

MARKET MAP

Chinese membrane companies conquering new frontiers

In response to the evolving stringent environmental standards, the domestic membrane power of China is rising, creating more intense competition with foreign companies. How are they adapting to the opportunities on offer?

Since the 1990s, a gradual uptrend in the performance of domestic players' products and business capabilities in the Chinese ultrafiltration (UF) and microfiltration (MF) membrane market has been observed. It is understood that though there are about 1,000 Chinese membrane manufacturing or integrator companies operating in the market, many are confined to their localities or niche markets, with only about 20 companies really considered as significant players. Chinese customers today have more cost-efficient options with less discrepancy in quality from domestic players, while the interna-

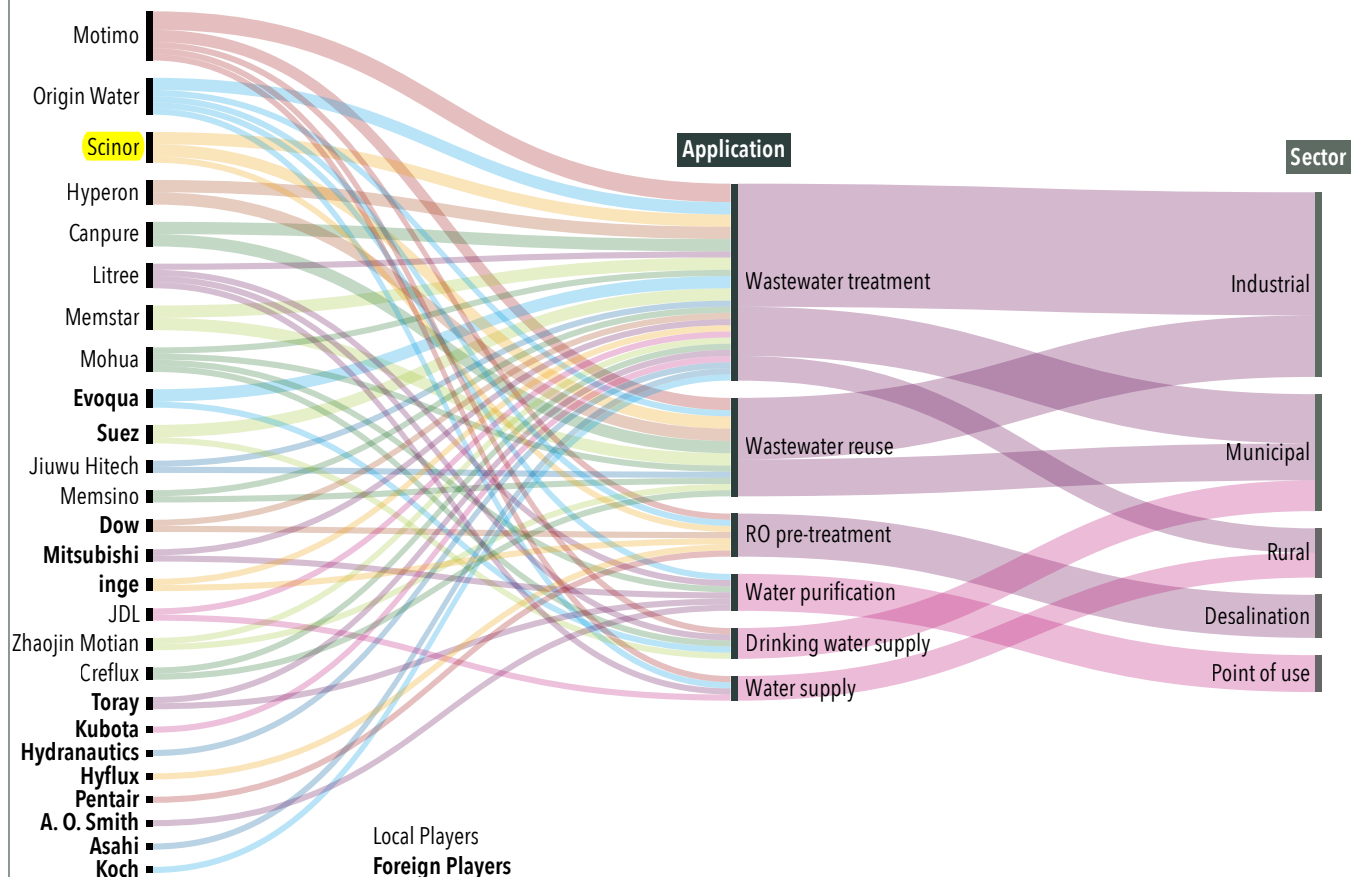
tional membrane companies are losing market share as they become more selective in their deals to meet margin expectations. The market share ratio between Chinese and foreign companies is now estimated to be 65:35 for new installations and 80:20 in the replacement market. Historical analysis by GWI suggests that in 2014, at least for new installations above 10,000m³/d, the ratio was 50:50, while in 2010 the ratio was 70:30 in favour of foreign players.

