



ASX RELEASE | De.mem Limited (ASX:DEM)

## De.mem Presents Next Generation Membrane Technology

- De.mem launches new, proprietary graphene oxide-enhanced membrane technology
- The new technology provides significant customer benefits including increased throughput and therefore, reduced operating cost, and superior filtration performance
- The new Intellectual Property complements De.mem's existing membrane technology portfolio and further positions De.mem as a leader in hollow fibre membrane technology and development

7 September 2021: Australian-Singaporean water and waste water treatment company De.mem (ASX:DEM) ("De.mem" or "the Company") is pleased to present its "next-generation" hollow-fibre membrane technology, potentially disrupting the existing global US\$9.4 billion hollow-fibre membrane market.

### Introducing De.mem's Graphene Oxide (GO) enhanced polymer membranes

De.mem has today released to the Australian Securities Exchange a *Technology and Product Presentation* (attached to this announcement) describing its "next generation" graphene oxide (GO) - enhanced membranes.

De.mem's new technology is based on the Company's existing polymer membranes, which are infused with GO nanoparticles as an additive. The manufacturing process is highly scalable, consistent with existing manufacturing processes.

De.mem's new membrane technology has the potential to disrupt the existing global market for hollow-fibre membranes, which is expected to grow from a US\$9.4 billion global market (2019) to US\$16 billion by 2026 (source: *Global Market Insights Inc.*).

### Benefits of new GO membranes

**Graphene is the new "wonder material"**, one of the strongest, lightest, most conductive and transparent materials, known to humanity, with increased durability relative to other materials.

**Graphene has exciting applications in water and wastewater treatment.** When oxygen groups are added to create graphene oxide (GO), the material promotes rapid water permeation, can deliver a substantially higher water flux (throughput) and increased rejection over current state-of-the-art hollow-fibre membranes, while it displays a lower fouling tendency of the membrane.



## **New technology and product family added to De.mem’s existing, comprehensive Intellectual Property (“IP”) portfolio**

The new GO-enhanced membranes add further value to De.mem’s technology and IP portfolio. They are suitable for a wide range of applications, including potable water treatment and industrial waste water treatment.

De.mem’s existing technology portfolio comprises three **wholly-owned, royalty-free product families (categories), complemented by additional IP exclusively licenced from world-leading research institute, Nanyang Technological University, Singapore (“NTU”)**. NTU was ranked no. 2 globally in membrane research technology by Lux Research (2013).

De.mem’s wholly-owned product families / categories are:

- De.mem’s **hollow fibre nanofiltration membrane**, which, based on its minimized pore size in the nanometer range, produces high quality treated water in a simple, low-pressure and low-energy consumption process;
- De.mem’s **ultrafiltration membrane**, an established water treatment process deployed for potable water generation to industrial waste water treatment applications as well as for Reverse Osmosis (i.e. seawater desalination) pretreatment;
- De.mem’s new **GO-enhanced membrane**.

The Company’s wholly-owned technology portfolio is complemented by the Company’s **hollow fibre forward osmosis de-watering membranes**, which were licensed from NTU.

## **Product Development Process**

Today’s announcement concludes a 24-months product development process involving De.mem’s team of in-house membrane experts based in Singapore.

At its state-of-the-art Singapore research facility, De.mem has successfully observed superior filtration characteristics from its GO-enhanced membrane technology. Internal testing demonstrates:

- **20-40% increased water flux** (throughput, or volumes of clean water produced) over standard polymer membranes, reducing the operating cost per liter of filtered water produced.
- **Ultra-high water flux** for certain variations of the technology.
- **Increased rejection** (rejection of contaminants, or filtration performance) over standard polymer membranes.

The Company is currently commencing industrial scale pilot projects.



## CEO Commentary

CEO Andreas Kroell said,

*“While being recognized by our clients as a leader in providing industrial water and waste water treatment solutions, the highly competitive position of De.mem is built around our portfolio of innovative hollow-fibre membrane technologies. This technology and Intellectual Property (IP) portfolio gives us a unique value proposition to the customer and provides our turn-key systems with a “competitive edge”.*

*Our existing hollow-fibre nanofiltration, ultrafiltration and forward osmosis technologies are already in the market.*

*With our new graphene oxide (GO)-enhanced membranes we are now adding another unique technology family to our IP portfolio. With their improved flux and high rejection of contaminants, they have the potential to disrupt the membrane industry.*

*We are very excited about launching this new technology and are now moving to the industrial-scale pilot stage. We look forward to updating the market with further progress.”*

This release was authorized by the Company’s Chief Executive Officer, Mr. Andreas Kroell.

