Toray’s Engagement in Environmental Issues

Toray Industries, Inc.
Executive Vice President & Representative Director
Hiroaki Kobayashi
Managing Director
Akihiro Nikkaku
◆ Summary
Executive Vice President & Representative Director
Hiroaki Kobayashi

◆ Outline and Strategies of Water Treatment Businesses
Managing Director Akihiro Nikkaku
**Toray’s Approach in Environmental Issues**

**Global Warming Control-conscious Businesses**

**Greenhouse Gases Reduction Measures**
1. Natural Gas Cogeneration Facilities
2. Conversion of Boiler Fuel

**Toray Group**

\[
\text{Eco-efficiency Index} = \frac{\text{Net Sales}}{\text{Greenhouse Gases Emissions}}
\]

**Net Sales**

**Greenhouse Gases Emissions**

- **Forecast**
  - 90: 252
  - 01: 248
  - 02: 244
  - 03: 240
  - 04: 286
  - 05: 310
  - 08: 400

- **Estimation**
  - 03: 283
  - 04: 246
  - 05: 240
  - 08: 230

**Target**

- **Forecast**
  - 01: 266
  - 02: 267
  - 03: 246
  - 04: 240

- **Target**
  - 08: 310

- **FY**
  - 01: 200
  - 02: 220
  - 03: 240
  - 04: 260
  - 05: 280
  - 08: 300

- **FY**
  - 90: 252
  - 01: 248
  - 02: 244
  - 03: 240
  - 04: 286
  - 05: 310
  - 08: 400

- **FY**
  - 90: 255
  - 01: 266
  - 02: 267
  - 03: 283
  - 04: 246
  - 05: 240
  - 08: 230

**Notes:**
- Toray reduced its greenhouse gases emissions by 6% over 1990 result (ahead of Kyoto Protocol goals) during 2005 and will reduce 10% before 2008.
- As a group, Toray will further promote reduction of greenhouse gases emissions.
- The Group will control eco-efficiency index and expand businesses while reducing environmental burdens.
Reducing Chemical Substances Emissions

Reduction measures in atmospheric emissions of chemical substances:
Installation of organic gas adsorption and recovery system

<table>
<thead>
<tr>
<th>Year</th>
<th>Toray</th>
<th>Affiliates</th>
<th>Forecast</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3,290</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>2,660</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>2,550</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>2,250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>1,970</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>1,740</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>1,480</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* PRTR (Pollutant Release and Transfer Register) : system for chemical substances dealing companies of reporting the volume of chemical emissions as well as the volume transferred as waste

We are steadily reducing chemical substances emissions and will set up further targets and tackle to achieve new goals.
Measures to prevent air pollution:
1. Conversion of fuel to natural gas
2. Efficiency improvement of desulfurization systems

We are steadily reducing emissions of air pollutants and will further work on such measures as conversion of fuels and efficiency improvement of desulfurization systems and others.
Toray has disclosed environmental accounting data in accordance with the Ministry of the Environment’s guidelines since 1999 which includes environment preservation cost, energy conservation cost, and recycling and other costs.

We will further invest in necessary environmental preservation matters which leads to steady environmental improvement.
Environmentally-friendly and Recycled Products

Environmentally-friendly Products: Products which reduce environmental burden at any part of its total lifecycle

- CO$_2$ gas reduction
- Energy reduction
- Water purification
- Air purification
- Hazardous materials reduction

Less Energy

Clean

Recycled Products: Products whose raw materials are made from used products or manufacturing process wastes

Pre-processing → Raw Materials → Manufacturing → Products → Use → Used Products → Disposal

Recycling
“Ecodream” is Toray’s overall brand to describe our advanced activities in resource saving and global environment conservation for the goal of developing a sustainable recycling-oriented society.

**Clean & Less Energy**

- "Ecodream" Prevention of global warming, contribution to environment preservation
  - Expansion of environmentally-friendly products
  - Promotion of recycling activities
  - Promotion of CSR activities

- "Ecodream" plan: Double the sales of environmentally-friendly products within five years
- Establish exclusive department for environment and recycling as well as company-wide committee to conduct environment-related activities (Global Environment Committee, Recycling Committee)
Sales of environmentally-friendly products are estimated to be ¥153.0 billion, 11% of total Group sales in FY Mar/2006.
## Products and Technologies by Expected Effects

<table>
<thead>
<tr>
<th>Expected Effects</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO₂ Gas Reduction</strong></td>
<td>PLA (Polylactic Acid) fibers, plastics, films 3GT fibers &amp; textiles</td>
</tr>
<tr>
<td></td>
<td>Bamboo composite fibers  Cellulose fibers  Soybean protein-fibers</td>
</tr>
<tr>
<td></td>
<td>Flexible and heat resistant films</td>
</tr>
<tr>
<td><strong>Energy Reduction</strong></td>
<td>Torayca* for transport machineries  Engineering plastics</td>
</tr>
<tr>
<td></td>
<td>Components for turbine generators  Components for fuel cells</td>
</tr>
<tr>
<td></td>
<td>Films for solar cells  Capacitor films for hybrid cars</td>
</tr>
<tr>
<td><strong>Water Purification</strong></td>
<td>RO (reverse osmosis) membranes  UF-MF membranes</td>
</tr>
<tr>
<td>(Water treatment)</td>
<td>Immersed membranes for MBR  Water treatment system businesses</td>
</tr>
<tr>
<td></td>
<td>Torayvino*</td>
</tr>
<tr>
<td><strong>Air Purification</strong></td>
<td>Heat resistant bag filters (PPS, PTEF fibers)  Air filters</td>
</tr>
<tr>
<td><strong>Hazardous Materials Reduction</strong></td>
<td>Non-halogen fire-retardant (fibers &amp; textiles, plastics, films)</td>
</tr>
<tr>
<td></td>
<td>Waterless CTP plate  Non-halogen circuit materials</td>
</tr>
<tr>
<td></td>
<td>Heavy metal-free color filters</td>
</tr>
<tr>
<td><strong>Recycling</strong></td>
<td>PET  Nylon 6  PBT  ABS  PPS  CFRP  Toraysurou*  DMSO</td>
</tr>
</tbody>
</table>
Energy Reduction through Weight Reduction of Automobiles

