China’s investment in WWTP/WSP/WRP (over $8.2m in per plant) in 2014

Numbers of plants
- 1 to 19
- 20 to 49
- 50 to 79
- Over 80

1.

CHINA’S MEMBRANE-BASED WATER TREATMENT INDUSTRY

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Overview

CHINESE MARKET ANALYSIS

Chinese markets for water treatment membranes are currently strong with growth rates exceeding that of the global membrane market and that of the Chinese GDP. Over the past 10 years, the compound growth rate of the membrane industry is estimated at over 20%, and throughout the 13th Five Year Plan (FYP) the industry is aiming to maintain and expand these figures. It is conservatively projected that the total output value in 2020 will be doubled from that of 2016, reaching about USD 30bn. Chinese general membranes’ market scale has comprised of 20% to 30% in the global market, becoming the largest sales market of membrane products in the world.\(^1\)

CHART 1: CHINA’S MEMBRANE GROSS PRODUCTION VALUE AND FORECAST\(^2\)

![Chart 1: China’s Membrane Gross Production Value and Forecast](image)

CHART 2: MARKET SHARE OF MEMBRANES BY TYPE\(^3\)

![Chart 2: Market Share of Membranes by Type](image)

RO membranes prevail in Chinese wastewater treatment making up the largest membrane market share with nearly 45% in total (MF membranes make up approximately 30% of the market and UF/NF holds roughly 20%).

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\(^1\) China Water Risk, *China’s Membrane Rush.*

\(^2\) New material online, *water treatment membrane material market research report.*

\(^3\) Ibid.
Prevalence of foreign companies in Chinese RO market

RO membrane, considered as one of the most effective and energy-saving technology, is currently prevailing in the wastewater treatment market. Nowadays in China, seven main players have occupied the whole market as shown below, with only one local enterprise VONTRON existing on the list.

Foreign opportunity in UF/MF membranes

As to UF/MF membrane, China has not formed monopoly yet and foreign companies have made high priority in the high-end market. The domestic production rate has reached 50%, leaving another 50% for more excellent competitive firms to take part in.

CHART 3a: RO MEMBRANE COMPANY MARKET SHARES

- Dow Chemical
- Nippon Denko Hydranautics
- TORAY
- GE
- KOCH
- CODY
- VONTRON

CHART 3b: UF/MF MEMBRANE COMPANY MARKET SHARES

- Litree (China)
- Tianjin membrane tech (China)
- Zenon/osmonics (USA)
- OMEX (USA)
- Asahi Kasei (Japan)
- Norit (Netherland)
- Hydecanne (USA)
- Zhaojin (China)
- OriginWater (China)
- Memcor USFilter (Germany)
- Other

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4 Zhen Xiang, *China’s membrane industry research report* (China Renmin University Press, June 2013).
5 Ibid.
GLOBAL FIGURES

Globally, sales for membranes and membrane modules reached USD 4.4bn in 1999 and grew to USD 12bn in 2012. With the booming of membrane market in the whole world since 2000s, the total sales volume in 2012 exceeded USD 12 billion and the annual growth rate is around 7% to 8%.

WATER TREATMENT MEMBRANES

Membrane is a type of material which possesses of selective separation function and it works by means of applying driving force on two sides of membrane such as concentration difference, pressure difference or potential difference to have raw material through the membrane in order to separate and extract. In recent years, membrane technology is utilized in the following industry:

- Pressure difference driven membrane: Microfiltration (MF), Ultrafiltration (UF), Nanofiltration (NF), Reverse Osmosis (RO), Gas separation (GS)
- Potential difference driven membrane: Electrodialysis (ED)
- Concentration difference driven membrane: Dialysis (D), Pervaporation (PV), Liquid membrane (LM)

According to China Membrane Industry Association, membrane application in water treatment industry constitutes 85% of total membrane market share, in which MF, UF and RO membranes are widely used. Based on difference of pore size and solute size, the water treatment membrane can be divided into four types: Microfiltration (MF), Ultrafiltration (UF), Nanofiltration (NF), and Reverse Osmosis (RO), with detailed category information below:

