Dais Analytic Corporation
11552 Prosperous Drive
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NanoClear™
Frequently Asked Questions
April 2018

What are the key benefits of NanoClear?

NanoClear

- Cleans water to "parts per billion" level of quality, which is 100 times cleaner than the US EPA drinking water standard
- Salts and metals do not pass through the membrane
- Thrives in harsh environments that tend to be beyond the capabilities of RO systems and other conventional technologies
- Can achieve recovery rates up to 99%, significantly reducing the amount of concentrated effluent
- Handles highly concentrated wastewater without significant increase in energy consumption
- Operates at low pressures with corrosion resistant plastic hardware instead of the high pressure stainless steel required by RO, which reduces capital expenditures
- Requires simple pretreatment (TSS filtration to 20 µm and pH adjustment for maximum output)
- Has relatively low maintenance requirements, which reduces operating costs

What is the highest total dissolved solids (TDS) and chemical oxygen demand (COD) concentration that NanoClear can reliably treat?

NanoClear can handle salt water with concentrations up to 250,000 mg/L. The highest COD concentration that we have tackled is about 50,000 mg/L, but we see no reason why that value cannot be pushed higher.

What happens to the contaminants in the wastewater as it is processed?

Salt and other contaminants do not pass through the membrane and are discharged from the system as part of the concentrated effluent. Depending on the recovery rate, the volume of the concentrated effluent is significantly smaller than the initial wastewater volume. It can either be dumped or sent to a post-processing step, such as a crystallizer or an evaporation pond.

How does NanoClear treat chemical oxygen demand (COD)?

NanoClear works by evaporating water molecules through the Aqualyte membrane to be condensed into ultra-clean product water, while contaminants are concentrated in the water that remains behind. Most of the chemicals that contribute to COD do not pass through the membrane and are concentrated as the water volume decreases. However, some organic molecules that are similar to water in size, polarity, and volatility may transfer through the membrane at a measurable rate, producing a nonzero COD in the product water. For more

information on COD, please refer to the external document titled “Chemical Oxygen Demand FAQ”.

What are the pretreatment and maintenance requirements?

NanoClear requires that the incoming wastewater be filtered to remove any solids larger than 20 µm. If the pH of the wastewater is too acidic or too alkaline, then it should be adjusted to be between 2-11 for optimal performance.

If the performance begins to degrade over time, Dais recommends performing a one-hour citric acid flush to remove any contaminants from the evaporator and rejuvenate the performance. If citric acid is unavailable, please contact Dais for alternatives.

How does NanoClear resist fouling and bio-fouling?

Dais’s patented Aqualyte membrane has a surface structure and internal chemistry that is specially engineered to help resist fouling. The membrane itself is non-porous, so there are no pores for contaminants to get stuck and/or become permanently lodged. The hydrophobic nature of the membrane creates an exclusion zone at the surface, which helps to prevent the material from fouling. Any foulants that do make it to the surface find it difficult to attach to the membrane and are easily swept away in cross-flow. The smooth surface and acidic environment make it difficult for bio-organisms to grow on the membrane, thereby making it resistant to biofouling.

What is the target market for NanoClear?

NanoClear can handle a wide variety of wastewater types, including very high concentrations of salt water and extremely dirty industrial wastewater. Ideally, we would target a project where a source of waste heat is readily available to minimize the cost of heating the wastewater. Because NanoClear can push the boundary of existing concentration limits, we are targeting facilities that are looking to further increase their recovery rate and reduce the volume of concentrated effluent. Companies that are looking to reduce their wastewater treatment costs and simplify their processes should consider NanoClear, as it can often replace multi-stage filtration processes with a single process.

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What conventional technologies can NanoClear replace?

NanoClear can significantly simplify existing industrial wastewater treatment processes by replacing a multiple stage process with a single process. For example, a plant that uses two UF stages and two RO stages to process highly concentrated brine can be replaced by NanoClear, which can reduce the maintenance costs and improve the recovery rate.

How does NanoClear compare to reverse osmosis (RO) and ultrafiltration (UF) in terms of cost and efficacy?

NanoClear produces water whose Total Dissolved Solids (TDS) level typically measures < 10 mg/L and can often reach 1 mg/L or better with a single pass through the system, even when the input water exceeds seawater salinity. Single-pass seawater reverse osmosis (SWRO) systems typically produce water whose TDS is in the 100 – 400 mg/L range, one to two orders of magnitude higher than NanoClear. Ultrafiltration membranes are not capable of reducing the TDS of their feed-water; instead, they reduce the Total Suspended Solids (TSS) levels.

NanoClear and RO systems cannot be compared on a component-by-component basis due to differences in the modules and pre-treatment requirements.

How does NanoClear compare to Mechanical Vapor Recompression (MVR) in terms of cost and efficacy?

Mechanical Vapor Recompression uses a vapor compressor to superheat the vapor and then transfers that heat through a heat exchanger to boil the incoming wastewater. It efficiently reuses the heat of vaporization so that it doesn't require a constant external source of heat. MVR does not use membranes of any type, so fouling management requires careful maintenance of a wastewater film covering the heat transfer surfaces to avoid local "dry" spots where the solids concentration is higher than the rest of the solution.
MVR has an electrical energy consumption of 30 – 50 kWh/m^3 of distillate and can typically produce water with TDS less than 50 mg/L. Compared to NanoClear, MVR uses significantly more electrical energy (up to 10x), but the thermal energy component is incorporated into its electrical usage. If waste heat is available, then NanoClear will ultimately have a lower energy consumption than MVR.