Future Trends

- Expand application section of engineering plastics
- Properly adopt CFRP into automobile applications

<table>
<thead>
<tr>
<th>Used amount by car</th>
<th>Conventional Cars</th>
<th>Next Generation Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Plastics</td>
<td>30 kg</td>
<td>Engineering Plastics 60 kg CFRP 300 kg</td>
</tr>
<tr>
<td>Vehicle weight (when conventional car is 100)</td>
<td>100</td>
<td>64</td>
</tr>
</tbody>
</table>

Present Situation

Application section of engineering plastics is expanding conducive to energy reduction through weight reduction.

Expand application section of engineering plastics and CFRP for the benefit of energy reduction (green house gas reduction).
Energy Reduction through Weight Reduction of Aircrafts

Future Trends
- Increase CFRP as structural materials
- Select CFRP as primary structural material in large quantity

Next Generation Aircrafts
- Tare can be reduced by 20% when usage of CFRP is extended up to 50%
- Fuel consumption can be reduced by 20% when efficiency derived from advanced engine is included

Usage of CFRP for aircraft application is increasing significantly

B787 (Next generation medium-sized aircraft)
## Environmentally-friendly Products

**Toray Products Contributing to Energy Reduction**

<table>
<thead>
<tr>
<th>Wind Turbine Generators</th>
<th>Fuel Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Wind Turbine" /></td>
<td><img src="image" alt="Fuel Cells Diagram" /></td>
</tr>
<tr>
<td>Carbon fiber composite materials for Windmill blades</td>
<td>Electrolyte membrane</td>
</tr>
<tr>
<td>Back Sheet Films</td>
<td>Hydrogen oxygen</td>
</tr>
<tr>
<td>Solar Cells</td>
<td>Hybrid Cars</td>
</tr>
<tr>
<td><img src="image" alt="Solar Cells" /></td>
<td><img src="image" alt="Hybrid Cars" /></td>
</tr>
<tr>
<td>Electrolyte membrane</td>
<td>Battery</td>
</tr>
<tr>
<td>C/C paper for electrode</td>
<td>Capacitor</td>
</tr>
<tr>
<td>PP film for high-capacity capacitors</td>
<td>Motor</td>
</tr>
</tbody>
</table>

We are expanding a variety of products in wide business areas which contributes to energy reduction
Toray is developing non-petrochemical raw materials making full use of biotechnology.

- **Fossil raw material**
  - refining / synthesis
  - polymerization
  - various materials (nylon, polyester, acrylics, polyurethane, others)
  - plastics, films, fibers & textiles

- **Plant-based raw materials**
  - biotechnology
  - polymerization
  - lactic acid → Polylactic acid
  - 1,3-propanediol (+TPA) → Polylactic acid
  - flexible, heat-resistant films

- **Photosynthesis**
  - plant oil
  - water, carbon dioxide

**Example of PLA plastics products**
“100% plant-based raw materials” made from corn or sweet potato

“Biodegradable materials” which gradually degrade into carbon dioxide and water after landfill or disposal

“Carbon neutral” which prevents CO₂ increase, the cause of global warming, even after incineration

Developing fibers & textiles and plastics products under and overall polylactic acid brand
Environment Surrounding Polylactic Acid

Nonpetroleum-based polylactic acid which does not lean on precious resources, leads to 40~60% of resource saving compared to that of conventional plastics.

<table>
<thead>
<tr>
<th>Material</th>
<th>Required Quantity of Petroleum to Make One Tatami Equivalent Carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polylactic Acid</td>
<td>2.6LTR</td>
</tr>
<tr>
<td>Nylon</td>
<td>6.4LTR</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>4.0LTR</td>
</tr>
<tr>
<td>Polyester</td>
<td>4.0LTR</td>
</tr>
</tbody>
</table>

* Oil equivalent conversion of required energy amount to produce BCF yarn for one tatami (about 1.7m²) equivalent carpet

Price trend images of PLA plastics (Estimation of North American Market)

- PLA: declining
- Conventional plastics (average of PET and polystyrene)

The crude oil prices soared from $30/bbl to about $60/bbl during this period.