### TABLE 1: MEMBRANE FILTER SPECIFICATIONS AND FUNCTIONS

<table>
<thead>
<tr>
<th>Membrane Category</th>
<th>Filtering precision (μm)</th>
<th>Functionality (removals)</th>
<th>Primary applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microfiltration (MF)</td>
<td>0.1-10</td>
<td>Suspended particles, Bacterial, Parts of viruses, Larger size colloids</td>
<td>Turbidity removal from drinking water, Reclaimed water recycling, NF and RO pretreatment</td>
</tr>
<tr>
<td>Ultrafiltration (UF)</td>
<td>0.002-0.1</td>
<td>Colloids, Proteins, Microorganisms, Larger molecular organics</td>
<td>Drinking water purification, Reclaimed water recycling, NF and RO pretreatment</td>
</tr>
<tr>
<td>Nanofiltration (NF)</td>
<td>0.001-0.003</td>
<td>Multivalent ions, Part of monatomic ions, Organic matter with molecular weights between 200 and 1000 Daltons</td>
<td>Well water hardness removal, Color removal, Radioactive radium removal, Soluble salts removal, Process material enrichment</td>
</tr>
</tbody>
</table>

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6 Freedonia: industry studies.
7 Gao Tingyao, etc, Water Pollution Control Engineering. (Beijing, Higher Education Press, 2012).
Reverse osmosis (RO) & 0.0004-0.0006 & • Soluble salts  
• Organic matter with molecular weights over 100 Daltons & • Desalination of seawater  
• Desalination of brackish water  
• Preparation of boiler feedwater  
• Preparation of industrial pure water  
• Wastewater treatment  
• Special separation applications
Regulatory summary

THE 13TH FIVE YEAR PLAN (FYP)

China’s 13th Five Year Plan (FYP) (2016-2020) begins this year and official outlines will be released in March. As the 12th FYP (2011-2015) ends, the chief economic manager of Shanghai Municipal Statistics Bureau and press spokesman points out that there are fifteen targets that have been hit in advance and another fifteen targets that may be achieved; this will comprise of 86% of total 12th FYP targets.

13th FYP suggestions were passed in the Fifth Plenary Session and provide expectations in the following general areas.

Industry upgrading in the 13th FYP suggestion and the water pollution prevention action plan of 2015

In the 13th FYP suggestion, it is required to complete industry projects with improved product technology, process equipment and energy efficiencies across the board.

In the water pollution prevention action plan, there is an increased recognition of the importance of cooperating with foreign technological partners in the area of water treatment process equipment, an important development for the international community. In addition, researching and advancing in high-end techniques are suggested to reinforce industrial technological strengths. Amid the key industries it mentions seawater desalination and industrial wastewater desalination with high salt concentrations as focal points.

Seawater desalination industry in 13th FYP suggestions

China is establishing the strictest feasible water resource management systems and enhancing water resources throughout society. In the suggestion, content promotes the requirement that both social production and urban construction ought to be based on the water condition. Furthermore, pricing water and formulating water saving programs are appropriately contained in the planning.

According to the staff in the Resource Saving and Environment Protection Department of the National Development and Reform Commission (NDRC), China will impel the development of seawater desalination industry in four areas:

- Conducting island seawater desalination utilization projects in order to meet basic living and working needs in island areas.
- Contributing to the development of seawater desalination industry funds.
- Strengthening the supporting force of facilities operations in seawater desalination while lowering costs.
- Establishing and optimizing standard seawater desalination systems as well as fostering leading enterprises to form industrial scale works.