The Chinese government's wide-ranging and ambitious environmental plan is enabling clear opportunities for membrane

technologies, which many Chinese companies are ready to take advantage of. Most interestingly, through inventive business models or improved quality of membranes, Chinese membrane companies are winning replacement projects in the industrial wastewater treatment sector, the traditional realm of international players who offered superior quality products to deal with tough-to-treat wastewater. However, questions around prolonged operational performance remain. Chinese players have also attempted to sell their products abroad, though with significantly varying degrees of fortune. ▶

COMPETITIVE DYNAMIC IN THE CHINESE UF/MF MARKET

Industrial applications for low pressure membrane filtration have become the most competitive market as the quality of Chinese products has improved. Though Evoqua and Suez have also played in the municipal market, it will be increasingly populated by domestic players.



Source: GWI

Technology and player landscape

The current market opportunities for UF/MF membranes in China are well established in four key areas: industrial wastewater reuse, upgrading municipal water and wastewater treatment, point-of-use water filtration, and rural wastewater treatment. A small number of large-scale Chinese membrane specialists including Beijing Origin Water (Origin Water), Litree Purifying Technology (Litree), Tianjin Motimo Membrane Technology (Motimo) and Scinor Membrane Technology (Scinor) rely on good relationships with local governments or state-owned enterprises (SOEs) to dominate the municipal sector through the public-private partnership (PPP) model as project developers. These players, as well as some small- and medium-sized Chinese players, are now increasingly competing on price for industrial contracts that in the past have been dominated by big foreign brands. Retrofitting the used foreign membranes at a lower cost has become a stepping-stone for Chinese players to access the industrial market. While more local products have gained recognition among industrial users, at the same time they are confronted by the challenge of a perceived lack of stability of their membrane products during long-running operations.

Submerged membrane filtration (SMF), pressurised membrane filtration and membrane bioreactors (MBRs) are the three most common applications of UF/MF membranes in the Chinese market. SMF is mostly used in municipal treatment plants for the replacement of the filtration step in the conventional coagulation-precipitation-filtration-disinfection process. Pressurised filtration meanwhile is usually used as a pretreatment step for industrial wastewater reuse to provide acceptable feedwater quality for subsequent RO-based systems. MBR systems are gaining significant uptake in the expansion and renovation projects relat-

TWO DEGREES OF SEPARATION					
The TIPS technique for membrane fabrication offers benefits to NIPS membranes but comes at a higher cost. Some players have reinforced their NIPS products to offer benefits of both worlds.					
Fabrication methods of hollow fiber membrane	Performance				Disadvantage
	Mechanical strength	Anti-fouling property	Chemical resistance	Energy cost	
NIPS	High	Low	Low	Low	Easy to break
TIPS	Low	High	High	High	High cost
NIPS + hybrid tubular braids	Low	High	Low	Low	Peeling problem of the separation layer

Source: GWI

ed to municipal wastewater treatment and reuse, mainly for the purpose of meeting increasingly stringent discharge standards and offering a smaller physical footprint. It is also widely applied for industrial wastewater treatment but is limited by complex influent components like toxic substances or heavy metals that might influence the performance of MBR systems.

Technology progress

Polyvinylidene fluoride (PVDF), which is the most common UF/MF membrane material used by foreign membrane companies, displays a better acid-base resistance property compared to other traditional membrane materials such as polyethersulfone (PES) and polyvinyl chloride (PVC). The use of PVDF has been gathering more momentum in China in recent years, especially for the membranes used in MBR systems to treat challenging wastewater streams.

The two most adopted methods of membrane preparation are non-solvent induced phase separation (NIPS) and thermally induced phase separation (TIPS).

Compared to a NIPS membrane, a TIPS membrane has around 4-6 times higher mechanical strength, well-distributed pore size and better resistance to alkalis (can be used in pH ranges of 1-13 while NIPS membranes can only withstand pH 1-11), but at a higher manufacturing cost and lower anti-fouling property.

Asahi, Scinor and Toray control the intellectual property around TIPS membranes, with Toray having only a small market share. The patent barrier blocks further players from becoming involved in the market and makes TIPS products much less common than NIPS. "Some companies are also selling products labeled as TIPS, but they are not actually real TIPS-made membranes," said Zhao Jie, general manager of Scinor China. Other TIPS manufacturers including Memstar (acquired by United Envirotech in 2014, which was renamed CITIC Envirotech in 2015) and Motimo apply a combined technology of both NIPS and TIPS methods. For example, in Memstar's TIPS product, only the supporting layer of the membrane is made through the TIPS process, while the surface functional layer is still fabricated by the NIPS method. Motimo's investment in developing a reinforced NIPS membrane product has contributed to a net profit loss in 2017. Scinor prices its TIPS product very competitively, significantly undercutting Asahi in the market. "Our product is more expensive than Motimo, but about 20 to 30% cheaper than Asahi," said Zhao.