What is the average list price per ton of NanoClear at the module and system level?

The NanoClear Membrane Evaporator modules are available in modular form, with different capacities offered for the customer to select, and the pricing per ton varies with the different module capacities. The list price of a module varies from $27,178 - $30,000 for 1 ton/hr (6,341 gal/day) of evaporator capacity, with the lower cost being more representative of what would be expected in a larger application.

The cost of the entire system is not something we can currently estimate in a format reasonable for a FAQ section. The type of system (e.g. air-cooled vs. water-cooled condenser, other choices) has a large impact on the costs, as do the size of the installation and the type of water being treated.

What is the average energy used by NanoClear per cubic meter of water produced, and how does this compare to reverse osmosis?

NanoClear uses approximately 4 - 5 kWh/m^3 of electrical energy and approximately 670 - 700 kWh/m^3 of thermal energy, typically from waste heat sources. Reverse osmosis claims 3 – 8 kWh/m^3 of electrical usage.

Are there any NanoClear pilot projects?

Dais currently has 15 pilot units in the U.S. and throughout China that are being used to treat wastewater from various markets.

The Dais East pilot site is located in Florida and has been operating since June 2013. It is currently used to treat municipal wastewater.

The Shanghai wastewater treatment device was commissioned in December 2017 and has been used to demonstrate the NanoClear technology to prospective customers. Some of the wastewater samples that it has treated include salt production brine, coal chemical waste, lithium battery waste, petrochemical wastewater, and desulphurization wastewater.

What are the typical operating temperature ranges for NanoClear?

The flux rate in the NanoClear system increases with temperature for the wastewater stream. Standard operating temperatures for the wastewater stream range from 50°C to 70°C.

The flux rate in the NanoClear system increases with decreasing temperature for the condensation system. Standard operating temperatures for the condensation system range from 4°C to 23°C.

While the temperatures affect the rate at which water is produced for a given amount of membrane, they do not significantly change the total energy required to produce a given amount of water.

How much waste heat is required to allow NanoClear to operate at peak efficiency?

The amount of waste heat required is based on the heat of evaporation that must be supplied to the wastewater to replace the heat carried away from the membrane with vapor. That same amount of heat must be removed from the condenser to return the vapor to a liquid state. The “M3 Customer Estimator” software tool is available to customers and will provide the exact

amount of heat required for a project. On average, NanoClear requires approximately 670 – 700 kWh of thermal energy for every cubic meter of water produced. For more details on wastewater heating, please refer to the external document titled "Wastewater Heating Summary".

What size should the condenser be?

The condenser should be sized based on the cooling required by the vapor as it becomes liquid. Dais will provide an estimator program that calculates this cooling requirement in kilowatts (kW). If this program is not available to the user, Dais or its authorized sales reps can provide the estimate to the customer. Specific details of how the condenser operates, how it is sized, and the materials used are the responsibility of the customer, specifically the engineer responsible for design of the balance of plant. The saturation temperature of the vapor inside the condenser should be communicated to Dais so that all sizing calculations are based on the correct design point.

What vacuum pump is recommended?

The exact vacuum pump specifications are the responsibility of the customer and the system design engineer. Dais recommends the following capabilities for the vacuum pump:

- Ultimate vacuum should be < 1 kPa (7.5 Torr) absolute for best operation of the condenser.
- For an ME305 evaporator, a minimum pumping speed of 15 m^3/hr (8.8 CFM) measured at 2 kPa (15 Torr) is recommended.
- If multiple evaporators are evacuated by the same vacuum pump, the recommended pumping speed is additive. Three ME305 modules would imply a pump with greater than 45 m^3/hr (26.4 CFM) pumping speed.
- The pump should be capable of handling water vapor in the exhaust, which typically requires a gas ballast valve to prevent condensation.

How much membrane is available in a single evaporator?

Each ME305 membrane evaporator exposes 33.75 m^2 (363.3 ft^2) of membrane surface for transfer.

What are the connections to the membrane evaporator?

The connections to the membrane evaporator are female threads that can be specified as either English or metric threads. The English connections are 3/8'' and 1'' NPT. The metric connections are DN10 and DN25 BSPT.

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What is the warranty offered for NanoClear media?

NanoClear modules come with a one-year warranty against defects in materials and workmanship and a limited two-year performance warranty.

What kind of technical support can Dais provide?

Upon purchase of a membrane evaporator, Dais will provide an instruction manual that details the unpackaging, installation, operation parameters and instructions, shutdown procedures, maintenance instructions, and troubleshooting steps.

Dais also provides a complimentary version of the “M3 Customer Estimator”, which is an Excel-based program that allows the user to enter various inputs regarding their system and it calculates how many evaporators are required for that project. It also sizes the equipment for the balance of plant (BOP), which includes heat exchangers, condensers, and vacuum pumps, and it will determine how much thermal heat is needed to maintain the wastewater temperature during operation.

For a one-time fee, Dais will also provide a professional tech-support design package. This package includes a BOP design guide to help size and select the various components needed for a complete system, and an installation guide with BOP plumbing recommendations to get the most out of your NanoClear system.