Pharmaceutical industry in the 13th FYP suggestions

In the primary suggestion of 13th FYP framework, three fields are noted as priority: medical informatization, high-performance medical devices and biological medicine. This indicates potential opportunities within these segments of the pharmaceutical industry. Biological medicine is becoming a huge market in China with hundreds of billions of

---

US dollars pouring in to support an aging population and the improvement of health awareness. The numbers of cases of chronic ailments such as cardio-cerebrovascular disease and diabetes have seen a substantial increase in recent years, and it is estimated that by 2020 China will become the second largest biological medicine market in the world following the USA with a market value totally between 94 and 125 billion US dollars.\(^{12}\)

**Food industry in the 13\(^{th}\) FYP suggestions**

The detailed planning of food industry in 13th FYP has reportedly been finalized with key content across five different fields:

- Accelerating the pace of independent innovation.
- Ensuring and improving livelihoods.
- Reforming state-owned enterprises (SOEs).
- Accelerating adjustment of industrial structure.
- Promoting coordinated regional development.

Breakthrough in these five core points will facilitate the innovation of whole industry. For the food and beverage industry, the commercial mode innovation is being enhanced.

For white wine and beer industry, the state-owned enterprises (SOEs) take up the most of market share and the SOEs reforming will release more vitality for this industry. For the mid to low wine and dairy products industry, the merger & acquisition (M&A) actions are on the progress, and some large firms which have occupied huge market share are probably to conduct denotative expansion.\(^ {13}\)

**SEAWATER DESALINATION**

**Suggestion of accelerating development of seawater desalination industry**

- **6 February 2012** – official document issued by the State Council (国务院)
- **Chinese**: 关于加快发展海水淡化产业的意见 (国办发 [2012] 13 号文件)

It was pointed that sweater desalination is a systematic project led by National Development and Reform Commission (NDRC) and the NDRC shall cooperate with relevant departments to establish “coordination mechanism of seawater desalination development” for the purpose of propelling industry development\(^ {14}\).

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Opportunities and challenges

GENERAL WATER AND WASTEWATER TREATMENT MEMBRANE LANDSCAPE

Membrane materials production is regarded as the most high-tech component of the membrane system manufacturing process. As such, this is an area of opportunity of skilled foreign companies looking to operate in China and other technologically developing geographies.

WATER PRETREATMENT AND TREATMENT

Ultrafiltration pretreatment applications

Increased water contamination levels and stricter effluent quality requirements are creating a booming market for foreign water treatment and pretreatment equipment, technologies and services. Ultrafiltration (UF) membrane has been adopted as the most effective means of water pretreatment and has the ability of guaranteeing normal operations of subsequent reserve osmosis systems. KOCH’s UF membrane plays a crucial role in the Chinese market, as does Hyflux, a leading Singapore-based water and liquid treatment firm. Hyflux provided UF membranes for the large Tianjing Dagang seawater desalination plant project, which used the company’s Kristal UF membrane as pretreatment process in 2009.16

Ultrafiltration treatment applications

In addition, UF membrane is applied in industrial water treatment for a long time as the global industrialization get booming development and in industry has various advantages such as low investment cost, high processing efficiency, easy operation and so on. As reported in July 2015 in III Corp opportunities, a local Chinese environmental technology firm called Beijing Lucency Enviro-Tech Co Ltd, is looking for foreign-made ultrafiltration (UF) membranes for the fine chemicals production wastewater treatment and reuse (WWTR) project. And the fine chemicals production project needs a total investment of USD 3.25bn (CNY 19.82bn), according to Yitai’s previous company press releases.17

15 New material online, water treatment membrane material market research report.
MEMBRANE SYSTEMS FOR DOWNSTREAM OIL

Ultrafiltration for refinery wastewater treatment

PetroChina Lanzhou Petrochemical Company (中国石油天然气股份有限公司兰州石化分公司) is acquiring ultrafiltration (UF) membranes for its Gansu province refinery. The facility, which is ultimately owned by China National Petroleum Corporation (CNPC), requires 384 membrane sets for the establishing of a deep water treatment system for generated wastewater. The procurement budget has been set at USD 0.4m. III Corp reported on this procurement opportunity at the start of December 2015.