- Plant-based raw materials are expected to expand drastically through growing recognition of global environment issues
- Undisturbed by soaring oil prices, polylactic acid will constantly continue to reduce costs

Toray estimation based on evaluation documents of MAFF [March/06]
Toray Technologies

**Fundamental Technologies and Example of Product**

- **High-strengthening Technology**
  - Nucleus formulation
  - Stereo complex

- **Nano-alloy Technology**
  - Alloy (PMMA, POM)
  - Compatibility formulation

- **Softening Technology**
  - Elastomer formulation

- **Hydrolysis Control Technology**
  - Terminus closure chain extension

- **Flame Retarding Technology**
  - Non-halogen fire retardancy formulation

**Fibers & Textiles**
- Apparel
- Automobile materials
- Industrial material
- Interior

**Plastics**
- Office automation equipment/home appliances/automobiles/miscellaneous goods, others
- Personal computers
- DVD

**Films**
- Industrial applications/packaging materials, others
  - Plain type
  - Flexible type
  - Blister pack
  - Molding

- Develop various applications utilizing Toray’s unique fundamental technologies
- Promote expansion of PLA businesses as company-wide project through establishment of exclusive in-house conference
**Environmentally-friendly Products in the IT Areas**

<table>
<thead>
<tr>
<th>Flame-retardant plastics components</th>
<th>Copper clad laminated polyimide film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printer fuser cover</td>
<td>Halogen free</td>
</tr>
<tr>
<td>Electrical / electronic connectors</td>
<td>Halogen free</td>
</tr>
<tr>
<td>No harmful heavy metal (Cr)</td>
<td>No harmful wastewater</td>
</tr>
</tbody>
</table>

Toray will enlarge its growing IT-related business area while giving consideration to the environment effects through development and provision of eco-friendly materials.
### Promotion of Recycling

**Basic Policies and Present States of Recycling**

**Basic Policies**: - Positively expand and promote recycling activities  
- “Less energy recycling” is the bases where appropriate recycling technologies are applied according to the materials

<table>
<thead>
<tr>
<th>Recycling Method</th>
<th>Fibers &amp; Textiles</th>
<th>Plastics</th>
<th>Composite Materials, others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material Recycling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(reuse without decomposing polymers)</td>
<td>Nylon 6</td>
<td>ABS</td>
<td>Carbon Fibers</td>
</tr>
<tr>
<td></td>
<td>PET</td>
<td>Nylon</td>
<td>CFRP</td>
</tr>
<tr>
<td></td>
<td>Acrylics</td>
<td>PBT</td>
<td>DMSO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PET</td>
<td>Toraysurou*</td>
</tr>
<tr>
<td><strong>Chemical Recycling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(system to chemically decompose into raw materials for reuse)</td>
<td>Nylon 6</td>
<td>PET</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PET</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thermal Recycling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(incineration heat recovery)</td>
<td>PET</td>
<td></td>
<td>CFRP</td>
</tr>
</tbody>
</table>
Recycling of Polyester Fibers

Promotion of Recycling

Recycling type

Material Recycling

- PET bottles
- various process wastes

Depolymerization

BHT

Polymerization

Pellets

Yarn making

Fibers (SF, FY) / non-woven fabrics

Chemical Recycling

(BHT method)

Collection and recycling type

Material Recycling

- collected fibers

Depolymerization

Raw BHT

Refining

Refined BHT

Polymerization

Pellets

Sub-material

Yarn making

Fibers (FY)

Recycled volume: material 8,300 tons, chemical 6,100 tons; Total 14,400 tons (05 forecast)

Top recycling volume in Japan by utilizing diversified recycling technologies
Recycling of Nylon 6 Fibers

Promote recycling positively by utilizing unique chemical recycling technologies.
Promote recycling activities to achieve the target of 50 billion yen in net sales of recycled products businesses in FY 2010.
Expand environmentally-friendly products businesses to double or more the FY 2005 results in FY 2010 where net sales target is 340.0 billion yen and operating income to be 56.0 billion yen.
* Summary
  Executive Vice President & Representative Director
  Hiroaki Kobayashi

* Outline and Strategies of
  Water Treatment Business
  Managing Director
  Akihiro Nikkaku
1. Overview and Policies of Toray’s Water Treatment Business
2. Water Problems and Water Related Markets in the World
3. Membrane Technologies and Toray’s Membrane Products
4. Large Water Treatment Projects in the World
5. Outline and Strategies of Toray’s Water Treatment Business
6. Organization and Policies of Research and Development for Water Treatment Technologies in Toray
7. Summary
1. Overview and Policies of Toray’s Water Treatment Business

**Position of Water Treatment Business in Toray Group**

**<Core Technologies>**
- Organic Synthetic Chemistry
- Polymer Chemistry
- Biochemistry

**<Advanced Materials>**
- Nanofibers
- High-performance Fibers
- Nano-alloy Materials
- Advanced Electronics Materials
- Biomaterials
- Separation Materials
- High-performance Composite Materials
- Recycling Materials

**<Three Growth Areas>**
- IT-related Products
- Life Sciences
- Environment, Safety and Amenity

- **Environment related Businesses**
  - Water Treatment Business
  - Non petroleum-origin materials
  - Environment Recycle businesses, etc

**Cultivate Water Treatment Business as a core of Environment related Businesses**
1. Overview and Policies of Toray’s Water Treatment Business