-ENDS-

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**De.mem Limited (ASX:DEM)** is a decentralised water and wastewater treatment business that designs, builds, owns and operates turnkey water and wastewater treatment systems for some of the world’s largest companies in the mining, electronics, chemical, oil & gas, and food & beverage industries. Its systems also provide municipalities, residential developments and hotels/resorts across the Asia Pacific with a reliable supply of clean drinking water.

De.mem’s technology to treat water and wastewater is among the most advanced globally. The Company is headquartered in Australia and has international locations in Singapore, Germany and Vietnam. It is commercialising an array of innovative proprietary technologies from its research and development partner, Nanyang Technological University (NTU) in Singapore, a world leader in membrane and water research. Technologies uniquely offered by De.mem include a revolutionary low-



pressure hollow fibre nanofiltration membrane that uses less electricity and is cheaper to operate than conventional systems, as well as a new Forward Osmosis membrane deployed in de-watering applications or the concentration of liquids.

To learn more, please visit: [www.demembranes.com](http://www.demembranes.com)

### **Forward Looking Statements**

Statements contained in this release, particularly those regarding possible or assumed future performance, revenue, costs, dividends, production levels or rates, prices or potential growth of De.mem Limited, are, or may be, forward looking statements. Such statements relate to future events and expectations and, as such, involve known and unknown risks and uncertainties. Actual results and developments may differ materially from those expressed or implied by these forward-looking statements depending on a variety of factors.



demem 

## Technology Presentation

Advanced Membrane Technologies  
for Water and Waste Water Filtration

7 September 2021



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DE.MEM  
TECHNOLOGY  
POSITIONING  
AND MARKET  
OPPORTUNITY

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**De.mem owns extensive IP in hollow fibre membrane technology**

De.mem specializes in **hollow fibre membrane technology** for use in water and waste water treatment and industrial processes - developed and manufactured at its facility in Singapore

De.mem's Intellectual Property (IP) comprises three main product families / categories (for details see section II):

- **Hollow fibre nanofiltration,**
- **Ultrafiltration,** and
- **Graphene-Oxide (GO) enhanced membranes** (new and presented today)

De.mem offers products for a wide range of “high value add” applications, including:

- potable water generation
- industrial waste-water treatment
- recycling/reuse
- industrial processes such as milk or beverage production



IMAGE: Membrane production in Singapore



IMAGE: De.mem Ultrafiltration system



# DE.MEM MARKET OPPORTUNITY: HOLLOW FIBRE MEMBRANES

De.mem is well positioned in a high-growth, high-value add segment with substantial market size

## Market Trends

Global market for hollow fibre membrane filtration\*:

- From US\$9.4 bn in 2019 to **US\$16 bn by 2026** (forecast),
- **CAGR of 7.9%** from 2019 to 2026
- Higher growth rates vs. overall market
- Driven by R&D and innovation (vs other segments driven by cost – i.e. high volume manufacturing and economies of scale)

Macro-economic drivers:

- Population growth
- Growing emerging markets
- Growing industrial demand
- Food & beverage sector growth
- Mining & resources sector growth

Asia-Pacific ~33% of global\*\*

## demem Positioning & Strategy

**Hollow fibre membrane specialization**

**Technology broadly applicable** across multiple industries with focus on high-growth, industrial segments such as F&B and agriculture

Proprietary hollow-fibre membrane portfolio **targeting “high value add”** applications, validated and in the market, including:

- potable water generation
- industrial waste-water treatment
- recycling/reuse
- Industrial processes such as milk or beverage production

**Expanding proprietary technology portfolio; now launching “next gen” membrane technology**

\*Source: Global Market Insights Inc.

