Abundant Water for People, Agriculture, & Industry

www.chasmtek.com

An Abundance of Water for All Applications

Purified water is not only essential to sustained life, it is integral to the food we eat and the goods and services surrounding daily living. For those bearing the responsibility of providing more in the face of increasing demand while available reserves are dwindling, breakthrough innovations are required simultaneously producing more of the quality of water desired at less of an investment and with less waste. Whether needing drinking water for municipalities or remote villages, ingredient water for consumer goods, feedwater for agricultural purposes, process water for industrial applications, or greater return from treated wastewater, advanced CHASM-H2O membranes provide efficiencies well beyond existing thin film composite membranes to deliver more water at a lower cost and a smaller footprint.

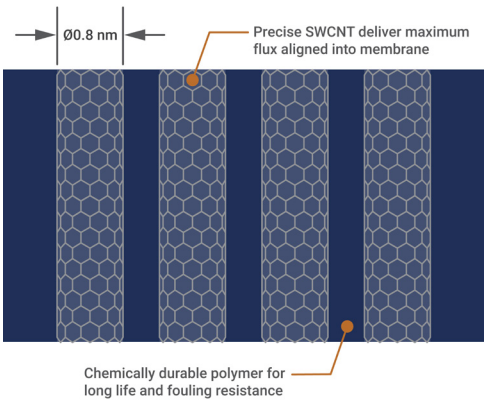
With a distinguished history in functionalizing materials at the nanoscale delivering disruptive performance, CHASM Advanced Materials has created a new category of membrane materials enabling breakthrough water purification innovation not seen in the industry for more than 40 years.

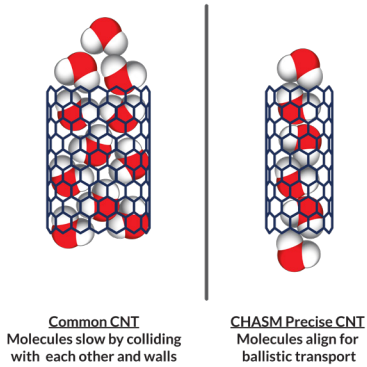
Visit www.chasmtek.com/chasmh2o to learn more.

CHASM H2O

Nanoscale Innovation Powering Record Breaking Flux

CHASM-H2O membranes deliver performance results orders of magnitude beyond the best TFC membranes on the market today. CHASM's patented technology employs a powerful combination of precisely manufactured single-wall carbon nanotubes (CNTs) with a proprietary method for roll-to-roll fabrication of vertically aligned CNTs locked in a UV-cured polymer matrix. The result is an advanced membrane delivering 100X the water permeability of traditional TFC membranes with increased robustness to fouling. An innovative combination of diameter and aspect ratio unique to CHASM CNTs cause near ballistic transport of water molecules and 100% rejection of containments including dissolved solids, viruses, organics, and carcinogens. CHASM-H2O membranes are also comprised of CNTs and a specifically selected polymer matrix that are impervious to attack by chemicals typically used in industrial water treatment, making them inherently resistant to degradation due to fouling — unlike commercially available TFC membranes today that are attached by chlorinated water and easily damaged during membrane cleaning processes using low and high pH cleaning solutions. The CHASM-H2O platform is a game changer for reverse osmosis (RO) desalination and water purification across all applications and in all industries.





Common CNT
Molecules slow by colliding with each other and walls

CHASM Precise CNT
Molecules align for ballistic transport

Benefits

A product of our exclusive platform, CHASM-H2O advanced membranes combine a variety of features delivering superior value across many water purification applications.

Record-Setting Flux – Delivering 100X the water permeability of standard TFC membranes, CHASM-H20 membranes ensure recovery of every available drop of purified water to lower CAPEX by reducing the complexity and overall size of required RO systems.

Complete Contaminant Rejection – Fabricated from exclusive precisely and tightly controlled diameter CNTs, CHASM-H2O membranes reject 100% of contaminants without compromising flux assuring confidence of permeate safety even in the most difficult treatment applications.

Robust to Fouling – The high permeability of CHASM-H2O membranes gives greater resistance to fouling by delivering greater consistency along pressure vessels preventing locations of stagnant flow common in traditional TFC membranes, resulting in decreased downtime to CIP maintenance and less operational expense.

Chemical and pH Resistant – Constructed from a polymer specifically designed to withstand deterioration by chlorine and other chemicals as well as the caustic effects of high pH feedwater, CHASM-H2O membranes provide extended service life reducing operational expense.

Energy Efficient – The patented CNTs comprising CHASM-H2O membranes produce nearly frictionless and ballistic transport of water molecules requiring an absolute minimum of pressure over and above osmotic pressure and a fraction of the energy demanded by traditional RO membranes.

Using CHASM-H2O membranes in your RO system not only recovers every usable drop of water for your desired application, but also with a minimum of CAPEX and OPEX for a healthy bottom line.

Applications

CHASM-H2O membranes offer wide versatility, suitable across a wide variety of water treatment applications.

