SUCCESS STORY:
AERZEN USA
Steam ZLD Case Study

AERZEN USA: EAST PENN STEAM ZLD CASE STUDY

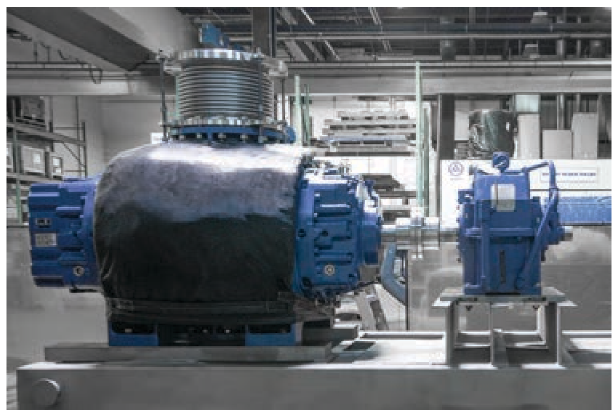
Process:
ZLD (zero liquid discharge) is a wastewater distillation process that helps reduce waste brine discharge to the environment and recover the majority of the wastewater as clear reusable water. In addition, it can turn the brine to a solid waste and in some cases even a useful product that can be profitably sold.

The ZLD process is becoming very important and economical for many industry segments to meet more stringent environmental regulations. Industries such as power, chemical, refining, manufacturing, paper, and others utilize ZLD processes. One of the last steps of the ZLD process is crystallization, in which the concentration is further increased by evaporating water from the pre-filtered or already concentrated wastewater to a level not possible or efficient by distillation.

For water evaporation in the crystallizer, the process needs a huge amount of heat. This heat can be provided by several options, but the most cost efficient is to use some type of MVR (mechanical vapor recompression) and use the latent heat of the already evaporated steam as a heat source. The goal of MVR is to increase the pressure of steam. This higher pressure steam is then fed into a heat exchanger, which evaporates water from the salty water on the other side of the heat exchanger.

During this process, the steam that is condensing in the heat exchanger escapes as clear water into a storage tank. The discharge pressure of the steam in the MVR depends on the boiling point of the wastewater, which depends on the type and the concentration of the salts in the wastewater.

In the crystallizer phase of the ZLD process, because of the high concentration and boiling point of the brine, higher steam pressures are required at relatively smaller flows compared to the earlier distillation steps. This pressure and flow combination is a very good fit for a positive displacement rotary lobe blower, or a screw compressor when higher discharge pressures are required. In most cases, the high inlet temperature of the steam requires cooling water injection to control the discharge temperature, and thus the thermal expansion of the machine.



Process ZLD for a battery factory waste water treatment plant

Problem Lack of reliability and efficiency

Solution AERZEN modular steam blower package specifically designed for aggressive steam

Results As of the date of publication over 16 months of continous operation without losing efficiency or having any mechanical problems, compared to only 3 - 9 months for the previous machine compared to only 3 - 9 months for the previous machines

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
United States
T +1 800-444 1692
T +1 610 380 0244
F +1 610 380 0278
processgas@aerzenusa.com
www.aerzenusa.com

Contact Doug Cagney
Cell: +1 484-678-6811
Email: dcagney@aerzenusa.com

Since steam is a neutral fluid, many blower suppliers use their "modified standard" air blowers for steam compression. However, in ZLD applications, the pH of steam can be far from neutral for both the steam and the injection water. If we combine the mechanical difficulties inherent with 'neutral steam' – oil degradation because of the dissolved/mixed water in the oil, different clearances because of the thermal expansion, and possible erosion effect of cooling water injection on the rotors and the housing – with the fact that the ZLD steam is much more aggressive than a standard "clean" or "neutral" steam application, then it is clear to see that standard blowers are not suitable for this application.

Problem:

This ZLD customer receives waste water from a battery production plant. They found us because their existing blower had reduced flow followed by repeated failures after short periods of operation. The reduced flow meant that two ZLD trains had to run simultaneously when one should have been able to handle the entire flow. These failures resulted in numerous unplanned outages and a very high cost of replacing the blower stage multiple times.
The failures include:

- Reduced flow / volumetric efficiency caused by erosion and corrosion on the rotors and the housing
- Increased discharge temperature caused by low volumetric efficiency that was the direct result of the erosion/corrosion, which led to overheating of the blowers
- High oil consumption and oil contamination of the process caused by repeated process seal failure
- Stub shaft failure

In addition, the blower required a much higher injection water flowrate than would be expected with normal compression and volumetric efficiency. One reason for the excessive water injection was to offset the high discharge temperature, but at the same time, a lot of water was not evaporated and simply drained out. The lifetime of a blower stage was between 6 and 12 months, but in less than 3 months the new blower would have a measurable capacity decrease.

Aerzen's challenge was to provide a reliable, long-term solution to reduce the maintenance costs and plant downtime, while maintaining consistent flow/production rates as the blower ages. We had to be flexible during the design to enable ease of implementation of the new unit into the existing system, since the customer wanted to keep some parts of the old unit (motor, gearbox).

Solution:

Material/construction

The AERZEN solution for this challenge was a modular AERZEN GM steam blower package, specifically designed for aggressive ZLD applications. The design concept originates from standard air blowers, but all similarity ends there.

To be able to handle the aggressive, low pH steam, the blower is equipped with a special Nickel Resist housing and stainless steel rotors with closed cavities and a solid through-shaft. The closed rotors ensure that no scaling or corrosion can build up in the rotor cavities. The through-shaft eliminates failures due to stub shafts. The clearances are specially modified between the housing and the rotors to allow for the increased thermal expansion and to give a higher safety margin against mechanical failure. Thanks to extra separation of the oil system from the steam via the sealing system described below, the blower has zero risk of water contamination of the oil or oil contamination of the steam.

AERZEN blowers also utilize standard splash lubrication without any external oil pump or oil cooler- thus further reducing potential points of failure. The specified oil is modified to give proper viscosity even at high temperatures.

Sealing

An additional section is added into the blower housing between the process (compression) chamber and the oil sump. This extra sealing section contains a PEEK restrictive ring sealing pack with an internal neutral chamber for pressure balancing and for reducing the steam loss through the seal. It also features a large atmospheric neutral chamber between the standard oil/process seal and the special additional PEEK ring seals. The oil side seal can be purged with instrument air to ensure the full positive separation of the steam from the oil. Because these are non-contacting seals; seal life is increased indefinitely and risk of seal failure is dramatically reduced.

Injection

With water injection built into the suction side of the machine, AERZEN ensures that the blower housing and rotors are continuously cooled by a water film, hence discharge temperature and thermal expansion are controlled. The water also helps increase the volumetric efficiency of the unit. With optimized injection pattern and droplet size, the injection water consumption is reduced significantly from the previous blowers. The reduced flow, the smaller droplet size, and the correct material selection all together reduce dramatically the chance of erosion in the machine.

Result:

The AERZEN blower has been running continuously since beginning of June 2016 without any maintenance or unexpected plant shutdowns caused by the blower. As of the date of this report, the volume flow rate of the blower and thus production rate of the ZLD system have not changed. The oil shows no sign of degradation or water content based on the oil sample analysis.

AERZEN
EXPECT PERFORMANCE