To reduce the vulnerability of traditional NIPS membranes to higher flux rates, some NIPS manufacturers such as Suez Water Technologies (ZeeWeed 500 series) and Origin Water have added a tubular braid supported layer inside the separation layer as reinforcement. By these means, ►

MATERIAL GAINS				
PVDF's higher mechanical strength and anti-fouling properties versus PES membranes make them more conducive to industrial applications. Ceramics are gaining in popularity but are still restrained by high cost.				
	PVDF	PES	PVC	Ceramic
Mechanical strength	High	Low	Low	High
Anti-fouling property	High	Low	Low	High
High-temperature resistance property	Low	Low	Low	High
Acid-base resistance property	Low	Low	Low	High
Price	Low	High	High	High

Source: GWI

the mechanical strength of the reinforced NIPS composite membrane is significantly enhanced by almost 10 times over, but the system is vulnerable to a potential peeling problem of the surface separation layer.

Hangzhou Creflux Membrane Technology (Creflux) meanwhile has developed a concrete-lined structure of PVDF hollow fibre membrane to combat this issue. "This method is different from the braided membrane preparation in which the casting solution of separation layer is coated outside the hybrid tube and may lead to the peeling at interface," a source familiar with the technology told GWI. "Creflux directly embeds four reinforcement fibres into the casting solution, thin as human hairs, improving the strength without peeling risk as no interface exists." The company introduced two large SOE developers in 2016 as its major shareholders, Beijing Enterprises Water Group (BEWG) and Beijing Capital, and saw its membrane engineering revenue rise by 56% that year. Another hollow fibre technology supplier that has been doing well in recent years is Beijing Hyperon Membrane (Hyperon), which supplies MBR systems. It successfully secured a \$30 million investment from Morgan Stanley in early 2018 to help get a larger piece of the market, as well as

to fuel its overseas expansion plans, where it is eyeing up the American and European markets. Hyperon has also retrofitted numerous installations of Mitsubishi Chemical membranes.

In addition to the progress of polymeric membranes, since 2010 the ceramic membrane market has also experienced significant growth in China, especially for use in treating particularly challenging industrial wastewater streams featuring high levels of turbidity, suspended solids and temperature. "Ceramics are obviously superior to the organic membranes especially in oily wastewater treatment," one industrial insider told GWI. "They enjoy a longer membrane life of more than twice that of the organic ones, but also at an expense about 6 to 10 times higher." Though foreign players have a good share of the market, some Chinese players have achieved strong reference lists. Only a handful of local ceramic membrane specialists have their own R&D capability. Jiangsu Jiuwu Hi-tech (Jiuwu Hi-tech), a Shenzhen-listed membrane engineering company originating from the research team of Nanjing Tech University, controls an estimated 40% of the overall market share in China. Positioned as a system integrator, Jiuwu Hi-tech provides a complete solution to the

“ The requirement of wastewater reuse is driving the growth of the UF/MF and RO/ED membrane market.