MEMBRANE SYSTEMS FOR DOWNSTREAM COAL

RO membranes for coal-to-liquids wastewater treatment

China Shenhua Coal to Liquid and Chemical Co Ltd, a subsidiary of Shenhua Group Corporation Ltd, has sourced reverse osmosis membranes from two foreign companies: Toray Industries, Inc. and Hydranautics, a brand now owned by Nitto Denko Corporation. III Corp reported on this activity in a December 2015 publication. Previously, III Corp has reported on RO membrane procurements for medium-sized coal-to-chemical projects with costs in the area of USD 1.1m.

SEAWATER DESALINATION

Among Chinese existing seawater desalination methods, RO-based systems serve 74% of facilities, distillation desalination (thermal process) constitutes 25% and other methods represent 1%. Overlooking the global seawater desalination market, general membrane-based technologies account for nearly 65% and thermal process makes up around 30%.

According to Jin Yan, Director of Membrane Industry Association of China (MIAC), RO-based solutions tend to yield higher desalination rates and higher water yields, thus lowering the cost of seawater desalination while improving the quality of desalted water. This is an important development for an industry that has been marred by insurmountable high costs.

Foreign opportunities from Chinese industry challenges

Challenges within the Chinese markets yield opportunities for foreign companies with viable solutions. As noted by Song Xianzhu, the vice-president of Qinghai Salt Lake Industry Group Company, there are major challenges facing China’s membrane industry, however, opportunities follow.

- Chinese companies struggle to obtain high-end membrane materials, membrane products and membrane production equipment. Chinese membrane manufacturers rely heavily on foreign-made products in these areas. As such, foreign companies can find opportunities supplying core technologies and components to foreign system providers, in addition to opportunities for full foreign systems.

> Regarding small to medium sized enterprises and smaller scale projects opting for domestic systems: Opportunities for component supply to domestic system providers vastly increases the
potential deal flow for foreign companies. Knowledge of smaller-size projects occurring throughout China is essential. Many of these opportunities are not as widely publicized as larger-scale projects, which often opt for foreign systems. To maximize your deal flow, aim to be aware of all types of supply opportunities.

- **Imported products:**
  - Raw materials – 50% to 70% of polysulfone, polyvinylidene fluoride, polyethersulfone, PVC (food grade) and other membrane production materials.
  - Membrane products – most of RO membranes, NF membranes, gas separation membranes, blood dialysis membranes and special separation membranes.
  - Membrane production equipment - not only production capacity but technological precision are lower than foreign-made products, resulting in frequent imports of large domestic membrane production line equipment.

The seawater desalination area is of huge space as China’s water resource problem and wastewater issues are becoming rigorous and China is lack of advanced technology in membrane at present. Since the 1980s, China has been importing production lines and several well-known international companies have penetrated into this large market.

In recent years, Dow Chemical has reinforced the investment, in which the Huzhou RO membrane production line came into use in 2013. A total investment of USD 45 m was put into Liyang City in Jiangsu Province by the global RO membrane supplier NanoH2O, to construct an integrated RO membrane production plant with an area of 10,000 square meters which was operated in 2014 and paved the way for NanoH2O to exploit China’s seawater desalination market and wastewater treatment market.

**PHARMACEUTICAL INDUSTRY**

Reverse osmosis membranes, the most advanced widely applied membrane technology in wastewater treatment, has been used extensively in treating pharmaceutical industrial wastewater in China since the 1990s. This membrane technology can extend regeneration periods of traditional ion exchange equipment and reduce emission of acid and base, thus strongly protecting ecological environment. With technology standard of Good Manufacturing Practices (GMP) deeply implemented, a variety of pharmaceutical plants in China consecutively are proceeding to upgrade their technology and import leading equipment and services from other countries.