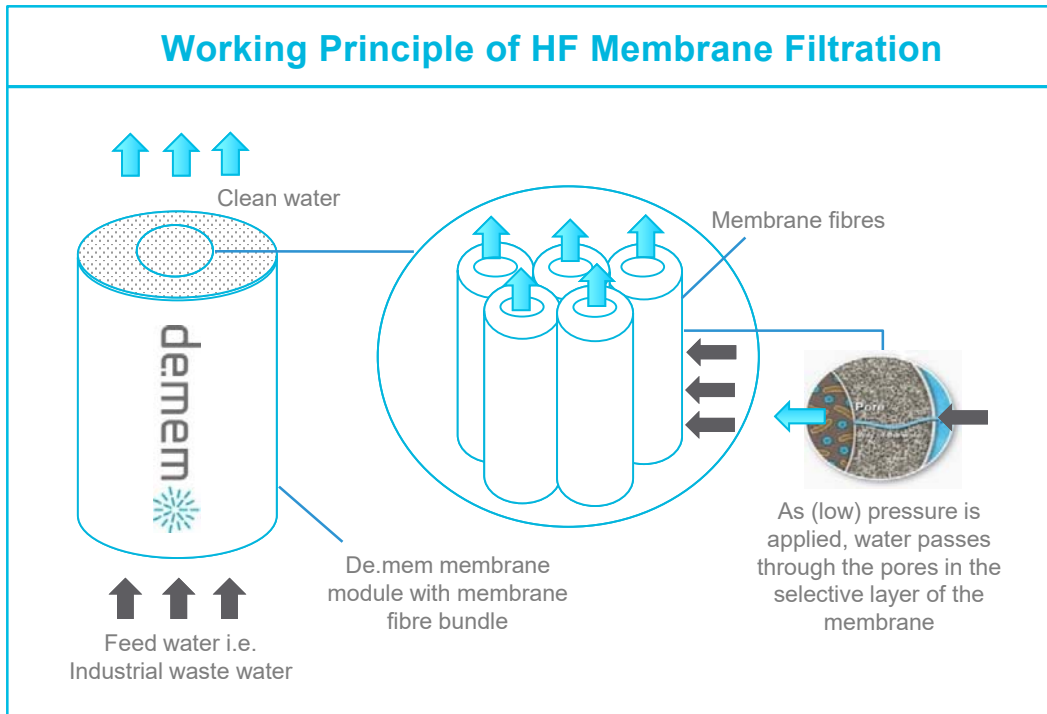
\*\*Source: Markets & Markets

DE.MEM  
HOLLOW-FIBRE  
MEMBRANE  
PORTFOLIO

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# WORKING PRINCIPLE OF HOLLOW FIBRE MEMBRANE FILTRATION



- Membranes are a microporous structure
- Only water molecules smaller than the pores pass through the membrane “barrier”
- Depending on pore size, a wide range of contaminants can be removed
- Hollow fibre (HF) membranes are straw-shaped fibres with hollow interior and microporous walls
- Hollow fibre membranes generally operate under low pressure and are easy to clean and maintain