Gao Congjie, Chinese Academy of Engineering

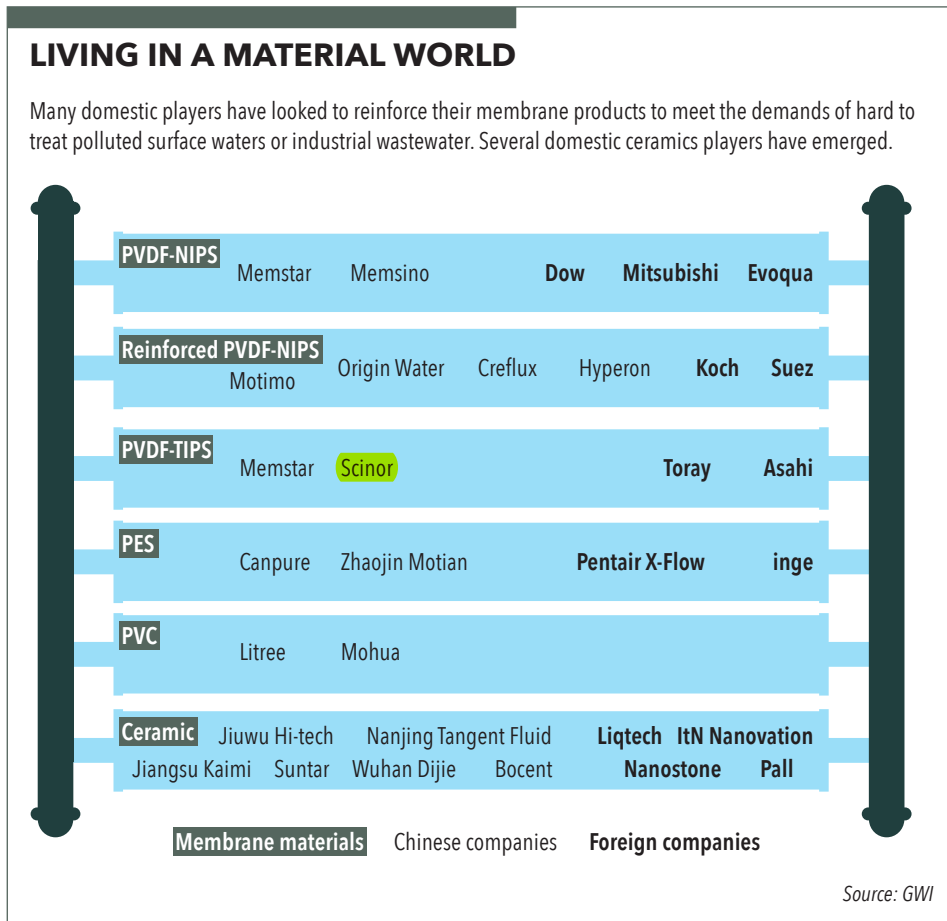
customers including membrane systems and pumps, while in some cases it also purchases polymeric UF membranes from Suez or Dow. "We do not use the ceramics in all of our projects. If the customer hopes to control the total cost, we will also apply the organic membranes as pretreatment for industrial wastewater reuse process," one sales staff from Jiuwu Hi-tech explained to GWI. "The main rivals for us are Pall Corporation, TAMI Industries and some other international ceramic players."

Replacements in the industrial market

Industrial users in China are seeking effective methods for advanced wastewater reuse under the pressure of nationwide constraints on fresh water usage and wastewater disposal. The Chinese government has established a Strictest Water Resources Control System in 2012 to draw a red line on control over the efficiency of water use. The intention is that the volume of water required to generate every extra RMB10,000 (\$1,500) in industrial value will decrease to 40m³ or below by 2030 (the value was 61m³ in 2014) to be close to levels seen in developed economies. On the other hand, since 1 January 2018 the Chinese government has started to implement its Environmental Protection Tax, meaning industrial companies are now incentivised to treat and reuse wastewater rather than confront the risk of discharging to the environment.

The industries of steel, nitrogenous fertiliser, paper-making, pharmaceutical, leather-making, textiles and dyeing are strictly required to reduce discharge to the environment by the end of 2017. Since the implementation of the government's Action Plan for Prevention and Control of Water Pollution ("Water Ten Plan") that came into effect in 2015, 47% of the 251 papermaking companies in China have chosen to install reuse facilities at their sites.

"The requirement of wastewater reuse is driving the growth of the UF/MF and RO/ED membrane market," Gao Congjie, an expert on membrane technology from ▶



the Chinese Academy of Engineering, told GWI. A wastewater reuse facility serving an industrial site in China is usually composed of ultrafiltration, reverse osmosis (RO) and electrodialysis (ED), where ED is applied only when the treated water is reused as high purity process water. “Ultrafiltration pretreatment is a necessary step to be employed in this process,” Gao said.

An increasing number of Chinese membrane companies like Motimo, Memstar, Scinor, Canpure and Zhaojin Motian are stepping into the industrial wastewater treatment sector which has long been dominated by the foreign brands, including Suez Water Technologies (which now includes the assets formerly comprising GE Water), Evoqua (formerly Siemens Water Technologies), Koch Membrane Systems, Asahi, Mitsubishi Chemical and Dow. The latter entered the UF membrane market by acquiring Chinese membrane specialist Zhejiang Omex Environmental Engineering in 2006.

A majority of the previously installed earlier generation membranes have already gone through a cycle of use and are now facing problems with lower mechanical strength (compared to improvements in the competition) and attenuation of their hydrophilic performance. “Asahi has won a lot of small-scale contracts in industrial wastewater treatment since around 2006 as Suez and Evoqua mostly targeted the municipal sector,” one senior membrane engineer told GWI. “However, when its membrane, particularly in the MBR system, has operated for a long time under conditions of a harsh influent quality or poor operational environment, it is easy to get fouled and fractured as the membrane needs to be washed by a high-concentration chemical cleaning method.” Under such circumstances, the opportunity of replacing the exhausted membranes at a lower price offers the local players a great opportunity to get their foot in the door. Foreign products are still, however, often chosen to accelerate a new plant’s approval process.

“Customers are willing to try a more cost-efficient product for replacement,” the senior membrane engineer continued. “For the membrane products fabricated by the same material, the Chinese products usually undercut the foreign ones by

“ The short-term performance of many Chinese membranes is now very close to that of the foreign ones, but there is still some space for enhancement.