Industrial Water & Wastewater Reuse – Coupled with increasing demand, rapidly rising municipal water prices and water tariffs necessitates efficient reclamation and reuse of all water streams. The record-setting permeability and chemical resistance of CHASM- H2O membranes, not only ensures purity of boiler feed water protecting heat exchangers from destructive mineral calcification, but also maximum recovery of high TDS cooling tower blowdown lowering demand on municipal water supplies.

Spot Free Rinse Water – Industrial processes for many manufactured goods such as automobiles, aircraft, and electronics rely heavily upon in-process surface cleaning and rinsing operations to remove dust and debris created during manufacturing and to prepare clean surfaces for subsequent operations like painting and plating. The complete rejection of contaminants and dissolved solids by CHASM-H2O membranes eliminates hardness in source water, removing calcium and magnesium salts that cause scaling and water spots on cleaned surfaces.

Ingredient Water – When food and beverage brands rely on a consistent flavor regardless of where in the world they are being bottled or packaged, consistency of water is as critical to the recipe as any ingredient. CHASM-H2O membranes reject 100% of salts, dissolved solids, and contaminants that can potentially alter the taste or even the aroma of food or beverages.

High Purity Water – Select manufacturing industries such as pharmaceutical or microelectronics demand highly purified water so drugs adhere to exacting recipes and microelectronics perform flawlessly. The 100% rejection achieved by CHASM-H2O membranes not only ensures salts and contaminants are removed, but also keeps pharmaceutical and microelectronics water free of bacteria, organics, and all dissolved solids.

Potable Drinking Water – With nearly one fifth of the world's population living in areas of water scarcity and 3 in 10 people – or 2.1 billion worldwide – lacking access to safe and readily available drinking water at home according to the World Health Organization, higher recovery and portable purification systems can put an end to water scarcity. The record setting permeability of CHASM-H2O membranes along with their low energy requirements enable even small footprint portable systems can deliver the volumes of water equal to traditional RO systems many times their size. With 100% rejection of contaminants, CHASM-H2O membranes can remove common chemicals such as chlorine, heavy metals, or pesticides found in municipal water supplies keeping drinking water safe for citizens.

Whether designing a new water treatment system or needing to achieve more efficiency from an existing system, CHASM-H2O membranes process greater volumes of water containing a broader range of contaminants with reduced sensitivity to typical process chemicals.

Visit www.chasmtek.com/chasmh2o to learn more.

Functionalizing for Mass Production

Foundational work for CHASM-H2O membrane technology has been in development for more than 7 years. Born of a Department of Defense (DOD) protective clothing initiative between CHASM, Lawrence Livermore National Labs and Rutgers University, CHASM-H2O membranes help protect soldiers from exposure to biological or chemical warfare agents without compromising the breathability of the fabric. The ultrafast water transport rates are achieved by a combination of the tiny CNT pore size of 0.8nm and their extreme hydrophobicity repelling water from pore wall reducing friction. At this optimal size, water molecules can only flow "single-file" and at an ultrafast water transport rate that is 3-5 orders of magnitude higher than predicted by state-of-the-art continuum flow computer models. The product roadmap for CHASM-H2O membranes includes mass production for DOD protective clothing and for water desalination and purification.

Production of CHASM-H2O membranes is done through the following steps:

1. Using CHASM's proprietary CoMoCat™ process, precise 0.8 nm diameter CNTs are synthesized at production scale and within a tight diameter distribution.

2. Applying more than a decade's worth of knowhow, the CNTs are uniformly dispersed into a curable monomer fluid, and then roll-to-roll coated onto a continuous substrate.

3. The CNTs are then electrophoretically positioned into vertical alignment and the monomer is UV-cured to lock the CNTs in a polymer matrix.

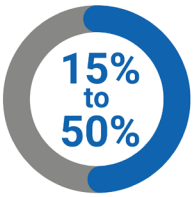
4. Proprietary post-processing creates the final membrane product structure for easy integration into standard pressure vessel modules.

Engineered for compatibility with existing reverse osmosis systems, CHASM-H2O membranes can be seamlessly used in new plant builds or to retrofit legacy systems for greater efficiency.

CHASM H_2O

Why CHASM-H2O

Regardless of application, CHASM-H2O membranes effortlessly produce the quantities of the quality water your business demands while eliminating a broader range of contaminants over traditional membranes. With their record-breaking permeability, overall purification systems require a fraction of the footprint, utilize less energy and are more cost effective to operate having fewer and less invasive CIPs. It's time to demand more from your water purification system, starting with more and better water brought to you by CHASM-H2O membranes.

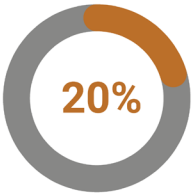


OPEX SAVINGS

Reduced Energy & Maintenance (SWRO - BWRO)

FOOTPRINT SAVINGS

Reduced Plant Floorspace



CAPEX SAVINGS

Lower RO System Acqusition Cost

Visit www.chasmtek.com/chasmh2o to learn more.

CHASM™

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