**HF Membrane Bundles**



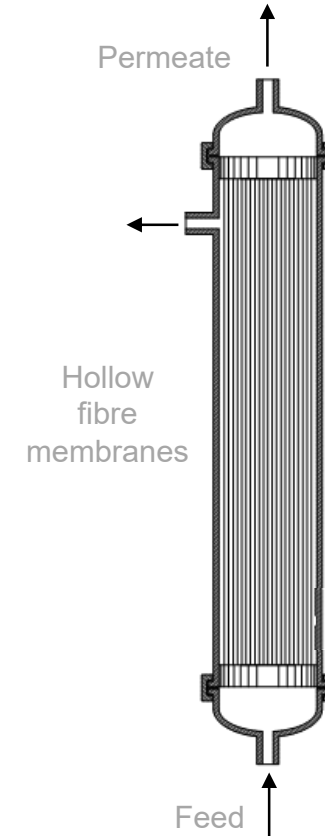
**Membrane Modules**



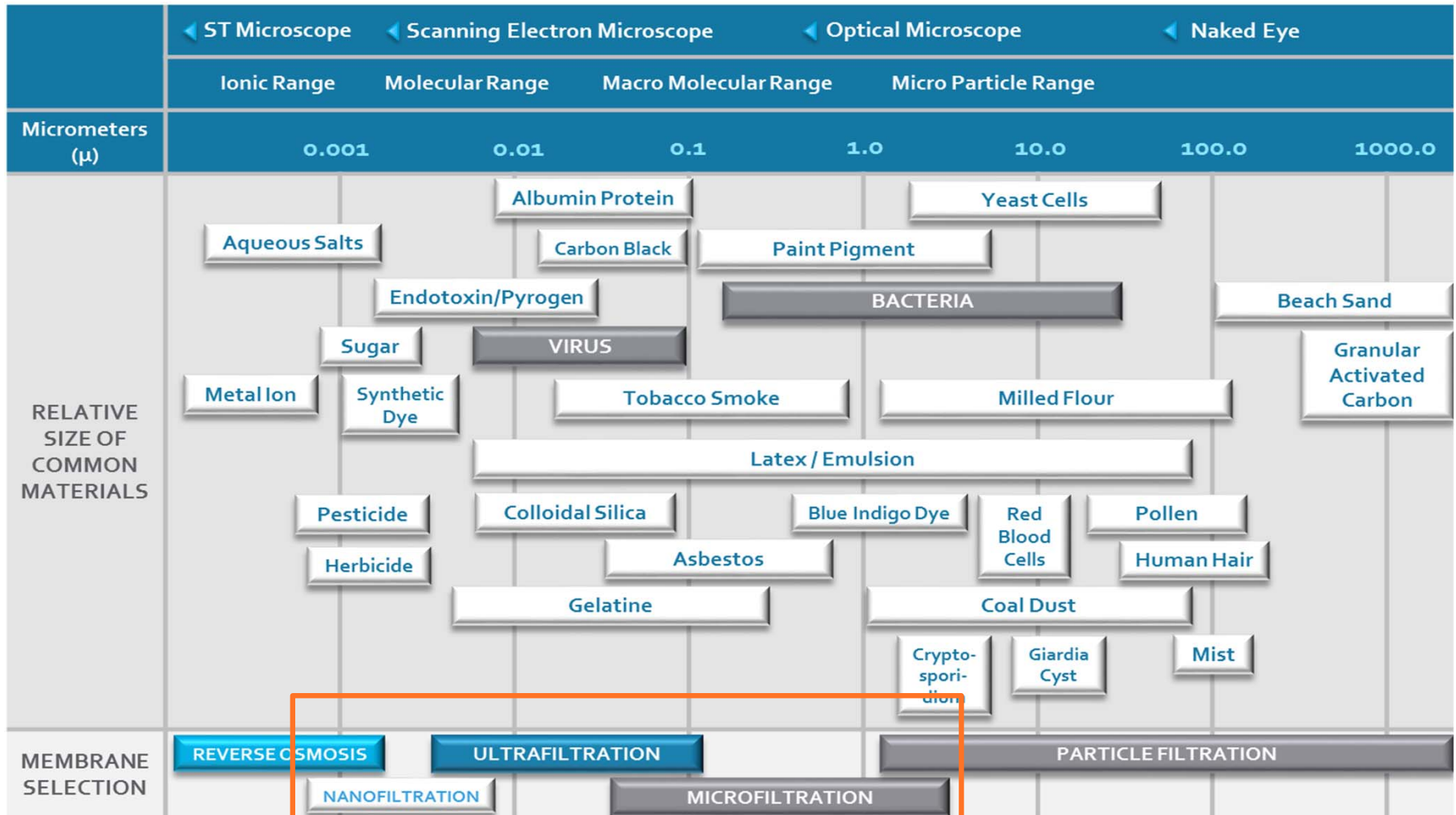
**De.mem membrane modules enable a compact and highly scalable water-treatment process**

- Membrane modules package bundles of membranes into a compact format. The modules are the key component in De.mem's integrated, turn-key water treatment systems
- Hollow fibre membranes are packaged in standard sized cartridges (=membrane modules), i.e. 4inch or 8inch in diameter
- The modular format makes it easy to scale the capacity of a plant, by just adding more modules to a rack or train
- Hollow fibre membrane modules can be cleaned easily in an automated backwash process, and are relatively insensitive to cleaning chemicals i.e. chlorine
- Module cartridges can easily be replaced