Senior membrane engineer

20-30%.” International competitors have also accused Chinese membrane companies of providing product trials either at a substantially discounted price or even for free in the first year to enable themselves to gain more access to the market.

A source from a leading international membrane company told GWI: “The replacement issue is very common in the industrial market. One case in Jiangsu Province for petrochemical wastewater treatment saw our membrane replaced by the product from a local membrane company. The main reason was that they promised the customer a one-year free trial.” The price advantage brings the local membrane specialists more opportunities to prove their significantly optimised products that seem strong on paper, but potentially present a serious test for the membrane stability under a long period of practical operation. “In some cases, the customers got back to us as the operation results of a few Chinese membrane products were not satisfactory,” the source told GWI.

“The short-term performance of many Chinese membranes is now very close to that of the foreign ones, but there is still some space for enhancement,” the senior membrane engineer said. “To be more competitive on the whole lifecycle cost, the manufacturing process needs to be improved for a better membrane consistency and stability through mass production.”

Setting sights on global markets

With advances in the quality of their products, a number of Chinese membrane companies are beginning to seek their way overseas. The One Belt, One Road (OBOR) initiative provides the biggest opportunity. Liu An Bo, vice president of Chinese membrane engineering company Beijing Origin Water explained the company’s business models overseas to GWI, saying: “For PPP projects, we sell our products by cooperat-

ing with large central government-owned enterprises that have extensive project experience in the regions along the OBOR routes. For EPC projects, we do it by ourselves as we are an engineering company and build an international team with local strategic partners.” Origin Water is currently expanding its business in southeast Asia, especially in Malaysia. “We will be the membrane provider for the largest WWTP in Malaysia, located in Kuala Lumpur with a capacity of 170,000m³/d,” said Liu. This is the first MBR WWTP in the Malaysian capital and it is interesting to note that Origin Water was not the lowest bidder for the project.

A small number of Chinese membrane companies are also making efforts to penetrate mature markets in North America and Europe, mainly through pilots with local project developers. However, entry into these markets remains challenging for some Chinese players. Origin Water set up a company in the USA several years ago, enduring slow progress compared to its business in OBOR regions. “It is really hard to do engineering projects there as the market is stably occupied by GE [now Suez],” Liu told GWI. Meanwhile, Motimo and Litree also tried to expand their sales in this market but failed as it is understood their membranes were regarded as too weak after trial projects.

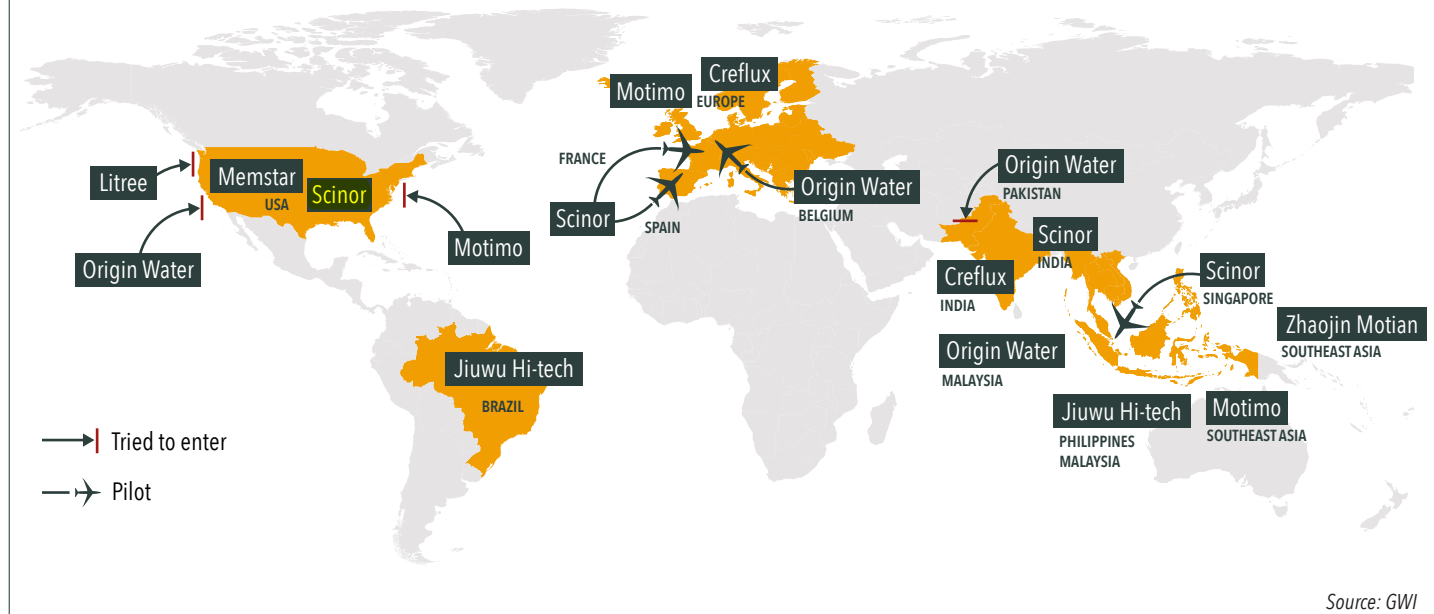
In contrast, Scinor has seen some success in North America, greatly benefitting from its strong local team which consists of numerous previous employees from Pall Corporation. This has given Scinor better sales channels since Pall has an exclusive distribution agreement for Asahi membranes – Scinor’s major competitor as a TIPS specialist – in North America and Europe. Moreover, the ability to directly retrofit also brings Scinor a huge opportunity to open up the American market where a great number of membrane systems installed in the early 2000s are now due to be replaced. “Our strength is the ability to retrofit any of our competitors’ products,” Tom Poschmann, CEO of Scinor Water America told GWI. “If you have a plant where the product is not performing well, we can come in with a better performing membrane and replace it without requir- ▶