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FOOD INDUSTRY

TABLE 2: MAJOR FOREIGN AND DOMESTIC PLAYERS

<table>
<thead>
<tr>
<th>Category</th>
<th>Major foreign players</th>
<th>Major domestic players</th>
</tr>
</thead>
<tbody>
<tr>
<td>UF/MF</td>
<td>Veolia (France)</td>
<td>Tianjin membrane tech (Tianjing)</td>
</tr>
<tr>
<td></td>
<td>US Filter (USA)</td>
<td>Litree (Hainan)</td>
</tr>
<tr>
<td></td>
<td>Memcor (Germany)</td>
<td>Euro Film (Dalian)</td>
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<tr>
<td></td>
<td>Zenon (Canada)</td>
<td>Zahaoyuan Motian (Shandong)</td>
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<tr>
<td></td>
<td>Norit (Netherlands)</td>
<td>OMEXELL (Shandong)</td>
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<tr>
<td></td>
<td>Mitsubishi Rayon (Japan)</td>
<td>Hangzhou Water Treatment Center (Zhejiang)</td>
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<tr>
<td></td>
<td>KUBOTA (Japan)</td>
<td></td>
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<tr>
<td></td>
<td>Pall Corp (USA)</td>
<td>Originwater (Beijing)</td>
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<tr>
<td></td>
<td>Hydecanme (USA)</td>
<td>Huzhou Dow (Zhejiang)</td>
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<tr>
<td></td>
<td>KOCH (USA)</td>
<td></td>
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<tr>
<td></td>
<td>Asahi Kasei (Japan)</td>
<td></td>
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<tr>
<td></td>
<td>Hyflux (Singapore)</td>
<td></td>
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<tr>
<td>NF</td>
<td>Trisep (USA)</td>
<td>VONTRON (Beijing)</td>
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<tr>
<td></td>
<td>Hydecanme (USA)</td>
<td>Suntar (Fujian)</td>
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<tr>
<td></td>
<td>Dow Chemical (USA)</td>
<td>Jinsai (Jilin)</td>
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<td></td>
<td>GE (USA)</td>
<td>Tianchuang (Zhejiang)</td>
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<td></td>
<td>KOCH (USA)</td>
<td>Hangzhou Water Treatment Center (Zhejiang)</td>
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<td>RO</td>
<td>Hydecanme (USA)</td>
<td>VONTRON (Beijing)</td>
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<td></td>
<td>Dow Chemical (USA)</td>
<td>TBMC (Beijing)</td>
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<td></td>
<td>TORAY (Japan)</td>
<td>Bedouxing (Zhejiang)</td>
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<tr>
<td></td>
<td>GE (USA)</td>
<td>North Membrane (Liaoning)</td>
</tr>
<tr>
<td></td>
<td>KOCH (USA)</td>
<td></td>
</tr>
</tbody>
</table>

Fruit and vegetable production
In this area, membrane technology is adopted in two major fields:

◊ MF and UF membrane used in classification and filtration

◊ NF and RO membrane used in concentration

Dairy industry
RO and UF membranes are mainly used in whey protein recycling and milk concentration. At present, this is the standard technology to recycle whey protein.

Wine production
UF membranes applied in wine production are able to remove yeast, bacteria and colloid in wine and alcoholic beverages. This has benefits of improving wine’s clarification property and conservation, as well as generating ripening flavor and shortened aging time.

Bean products
Protein separating and recycling serve as two primary membrane technology application in bean products industry. UF membranes have capacity of removing low molecular compounds which create beans muttany odor and affect stability of soybean milk whilst condensing protein in order to improve the quality of soybean milk.
About ICORP

Inside Industrial Infrastructure Inc. (ICORP) was founded by Charlie Welsh, who has over two decades experience in the global M&A, capital markets and business news and intelligence fields. ICORP’s commercial headquarters were established in New York in July 2014, after two years of existence as part of The Mergermarket Group, which Charlie co-founded. Its Shanghai-based subsidiary was registered in October 2014, closely followed by a Mumbai-based subsidiary in March 2015. Latin American and broader Southeast Asian coverage is currently being expanded thereby providing companies and financiers with the only truly global emerging infrastructure intelligence product.

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