater.

Figure 1. Brine Concentrator Schematic

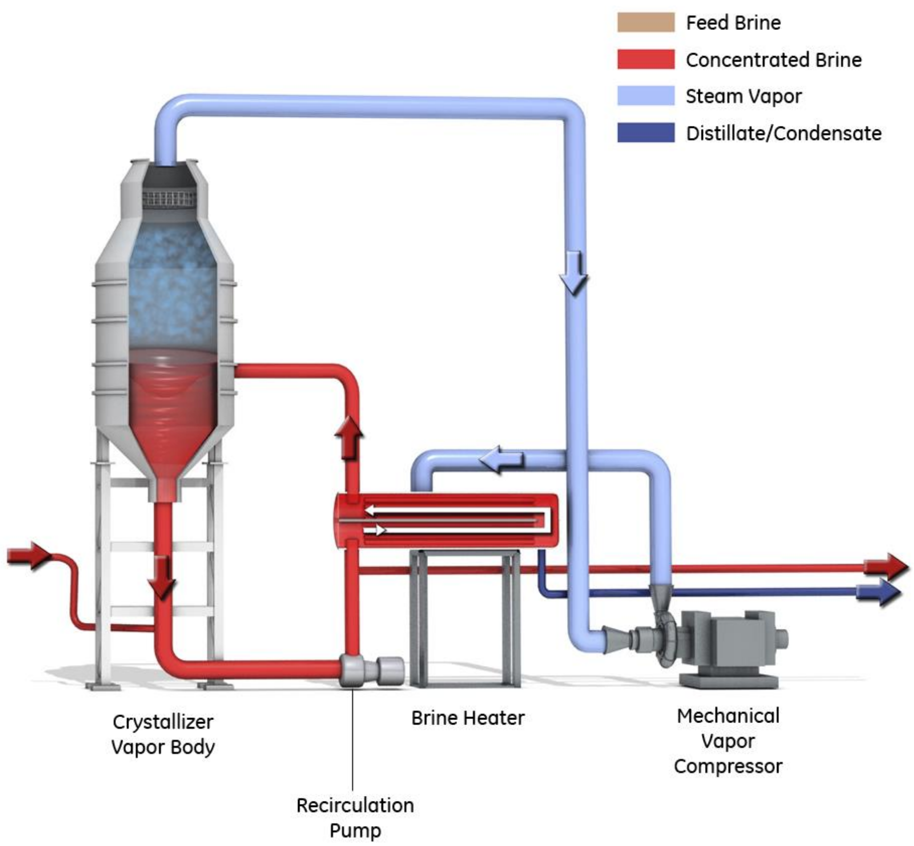


Figure 2. Crystallizer Schematic

Once the brine concentrator has reduced the volume of the wastewater from the cooling tower blowdown, the concentrated brine can be further treated to achieve zero liquid discharge in a mixed-salt crystallizer. The mixed-salt crystallizer is a forced circulation, mechanical vapor recompression system that produces salt cakes for landfill disposal.

The concentrated brine, or blowdown, from the brine concentrator is directed through the crystallizer where it is heated a few degrees to separate vapor from the crystalline brine. As the vapor gives up its latent heat, it condenses and drains to the bottom of the crystallizer to a condensate tank and processed as reuse water.

Salt crystals are continuously formed within the brine slurry in the crystallizer vapor body and precipitate from solution as the concentration increases and creates a brine slurry. The brine slurry is sent to a centrifuge, which uses screens and centrifugal force to further dewater brine from the precipitated solids and creates approximately 10 tons of dry salt cake per day composed of magnesium and sodium sulfate with a small amount of sodium and magnesium chloride. The moisture content of the salt cake will be less than 20 percent. The waste salt cake does not meet any of the dangerous waste characterizations (WAC 173-303) and is suitable for landfill disposal. Water is collected and recirculated through the crystallizer.

The high-quality distillate produced in the ZLD system is reused on site. Approximately 340 gpm of distillate will be directed as the sole source for the process water system (reverse osmosis/electrodeionization systems) make-up water. The remaining 62 gpm is returned to raw water treatment for reuse on site. Figure 3 shows the water flow chart with the ZLD system. The water reuse will reduce the raw water demand of the facility, including the amount of water needed from the collector well. Table 2 reflects the water cycle if the ZLD system is implemented.