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Tom Poschmann, Scinor Water America

FROM CHINA TO THE WORLD

Numerous Chinese players have tried to export their products abroad with the United States a particularly attractive market. However, many domestic companies are looking a bit closer to home in Southeast Asia where lots of water and wastewater infrastructure needs to be built.



ing system changes.”

In 2016 the company won the contract to replace Evoqua’s membranes in the West Basin Water Recycling Phase IV water treatment project in southern California. “After we replaced the membranes and made some adjustment, the water production there was increased by 40%, leading to a revenue growth of \$3.4 million per year,” Zhao told GWI. “Based on this good result, this year we will replace part of Evoqua’s membranes in the 400,000m³/d plant of Orange County’s Groundwater Replenishment System project.” When asked about the long-term target, Zhao told GWI: “We are working on a replacement for the more difficult-to-replace membranes and also developing some special separation membranes for retrofits in MBR applications.” Zhao added that in 2018 it expects the US market to contribute 20% to Scinor’s business, up from 12% in 2017, while business in Southeast Asia is anticipated to grow to 10% and Europe to 5%, up from 5% and 2% in 2017, respectively.

Hitherto Scinor is mainly undertaking membrane replacement in America and working with local OEMs to provide systems. “In the UF side, we do probably 65% in municipal and 35% in industrial. Our revenue last year was \$3 million,” said Poschmann. He also told GWI that from 2019 Scinor hopes to manufacture its membranes for the North American market within the region, and will look to supply hollow

fibre membrane material for companies who want to design their own module.

More opportunities at home

While the more intrepid Chinese membrane companies are making moves abroad, their domestic UF/MF membrane market looks set to boom in the coming years thanks to government initiatives. Increasingly strict standards and technical progress in water quality monitoring are driving the drinking water market to invest in improvements to water quality, creating significant scope for improvement in the treatment process. According to the 13th five-year plan (2016-2020) on National Urban Water Infrastructure Reconstruction and Construction, the upgrade of 65 million m³/d of water treatment systems needs to be completed by 2020. All the data on water quality collected from water sources, treatment plants and taps in the home are required to be exposed to the public in the “Water Ten Plan”.

In addition to this, the Standards for Drinking Water Quality (GB 5749-2006) that came into effect in 2012 have set strict limitations on toxicity indices including disinfection byproducts (DBPs) and algal toxin. Origin Water’s Liu An Bo told GWI that there seemed to be around 20 to 30 newly detected toxic substances in drinking water as the monitoring methods are getting advanced, providing opportunities for membrane technologies.

Tai, Chao and Dian lakes, known as the three major freshwater sources in China, are faced with the threat of drinking water contamination from algae organic matters (AOMs) released by algal blooms. AOMs not only lead to poorer water quality but also increase the production of carcinogenic DBPs during the disinfection process. “Some of the toxic algae substances can only be removed through membrane filtration,” Liu said. “We have done several experiments using our UF and MF membranes to treat this kind of water. The results are encouraging.”

The most active player in the Chinese municipal water sector is Litree, which is widely known for its unique PVC alloy capillary UF membrane and has a total installed membrane base of about 700,000m³/d for municipal water supply. “The PVC alloy capillary membranes have a long membrane life. They can be operated under a relatively low pressure of around 0.05 MPa and are able to reject cryptosporidium and giardia effectively,” a source close to Litree told GWI. The average membrane life for pressurised UF systems ▶

“Rural wastewater treatment is a huge market with fierce competition.”

Liu An Bo, Origin Water

PROSPECTS FOR THE DOMESTIC MEMBRANE MARKET

It looks set to be a strong few years for China's UF/MF membrane market with different dynamics in play for each application. The rural sector will prove to be one of the most interesting given very low existing coverage rates and extreme cost sensitivities.