Organization of Toray’s Water Treatment Business

- **President**
  - **Business Div.**
    - Water Treatment Div.
      - RO Membrane Products Dept.
      - MF&UF Membrane Products Dept.
      - Water Treatment System Dept.
      - Water Treatment Planning Dept.
    - Amenity Div.
      - Torayvino Sales & Marketing Dept.
      - Torayvino Production Dept.
  - **Mfg. Div.**
    - Mfg.
    - Mfg. Tech.
  - **R&D Div.**
    - Technology Center
    - Water Treatment Laboratories
    - New Frontiers Research Laboratories
    - Global Environment Research Laboratories
    - Functional Materials and Products Development Center
  - **Subsidiaries**
    - Toray Membrane America, Inc.
      - (TMA, Toray 51%)
    - Toray Membrane Europe AG
      - (TMEu, Toray 90%)
    - Suido Kiko Kaisha, Ltd.
    - Toray Fibers & Textiles Research Laboratories (China)
  - **Engineering Div.**
    - Engineering Development Center
    - Water Treatment Research Labs.
## History of Toray Water Treatment Business

### Fiscal Year ~1980
- **RO/NF membranes**: 1968 Started research on RO membrane
  - 1980 Started marketing ROMEMBRA* for ultra pure water plants
  - 1996 Installed in a large brackish water desalination plant
  - 2001 Installed in a large seawater desalination plant

### Fiscal Year 1981~1990
- **Hollow Fiber UF/MF membranes**: 1990 Started research on UF membrane
  - 2000 Started research on MF membrane
  - 2002 Started trial marketing MF membrane

### Fiscal Year 1991~2000
- **MBR**: 1996 Started research on MBR membrane
  - 2003 Started trial marketing

### Fiscal Year 2001~
- **Water treatment systems**: 1975 TEK started water treatment business (84- Business with Rural Sewage and human waste treatment facilities)
  - 1994 Started seawater desalination technology development project
  - 2004 Transferred domestic businesses to Suido Kiko

### Torayvino*
- 1986 Started marketing Torayvino*

### Subsidiaries
- 2000 TMA established
  - 2003 Took control of Ropur (TMEu)
  - 2004 Took control of Suido Kiko
  - 2004 Established water treatment Research Labs
### Types of Membranes and Toray’s Products

<table>
<thead>
<tr>
<th>Size</th>
<th>0.001 µm</th>
<th>0.01 µm</th>
<th>0.1 µm</th>
<th>1 µm</th>
<th>10 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation</td>
<td>Ion, Low molecule weight organics</td>
<td>High molecular weight polymer</td>
<td>Colloid</td>
<td>Clay</td>
<td></td>
</tr>
<tr>
<td>materials</td>
<td>Trihalomethane</td>
<td>Agricultural &amp; Organic Material</td>
<td>Virus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monovalent Ions</td>
<td>Multivalent Ions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types</td>
<td>RO (Reverse Osmosis)</td>
<td>NF (Nanofiltration)</td>
<td>UF (Ultrafiltration)</td>
<td>MF (Microfiltration)</td>
<td></td>
</tr>
<tr>
<td>Toray’s membrane products</td>
<td><img src="image" alt="RO/NF membrane" /></td>
<td><img src="image" alt="PAN Hollow Fiber UF membrane" /></td>
<td><img src="image" alt="PVDF Hollow Fiber MF membrane" /></td>
<td><img src="image" alt="Immersed membrane for MBR" /></td>
<td><img src="image" alt="PS Hollow Fiber MF membrane Home Water Purifiers Torayvino*" /></td>
</tr>
</tbody>
</table>

1. **Overview and Policies of Toray’s Water Treatment Business**
1. Overview and Policies of Toray’s Water Treatment Business

Policies of Toray’s Water Treatment Business

- Expand and Strengthen global sales system utilizing superior membrane technologies and variety of products
  - Global operations in Japan, US, Europe and China
- Strengthen profit structure by arrangement of production systems and increasing production capacity
  - Membrane production in Japan; Element and Module production in suitable places
- Expand Sales of home water purifiers Torayvino*
- Utilize Suido Kiko and enlarge water treatment systems business
- M&A
Global Operations of Toray’s Water Treatment Business

1. Overview and Policies of Toray’s Water Treatment Business

Established global sales & marketing team
Develop membrane business in worldwide market
Strengthen global operations
1. Overview and Policies of Toray’s Water Treatment Business

Business Plan of Toray’s Water Treatment Business

<table>
<thead>
<tr>
<th>Year</th>
<th>Membranes</th>
<th>Systems Business</th>
<th>Affiliates, etc.</th>
<th>Total Sales (Billion ¥)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>35.0</td>
<td>1.5</td>
<td>0.2</td>
<td>37.7</td>
</tr>
<tr>
<td>2007</td>
<td>42.0</td>
<td>2.7</td>
<td>0.5</td>
<td>45.2</td>
</tr>
<tr>
<td>2010</td>
<td>67.0</td>
<td>4.2</td>
<td>1.0</td>
<td>72.2</td>
</tr>
<tr>
<td>2015</td>
<td>Over 100.0</td>
<td>6.0</td>
<td>1.5</td>
<td>Over 100.0</td>
</tr>
</tbody>
</table>

Target - Over 100 Billion Yen in 2015
World Water Shortage - Now and Future

- World population is 6.5 billion
  - 1.1 billion people do not have good drinking water (including water for daily life)
  - 2.4 billion people do not have sanitary accommodations (wastewater and human waste treatment)

Water shortage presumed regions in 2025

Sources: WHO and others 1996

Water shortage:
- ≥ 40%
- 20~40%
- 10~20%
- ≤ 10%

Water Shortage: 
(1 - Water supply / water demand) × 100

World water and sewerage business size will increase by 40 trillion yen over 20 years
Difficult to secure quantity and quality of water only by natural purification due to the rapid increase of population.