Table 2. Industrial Water Cycle – ZLD System

Facility Element	Approximate Flow Rate (gpm)
Industrial Water Supply	
Raw Water Supply	3,038
Process Wastewater Reuse	135
ZLD Distillate Reuse	62
Process Water Use	
Cooling Tower	3,235
Process Water System	340
Process Water Disposition	
Evaporation from cooling tower	2,831
Process Wastewater Reuse as Raw Water	135
Average Discharge to ZLD	404
Consumed in chemical reactions	<100

If implemented, the ZLD system would be located adjacent to the planned wastewater treatment element on the northwest corner of the project site. Equipment would be housed in a single-story building (or buildings) totaling approximately 5,000 square feet. The crystallizer and brine concentrators are mechanical towers that will be less than 100 feet in height. These structures can be accommodated within the proposed project footprint and would not significantly change the project's appearance because of the presence of other structures and features nearby.

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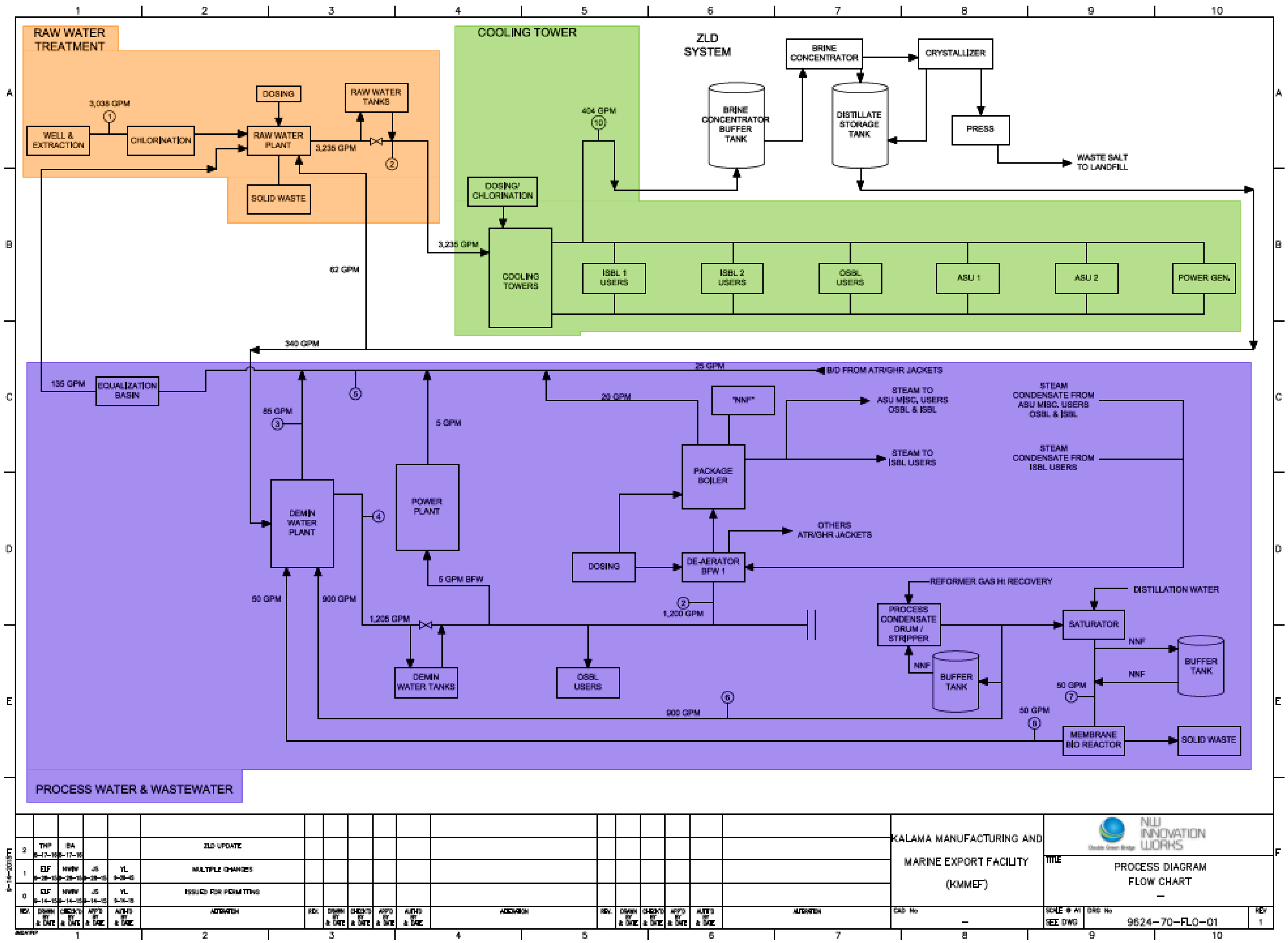

Figure 3. Water Flow Chart