## HF Membrane Filtration Module



De.mem technology comes with a variety of pore sizes. It removes tiny contaminants including dyes, pesticides/herbicides, microplastics, solids, viruses, bacteria etc. in a simple process



- De.mem's **hollow fibre Nanofiltration (NF)** membrane is a unique technology that comes with a pore size in the nanometer range. Due to the very fine pore size, the membrane can filter out smallest particles and generate a high quality treated water stream
- The technology removes small organics, viruses and bacteria, dyes/colour, pesticides/herbicides, microplastics and other small molecules from a water stream
- Applications are within industrial waste water treatment, re-cycling/reuse and potable water generation
- The membrane can operate under 1-2 bar operating pressure only, **enabling significant savings of up to 70% in energy consumption** vs. RO or flat sheet NF
- The technology can **combine multiple treatment steps** (i.e. UF and RO) into one single process



*IMAGE:  
Hollow-fibre  
Nanofiltration  
membranes made  
by De.mem in  
Singapore*



*IMAGE: HF Nanofiltration membrane system  
deployed in Vietnam*

- De.mem's **Ultrafiltration (UF)** and **Microfiltration (MF)** membranes describe a range of membrane technology which removes organics such as viruses and bacteria, suspended solids, yeast cells and other particles from the particular size range
- Applications are in Reverse Osmosis pre-treatment, potable water generation, industrial waste water treatment and industrial process applications such as dairy or beverage production
- UF and MF are an established, yet strongly growing market
- De.mem's offering comprises of PES- and PVDF-based polymer membranes with numerous variations in pore size; the customer is presented with a solution specific to the particular requirements



*IMAGE: De.mem Ultrafiltration skid*



*IMAGE: De.mem Ultrafiltration skid*

- De.mem offers a **residential filtration system** (installed under the sink) using the Company's Ultrafiltration membranes as the key filtration step
- The membrane is combined with other processes such as carbon filter and alkaline cartridge ("3 to 5 stage filtration")
- De.mem cartridges are exchanged with new ones during routine maintenance in regular intervals
- Products are available in Singapore
- De.mem plans for the market introduction into other countries – entry into some markets i.e. Australia subject to regulatory approvals
- **De.mem presents a variation of the product which is installed on the bench-top, by simple connection to the tap**
- The system can be self installed which greatly simplifies sales & marketing efforts



*IMAGE: De.mem 5-stage residential filter*



*IMAGE: De.mem residential water filter for bench-top installation*



# FORWARD OSMOSIS-DEWATERING MEMBRANE

- **Forward Osmosis (FO)** is a membrane separation technology based on osmotic pressure differences; without any external mechanical pressure being applied
- A highly saline “draw solution” pulls water molecules through the membrane out of a feed liquid, and effectively concentrates the feed
- The De.mem technology was licensed from NTU, Singapore, which won prestigious industry awards
- It enables “gentle” concentration of liquids, preserving Volatile Organic Compounds (=taste) and nutrients such as proteins, enzymes, vitamins
- The technology has been deployed for coffee and tea concentration with superior results compared to existing state-of-the-art (=evaporation), and is potentially applicable to the production of fruit juice, dairy products, beer, wine, etc
- Other applications are in brine management