Sector	Municipal	Industrial	Rural	Point-of-use	
Application	Water supply	Wastewater treatment/reuse	Wastewater treatment/reuse	Wastewater treatment	Residential water purification
Principal technology type	Immersed UF/MF	MBR or pressurised UF/MF	MBR or pressurised UF/MF	Containerised MBR	UF filters
Market drivers	- 13th FYP - Water Ten Plan - Advancement of monitoring tech	- 13th FYP - Water Ten Plan	- Water Ten Plan - Strictest Water Resources Control System	- 13th FYP - Low wastewater treatment coverage	- Poorly maintained water distribution systems - Low penetration of PoU filters
Market opportunity	WTP upgrades	WWTP upgrades and reuse	Reuse and ZLD	Decentralised wastewater treatment	PoU water filtration systems
Market dynamic	Build close relationships with local governments through PPP model		Retrofit foreign membrane products with cost-efficient business models	Build close relationships with local governments through PPP model	Develop a trustworthy brand

Source: GWI

supplied by domestic players in the municipal space is reportedly five years, but it is understood Litree has achieved up to eight. The 300,000m³/d Kaotan Water Treatment Plant in Kaohsiung City, Taiwan, which is one of the world's largest UF membrane water treatment plants, reached ten years of stable operation in 2017 using Litree's PVC UF membranes. "In this project, the pressurised PVC membrane system was installed along with a RO system. Because the influent water quality has seasonal variation, the RO system was only enabled when the influent contained an excessive level of some ionic substances," continued GWI's source.

Litree started the operation of its huge ultrafiltration membrane production base in Haikou City (Hainan Province) in 2016, which is expected to manufacture up to 30 million m² of PVC and PVDF capillary ultrafiltration membranes every year.

MBR key in municipal wastewater treatment

Driven by the strict discharge standards for sewage quality, MBR has been increasingly used in the expansion and upgrading of municipal WWTPs to lower COD and ammonia nitrogen concentration levels. A key application for MBR is water reuse, especially in northern and eastern parts of China which suffer severe water shortages. "To treat the municipal wastewater into reclaimed water is actually another form of WWTP upgradation," a technical engineer at Chinese wastewater reuse specialist GreenTech explained to GWI. "Most of the

reclaimed water is reused for road sweeping or landscaping, but usually not treated to a very high level of water quality considering the great expense. Except for Beijing and other developed regions, governments of smaller cities can barely afford the high cost."

With more privately financed MBR projects emerging, membrane companies that have a strong capability in EPC/BOT enjoy a great advantage as they can install and operate their own membranes in the plants with professional expertise. Origin Water, Motimo and Memstar are the top three players in the municipal wastewater treatment market. "For WWTPs over 100,000m³/d with MBR, Origin Water is the strongest with about 50% of this market, while the next two companies each capture a market share of less than 10%," a source familiar with the market told GWI.

Origin Water used bought-in membranes from Mitsubishi Rayon (MR) (now Mitsubishi Chemical) and Toray in its systems about 10 years ago and achieved dramatic progress in its own membrane manufacturing capability since it established a JV with MR in 2011. It managed to secure a first advanced wastewater treatment and reuse pilot project in Xiong An New Area, Hebei, in March this year by using its integrated MBR systems. "The wastewater treatment fee for this project is RMB2.8 (\$0.44)/m³, much lower than the diversion fee of transferring water from the south of the country to the north, which is around

RMB7 (\$1.11) per cubic metre of water," Liu told GWI.

Motimo also has an advantage in winning projects in the Beijing, Tianjin and Hebei regions through leveraging its strong connection with the Tianjin and Hebei governments. One of its shareholders is the investment arm of the State Asset Regulatory Commission of Hebei province. Similarly, Memstar has installed its membranes in eight WWTPs with a combined capacity in excess of 1.8 million m³/d since it became the subsidiary of CITIC, a central government owned conglomerate.

The opportunity in rural areas

In 2016, the wastewater treatment rate in rural areas of China was only 22%, far below the urban wastewater treatment level of 93%. In the 13th FYP, the Chinese government plans to complete comprehensive wastewater treatment for 130,000 villages and to invest RMB46.23 billion (\$7.32 billion) in agricultural and rural pollution control.

The dispersed distribution of rural residents lends itself to a decentralised approach to wastewater treatment processes, driving the uptake of pre-fabricated, containerised and modular solutions. There is a trend for MBRs to be adopted in this area, but competition is emerging from other technologies such as the membrane aerated biofilm reactor (MABR) supplied by international players such as Fluence Corporation. "The technical threshold of containerised MBR system is not very ▶

high,” a source from water engineering firm Trittech told GWI. “Most of the market participants are not competing on technologies or cost, but more on their business relationship with local governments and state-owned developers.”