Membrane technology, which enable precise control of water quality and high speed treatment, is essential in 21st century.
### Water Treatment Business Market and Target Areas for Toray Group

#### Main companies Toray- G Business Area

<table>
<thead>
<tr>
<th>Water service (water /sewerage)</th>
<th>Management (possession of property)</th>
<th>Operation (operation &amp; maintenance)</th>
<th>Engineering Procurement &amp; Construction (EPC)</th>
<th>Equipment / Materials supply</th>
<th>Market size (2025)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>Public</td>
<td>Public</td>
<td>Veoria G Suez G Thames G</td>
<td>MHI Hitachi Zosen</td>
<td>100 trillion yen</td>
</tr>
<tr>
<td>Japan</td>
<td>Public</td>
<td>Public</td>
<td>Suez G Thames G</td>
<td>Kurita Organo</td>
<td>10 trillion yen</td>
</tr>
<tr>
<td>Present</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 trillion yen</td>
</tr>
<tr>
<td>Target</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toray- G Business Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By utilizing membrane business, develop business in equipment facilities, chemicals, engineering and operation & maintenance areas.
Why Membrane Processing Method is Required?

Membrane process makes possible water treatment which are suitable for any targets and regional conditions and to secure safe water with low environment load.

**Conventional Process (Ex. Rapid filtration)**
- coagulant
- precipitation
- sand filtration
- coagulation

**Membrane Process**
- Membrane filtration
- Chlorine

<table>
<thead>
<tr>
<th>Problems</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>difficult to manage the operation on the feed water quality Ex)Cryptosporidium (protozoa)</td>
<td>Possible to secure good water despite the fluctuation of quality of water</td>
</tr>
<tr>
<td>cumbersome operation and maintenance insufficient technicians</td>
<td>Possible to operate automatically</td>
</tr>
<tr>
<td>difficult to secure land</td>
<td>Small-footprint</td>
</tr>
</tbody>
</table>

◆ Remove pathogenic microorganisms very well  
(high quality and safe processed water)  
◆ Compact facilities and fast processing (suitable for decentralize processes)

Membrane process makes possible water treatment which are suitable for any targets and regional conditions and to secure safe water with low environment load.
Practical Use Fields of Membranes

World wide insufficient water and water pollution

Secure sustainable water sources

1. Purification of river water and groundwater
2. Seawater desalination
3. Wastewater reuse

1. Rivers/lakes/groundwater
2. Sea water / brine water
3. Sewage water / wastewater

Hollow Fiber MF membrane
RO (Reverse Osmosis) membrane
Immersed membrane for MBR

Processed water is utilized for drinkable, industrial and agricultural use
3. Membrane Technologies and Toray’s Membrane Products

Water Production Costs by Membrane Processing

<table>
<thead>
<tr>
<th>Water Production Method</th>
<th>Water production costs (yen/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purification of river water and ground water (MF membrane)</td>
<td>20~30</td>
</tr>
<tr>
<td>Sewage water reuse (MF+RO membrane)</td>
<td>20~40</td>
</tr>
<tr>
<td>Seawater desalination (RO membrane)</td>
<td>60~80</td>
</tr>
<tr>
<td>(Ref.) Seawater desalination (Thermal Distillation)</td>
<td>90~140</td>
</tr>
</tbody>
</table>

(Reference) World consumer prices of water

<table>
<thead>
<tr>
<th>Type of Water</th>
<th>Supply price (yen/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap water (*)</td>
<td>10~700</td>
</tr>
<tr>
<td>Industrial water (*)</td>
<td>10~70</td>
</tr>
<tr>
<td>Ultra pure water</td>
<td>500~1000</td>
</tr>
<tr>
<td>Bottled water</td>
<td>20,000~300,000</td>
</tr>
</tbody>
</table>

*The consumer prices of tap water and industrial water reflect delivery costs and service costs besides production costs. However, the prices are decided with policy and are not necessarily calculated with actual costs.

Development of membrane technologies and process technologies decreased water production cost of membrane process (especially seawater desalination), and became competitive.
### Membrane Manufacturers in the World

#### Overseas

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>RO</th>
<th>NF</th>
<th>UF</th>
<th>MF</th>
<th>MBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOW / Filmtec (US)</td>
<td>✪</td>
<td>✪</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koch (US)</td>
<td>✪</td>
<td>△</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zenon (Canada)</td>
<td>✪</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Filter (US)</td>
<td></td>
<td>✪</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norit (Netherlands)</td>
<td></td>
<td>✪</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Japanese

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>RO</th>
<th>NF</th>
<th>UF</th>
<th>MF</th>
<th>MBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toray</td>
<td>✪</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitto Denko / Hydranautics (US)</td>
<td>✪</td>
<td>✪</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toyobo</td>
<td></td>
<td>✪</td>
<td>△</td>
<td>△</td>
<td></td>
</tr>
<tr>
<td>Daicel Chemical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asahi Chemical / Pall (US)</td>
<td></td>
<td></td>
<td></td>
<td>✪</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi Rayon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kubota</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✪</td>
</tr>
</tbody>
</table>