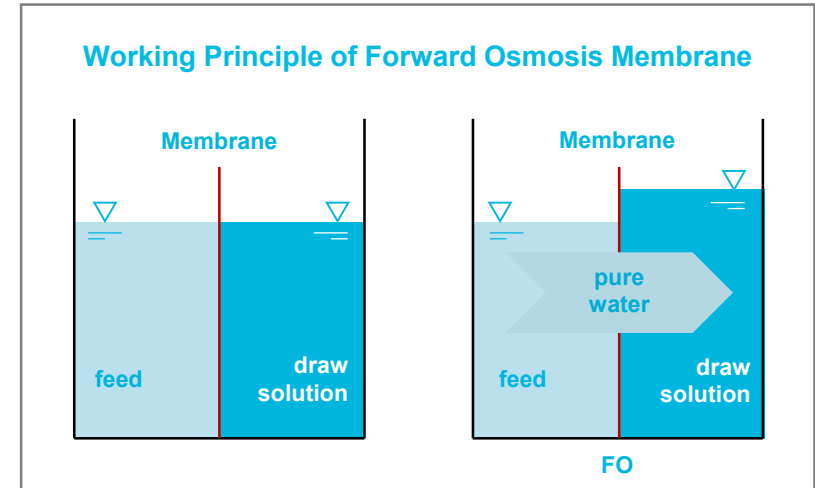


IMAGE: FO system supplied to multinational customer

De.mem IP comprises different types of nano-, ultra- and micro-filtration membranes



Type	PES-NF+	PES-NF	PES-NF next gen	PES UF	PES MF	PVDF MF	PES-GO next gen	PES-EGO next gen
Origin	NTU (license)	De.mem in-house	De.mem in-house	De.mem in-house	De.mem in-house	De.mem in-house	De.mem in-house	De.mem in-house
MWCO*	2,000	500-1,000	<500	<100K Da	<300K Da	< 300K Da	< 100K Da	< 100K Da
Status	In market	In market	Prototype	In market	In market	Industrial scale pilot	Industrial scale pilot	Prototype

\* Molecular Weight Cut-Off

DE.MEM'S  
"NEXT  
GENERATION"  
TECHNOLOGY

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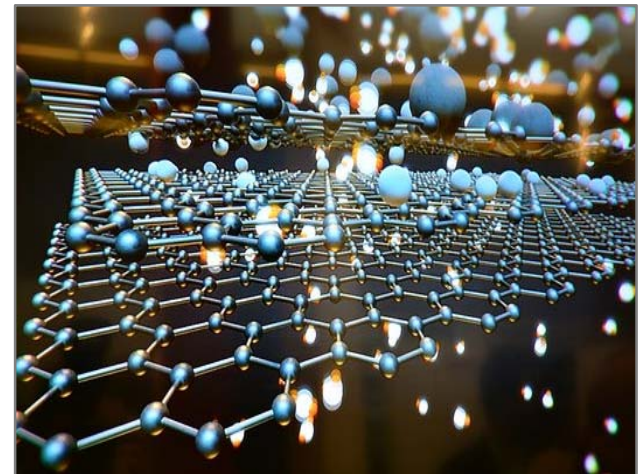


## Graphene is considered a new “wonder material” in membrane research & technology

Graphene has emerged into a highly researched topic in water treatment. The new material allows for super-efficient water filtration

Graphene is the new “wonder material”:

- an individual, two-dimensional layer of carbon atoms, bonded in a hexagonal honeycomb lattice
- one of the strongest, lightest, most conductive, and transparent materials known
- naturally repels water (is hydrophobic), but when oxygen groups are added to create graphene oxide (GO), the material promotes rapid water permeation
- Other applications include flexible electric/photonics circuits, solar cells etc.
- One of the most exciting application areas of the graphene-based materials is water and wastewater treatment



**We are excited to present our next-gen technology: Graphene-Oxide Enhanced Membranes**

De.mem's new range of "Next Generation" membranes are based on the company's self-developed polymer membranes, which are infused with Graphene Oxide (GO) nanoparticles as an additive

De.mem's new PES-GO membranes are produced at the Company's existing facility in Singapore, using existing manufacturing equipment

De.mem has tested the new PES-GO membranes in the lab, observing superior filtration characteristics i.e.

- Increased water flux (throughput) over standard polymer membrane by 20-40% - reducing operating cost
- Ultra high flux substantially above the latter can potentially be achieved for certain formulations
- Increased rejection (lower Molecular Weight Cut Off, MWCO) over standard polymer membrane

At this time, De.mem is conducting industrial scale pilot projects in Singapore and will update further about its progress



# APPENDIX





## Industrial Waste Water (F&B)

- Membrane based waste water treatment plant for F&B industry factory in Singapore
- Treats factory waste water to regulatory discharge standards
- High amount of oil & grease and volatile organic compounds in the waste water
- Integration of different process steps including DAF, Ultrafiltration and carbon filter