A PPP-based financing model is encouraged in the 13th FYP for comprehensive environment treatment projects in rural areas. This works in Origin Water’s favour since it has the China Development Bank (CDB) as its third biggest shareholder and has a design institute and engineering company as its wholly owned subsidiaries, giving it the power to secure PPP projects in-house by taking sole responsibility for financing, design and construction. “Rural wastewater treatment is a huge market with fierce competition,” observed Liu.

Alignment with the trends of the PPP project model is of critical importance. Jiangxi JDL Environmental Protection (JDL), another integrated MBR specialist known for its patented facultative-anaerobic-adapted MBR technology, is now developing an ability to take on PPP projects through cooperation with SOEs. This system eliminates any sludge discharge by recycling it as a carbon source supply to increase the organic loading. “JDL is mainly engaged in rural decentralised wastewater treatment. Its business model has matured over the last two years by developing a close relationship with SOEs to participate in the PPP market,” the GreenTech technical engineer told GWI. After shifting from the role of equipment provider for government procurement to PPP project developer, the company’s revenue reached RMB213 million (\$34 million) with year-on-year growth of nearly 100% according to JDL’s first semi-annual report in 2017.

In order to compensate for the lack of experienced technical operators in rural areas, the containerised MBR systems usually include remote monitoring and control. The Compact Wastewater Treatment System is an integrated containerised MBR system designed by Origin Water specifically for underground wastewater treatment in rural and remote areas. Beside the traditional anoxic and aerobic membrane units, Origin Water also installs a remote control device for intelligent management. “We usually arrange one technical staff for a certain project, who is responsible for managing and operating our devices in several rural WWTPs through apps,” Liu said.

Residential filtration taking off

Ageing and poorly maintained water supply systems that include old pipelines and water tanks can pose a risk to potable water

Terminology

Ceramic membrane: membrane made from inorganic materials such alumina, zirconium oxide or silicon carbide.

Hollow fibre: configuration of a membrane where fibres are bundled together and potted usually at both ends. Most products have fibres with an inside diameter of less than 1mm.

Non-solvent induced phase separation (NIPS): the most common method to develop porous asymmetric membranes whereby a change in stability of a polymer solution is achieved by mass exchange in a non-solvent bath.

Polyethersulfone (PES): a thermoplastic polymer used to manufacture UF/MF membranes making them inherently

hydrophilic and offers tighter pore size distribution than PVDF membranes.

Polyvinylidene fluoride (PVDF): a thermoplastic polymer used to manufacture UF/MF membranes that offer more flexibility than PES membranes and can better deal with a wider variety of feedwaters. Less inherently hydrophilic than PES.

Thermally induced phase separation (TIPS): an alternative, less common method to develop porous asymmetric membranes. Change in stability of a polymer solution is achieved by mixing with a solvent and high temperature, which is reduced to induce phase separation. TIPS membranes offer higher mechanical strength and narrower pore size distribution than NIPS products.

“ Consumers have a huge need for residential water purification. We have prepared for this part of the business for about six years...”

Liu An Bo, Origin Water

quality before it reaches the taps. To further purify the tap water, small residential filtration devices are receiving growing attention, carrying much less cost than the construction of pipelines.

UF, NF (nanofiltration) and RO membranes are all commonly applied in the point-of-use filtration market with RO taking the largest share. The three filters are suitable for water with different chemical composition and physical properties. “UF or ultra-low pressure NF membranes are more appropriate in the south part of China where soft water is in the majority,” Gao explained. “Whereas in the north where the water is hard, filters using NF or RO membranes will last much longer. For some areas of Hunan and the north part of Guangdong, NF membranes are a better fit because the water is heavily contaminated by metals there.”

Litree is the leading player in the point-of-use (PoU) UF market, introducing the technology into the market in 1998. The company was responsible for providing up to 150,000m³ of potable water for 73 million visitors to the Shanghai Expo in 2010 and became the leading PoU UF membrane manufacturer in China. Besides Litree, Origin Water is also attempting

to penetrate the PoU market through its wholly-owned subsidiary Beijing Origin Water Purification Technology. “Consumers have a huge need for residential water purification. We have prepared for this part of the business for about six years, during which we also provided our membranes to some other brands as original equipment manufacturer for online sales,” Liu told GWI.

The revenue of Origin Water’s PoU water treatment business in 2016 was RMB233 million (\$37 million), seven times that of 2012. “This market is focusing more on the product’s filtering effect and business model, which is quite different from the municipal engineering projects where you have to convince both the governors and experts,” Liu said. The DF membrane, a type of low operational pressure NF membrane, is the mainstream technology promoted by Origin Water for filters. “Compared with RO filtration systems our DF membrane has a much higher recovery rate of more than 80%,” said Liu. Potent Environment, the Chinese project developer, is also trying to take a share of the PoU market through the acquisition of Canature Environment, which specialises in residential water purification, in late 2017. ■