- ✪: High share product
- ✪: Product in the market
- △: Under development

 Investigated by Toray
### Toray’s Membrane Products

<table>
<thead>
<tr>
<th>Types</th>
<th>RO/NF membrane</th>
<th>UF/MF membrane</th>
<th>Immersed membrane for MBR</th>
<th>Torayvino*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance of product</td>
<td><img src="image1.png" alt="Image of RO/NF membrane" /></td>
<td><img src="image2.png" alt="Image of UF/MF membrane" /></td>
<td><img src="image3.png" alt="Image of Immersed membrane for MBR" /></td>
<td><img src="image4.png" alt="Image of Torayvino*" /></td>
</tr>
<tr>
<td>Removable material</td>
<td>Ion, Dissolved organic matter</td>
<td>Suspended solid, Bacteria, Virus</td>
<td>Activated sludge</td>
<td>Wastes, rust Residual chlorine, Lead</td>
</tr>
<tr>
<td>Application</td>
<td>Seawater desalination, Brackish water desalination Wastewater reuse, Ultra pure water production</td>
<td>Drinking water production, Treatment of wastewater, Pre-treatment for RO membrane, Industrial process water production</td>
<td>Treatment and reuse of wastewater</td>
<td>Home water purifier</td>
</tr>
</tbody>
</table>
3. Membrane Technologies and Toray’s Membrane Products

RO (Reverse Osmosis) Membrane

Feed Water

Separation membrane
Crosslinked aromatic polyamide
200 nm

Surface structure of RO membrane

Polysulfone support membrane
45 µm

Polyester non-woven fabric
150 µm

Structure of RO membrane

Structure of RO membrane element

Feed Water

Permeate

Center tube

Brine seal

Feed water spacer

Brine water

Feed water

Permeate spacer

RO membrane

Feed water
3. Membrane Technologies and Toray’s Membrane Products

Hollow Fiber MF (Microfiltration) Membrane

Water purification plant by membrane treatment

Feed water → Membrane permeate water

PVDF Hollow Fiber MF membrane

Hollow Fiber membrane module

Discharged water → Feed water

Container

216mm

2,300mm

300 µm
Immersed Membrane for MBR

Conventional activated sludge method

Activated sludge tank  Sedimentation tank

Wastewater  Discharge

MBR (Membrane Bioreactor, membrane separation activated sludge method)

Activated sludge tank  RO membrane  Immersed membrane module for MBR

Wastewater  reuse

Features of MBR
(1) Good quality of permeate water  (2) small footprint  (3) Wastewater reuse by combination with RO

Sterilization

Industry
Agriculture
Indirect Drinking Water
Home Water Purifiers, Torayvino*

- Removes the micro level dirt, bacteria, and red rust mixed in drinking water through MF Hollow Fiber membrane
- Removes chlorine and mold odor through simultaneous use of granular activated carbon

Directly tap-connected water purifier

Inside cartridge (observation window)

PS Hollow Fiber MF membrane

Surface structure of membrane
## Large scale Seawater Desalination RO Plants in the World

<table>
<thead>
<tr>
<th></th>
<th>Country</th>
<th>Plant Site</th>
<th>Capacity (m³/d)</th>
<th>Operation</th>
<th>RO membrane manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Israel</td>
<td>Ashkelon</td>
<td>272,520</td>
<td>2005</td>
<td>Dow</td>
</tr>
<tr>
<td>2</td>
<td>UAE</td>
<td>Taweelah</td>
<td>227,300</td>
<td>(2009)</td>
<td>(to be determined)</td>
</tr>
<tr>
<td>3</td>
<td>Saudi Arabia</td>
<td>Rabeeg</td>
<td>205,000</td>
<td>(2008)</td>
<td>Toyobo</td>
</tr>
<tr>
<td>4</td>
<td>Algeria</td>
<td>Hamma</td>
<td>200,000</td>
<td>(2006)</td>
<td>Toray (informally appointed)</td>
</tr>
<tr>
<td>5</td>
<td>California, USA</td>
<td>Huntington Beach</td>
<td>190,000</td>
<td>(2006)</td>
<td>Hydra</td>
</tr>
<tr>
<td>6</td>
<td>UAE</td>
<td>Fujairah</td>
<td>170,000</td>
<td>2003</td>
<td>Hydra</td>
</tr>
<tr>
<td>7</td>
<td>Trinidad and Tobago</td>
<td>Point Lisas</td>
<td>136,000</td>
<td>2002</td>
<td>Toray</td>
</tr>
<tr>
<td>8</td>
<td>Singapore</td>
<td>Tuas</td>
<td>136,000</td>
<td>2005</td>
<td>Toray</td>
</tr>
<tr>
<td>9</td>
<td>Australia</td>
<td>Perth</td>
<td>130,000</td>
<td>(2006)</td>
<td>Dow</td>
</tr>
<tr>
<td>10</td>
<td>Saudi Arabia</td>
<td>Yanbu</td>
<td>128,000</td>
<td>1998</td>
<td>Toyobo</td>
</tr>
<tr>
<td>11</td>
<td>Spain</td>
<td>Carponeras</td>
<td>120,000</td>
<td>2001</td>
<td>Hydra</td>
</tr>
<tr>
<td>12</td>
<td>Saudi Arabia</td>
<td>Jeddah</td>
<td>113,600</td>
<td>1994</td>
<td>Toyobo</td>
</tr>
<tr>
<td>13</td>
<td>Florida, USA</td>
<td>Tampa Bay</td>
<td>95,000</td>
<td>(2006)</td>
<td>(to be determined)</td>
</tr>
<tr>
<td>14</td>
<td>Israel</td>
<td>Palmachim</td>
<td>92,250</td>
<td>(2006)</td>
<td>Toray</td>
</tr>
<tr>
<td>15</td>
<td>Saudi Arabia</td>
<td>Al Jubail</td>
<td>91,000</td>
<td>2000</td>
<td>DuPont** / Toray (25%)</td>
</tr>
</tbody>
</table>