## Industrial Waste Water (F&B)

- Membrane based waste water treatment plant for F&B industry factory in Singapore
- Treats factory waste water to regulatory discharge standards, with recycling “option”
- High amount of oil & grease and volatile organic compounds in the waste water
- Integration different process steps including Ultrafiltration, Nanofiltration and carbon filter



## Forward Osmosis concentration system (F&B)

- Delivery of hollow fibre Forward Osmosis concentration system to leading multinational from the food ingredients industry
- Deployed to concentrate different types of beverages and flavours



## Potable Water for Municipality

- 2 MLD potable water treatment plant
- Ultrafiltration as key treatment process
- Deployed in a municipality in Nghe An province, Vietnam
- Using river water for the feed



## Water Treatment for Industrial Park

- Hollow-fibre Nanofiltration system treating river water to high-quality process water for industrial production at industrial park in Vietnam
- Simple one-stage, low pressure nanofiltration process



## Industrial Waste Water & Recycling (Oil & Gas)

- Deployed a series of Ultrafiltration systems at different locations within the factory of a large multinational in Singapore
- Treats waste water from testing pits for drilling equipment to recycling / re-use quality
- High amount of oil & grease in the waste water



## Industrial Waste Water (Plating industry)

- Ultrafiltration system for treatment of plating industry waste water to legal discharge standards
- Deployed at the factory of a multinational corporation in Singapore



## Industrial Waste Water (Plating industry)

- Reverse Osmosis system for waste water treatment from plating factory
- Nanofiltration membranes deployed as high quality pre-filtration prior to RO



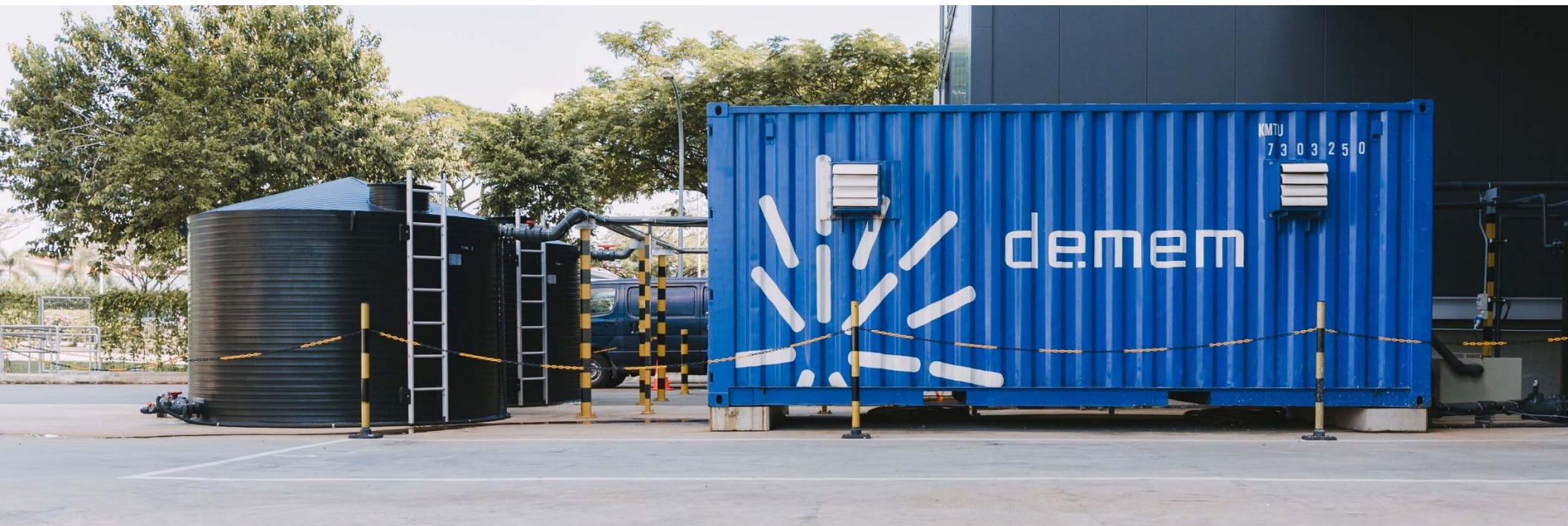
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