*10,000m³/d of water is equivalent to daily life water of 40,000 people [Investigated by Toray]

** DuPont withdrew from RO business in 2001
Largest Seawater Desalination Plant in the Asia-Pacific Region - Tuas, Singapore

Using Toray’s high boron rejection RO membranes
Production capacity is 136,000 m³/day

Photo credit: Hyflux (Singapore)
### 4. World Large Water Treatment Projects

#### Large Scale Membrane Treated Wastewater Reuse Plants in the World

<table>
<thead>
<tr>
<th>Country</th>
<th>Plant Site</th>
<th>Capacity (m³/d)</th>
<th>Operation</th>
<th>UF/MF membrane Manufacturer</th>
<th>RO membrane manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Kuwait</td>
<td>Sulaibiya</td>
<td>320,000</td>
<td>2005</td>
<td>Norit</td>
<td>Toray</td>
</tr>
<tr>
<td>2 USA</td>
<td>Fountain Valley</td>
<td>220,000</td>
<td>2007</td>
<td>US Filter</td>
<td>Hydra</td>
</tr>
<tr>
<td>3 Singapore</td>
<td>Ulu Pandan</td>
<td>140,000</td>
<td>(2006)</td>
<td>Asahi Kasei</td>
<td>Hydra</td>
</tr>
<tr>
<td>4 USA</td>
<td>West Basin</td>
<td>75,000</td>
<td>1997~2001</td>
<td>US Filter</td>
<td>Hydra</td>
</tr>
<tr>
<td>5 Singapore</td>
<td>Kranji</td>
<td>40,000</td>
<td>2003</td>
<td>US Filter</td>
<td>Hydra</td>
</tr>
<tr>
<td>5 China</td>
<td>Tianjin</td>
<td>40,000</td>
<td>(2006)</td>
<td>US Filter</td>
<td>Dow, Toray</td>
</tr>
<tr>
<td>7 Singapore</td>
<td>Bedok</td>
<td>32,000</td>
<td>2003</td>
<td>Zenon</td>
<td>Hydra</td>
</tr>
<tr>
<td>8 Singapore</td>
<td>Seletar</td>
<td>24,000</td>
<td>2004</td>
<td>Hyflux</td>
<td>Toray</td>
</tr>
<tr>
<td>9 USA</td>
<td>Scottsdale</td>
<td>22,700</td>
<td>1998</td>
<td>US Filter</td>
<td>Koch</td>
</tr>
<tr>
<td>10 Australia</td>
<td>Luggage Point</td>
<td>14,000</td>
<td>2000</td>
<td>Pall</td>
<td>Dow</td>
</tr>
</tbody>
</table>

[Investigated by Toray]
World’s Largest Wastewater Reuse Plant
Sulaibiya, Kuwait

Using Toray’s low-fouling RO (reverse osmosis) membranes
Production capacity is 320,000 m³/day

Photo credit: GE-Ionics (USA)
Asia and Middle East are predicted to expand by regional factors while seawater / brackish water desalination and wastewater reuses are expected to expand by application.
Business Strategies of RO Membranes

- Expand business utilizing high performance membrane
  - Seawater desalination application (high boron rejection membrane)
  - Wastewater reuse (low-fouling membrane)
- Strengthen marketing competitiveness
  - Develop global marketing system
  - Strengthen engagement with major engineering-related companies
- Enlarge marketing area
  - Arrange bases in USA, Europe, and Middle East
  - Increase personnel and business agents in China
- Strengthen cost competitiveness
- Develop and commercialize new products
5. Outline and Strategies of Toray’s Water Treatment Business

Water Treatment Plants in the World using Toray RO Membrane

- **KAE Curacao**
  - **Country**: Netherlands, Antilles
  - **Capacity**: 11,400 m³/day (1998)

- **Mas Palomas**
  - **Country**: Spain, Canary Island
  - **Capacity**: 13,500 m³/day (1985)

- **Daesan/Hyundai**
  - **Country**: Korea
  - **Capacity**: 84,000 m³/day (1997)

- **Point Lisas**
  - **Country**: Trinidad and Tobago
  - **Capacity**: 136,000 m³/day (2002)

- **Tuas**
  - **Country**: Singapore
  - **Capacity**: 136,000 m³/day (2005)

- **Sulaibiya**
  - **Country**: Kuwait
  - **Capacity**: 320,000 m³/day (2005)

- **Okinawa ***
  - **Country**: Japan
  - **Capacity**: 40,000 m³/day (1997)

- **Al Jubail ***
  - **Country**: Saudi Arabia
  - **Capacity**: 91,000 m³/day (2000)

- **Point Lisas**
  - **Country**: Trinidad and Tobago
  - **Capacity**: 136,000 m³/day (2002)

- **Cumulative installation**: about 6,400,000 m³/day (as of seawater desalination over 1,000,000 m³/day)

  - *About 10% of world’s seawater desalination RO
  - *Equivalent to water for daily use of 4,000,000 people

*Joint delivery with other companies [Toray research]
Hollow Fiber UF / MF Membranes Market

Market by region

Market by application (2005)

Drastic expansion mainly in USA and Europe
(annual growth rate : about 15%)
Drinking water application accounts for about 70%

[Billion ¥]

25.0
20.0
15.0
10.0
5.0
0

2005 2010

Japan
Asia
Europe / Middle East
North America

[Estimated by Toray]
### Superiority of Toray’s Hollow Fiber MF Membrane

**5. Outline and Strategies of Toray’s Water Treatment Business**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Toray</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
<td>PP</td>
<td>PVDF</td>
<td>PES</td>
<td>PVDF</td>
<td>PVDF</td>
</tr>
<tr>
<td><em><em>Permeability</em> (m³/m²/day)</em>*</td>
<td>4.8</td>
<td>1.5</td>
<td>3.0</td>
<td>5.3</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Membrane area (m²)</strong></td>
<td>30</td>
<td>56</td>
<td>35</td>
<td>50</td>
<td>72</td>
</tr>
<tr>
<td><strong>Test results at overseas water purification plant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery (%)</td>
<td>-</td>
<td>90</td>
<td>-</td>
<td>90</td>
<td>95</td>
</tr>
<tr>
<td>Electric power consumption rate (kWh/m³)</td>
<td>-</td>
<td>0.38</td>
<td>-</td>
<td>0.31</td>
<td>0.15</td>
</tr>
<tr>
<td>Frequency of chemical cleaning</td>
<td>-</td>
<td>once in 3 months</td>
<td>-</td>
<td>once in 2 months</td>
<td>once in 6 months or more</td>
</tr>
</tbody>
</table>

*Test condition: pure water, 50kPa*

[Estimated by Toray]

World leading in permeability, stain resistance, durability, and in module size Evaluated at overseas water purification plants in terms of high recovery rate, low electric power consumption, and long-term stable operation
5. Outline and Strategies of Toray’s Water Treatment Business

Business Strategies of Hollow Fiber UF / MF Membranes

- Expand sales by utilizing high performance membranes
- Enlarge marketing area
  - North America, Middle East, China
  - Wastewater reuse, industrial water, large size seawater pretreatment
- Sales expansion in Japan and East Asia
  - Cooperation with Suido Kiko and Japanese engineering companies
  - Involvement in East Asia development project of drinking water treatment technologies
- Increase production capacity
- Commercialization of new product
5. Outline and Strategies of Toray Group’s Water Treatment Business

**Major Water Treatment Plants using Toray MF Hollow Fiber Membrane**

<table>
<thead>
<tr>
<th>Plant Site</th>
<th>Application</th>
<th>Capacity (m³/day)</th>
<th>Operation Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio (USA)</td>
<td>for boiler water RO pretreatment</td>
<td>3,300 (2004)</td>
<td></td>
</tr>
<tr>
<td>Ishikawa</td>
<td>drinking water</td>
<td>5,000 (2002)</td>
<td></td>
</tr>
<tr>
<td>Ishikawa</td>
<td>drinking water</td>
<td>8,000 (2003)</td>
<td></td>
</tr>
<tr>
<td>Ohio (USA)</td>
<td>for boiler water RO pretreatment</td>
<td>3,200 (2004)</td>
<td></td>
</tr>
<tr>
<td>Ehime</td>
<td>for seawater desalination RO pretreatment</td>
<td>2,700 (2003)</td>
<td></td>
</tr>
<tr>
<td>Hyogo</td>
<td>drinking water</td>
<td>8,000 (2005)</td>
<td></td>
</tr>
<tr>
<td>Hokkaido</td>
<td>drinking water</td>
<td>3,500 (2003)</td>
<td></td>
</tr>
</tbody>
</table>

[Investigated by Toray]
MBR is highly evaluated for its good water quality, small footprint, and ability to reduce excess sludge.

The market is yet undeveloped.

Market of Immersed Membrane for MBR

- **Europe, Middle East, North America**: 60%
- **Japan**: 9%
- **Asia**: 8%

**Market size**

- 2005: (Billion ¥) 8.0
- 2010: (Billion ¥) 16.0

**Market by region (2005)**

- Europe, Middle East, North America accounts for about 80%

**Annual growth by about 15%**

[Estimated by Toray]
### Superiority of Toray's Immersed Membrane for MBR (1) Comparison in Spec.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>Toray</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Membrane type</strong></td>
<td>Hollow Fiber membrane</td>
<td>Flat sheet membrane</td>
<td>Flat sheet membrane</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>PVDF</td>
<td>PVC</td>
<td>PVDF</td>
</tr>
<tr>
<td><strong>Pore size(µm)</strong></td>
<td>0.04</td>
<td>0.4</td>
<td>0.08</td>
</tr>
<tr>
<td><em><em>Permeability</em> (m³/m²/day)</em>*</td>
<td>0.45</td>
<td>0.6</td>
<td>0.75</td>
</tr>
<tr>
<td><strong>Flux per-module footprint (m³/day/m²)</strong></td>
<td>170</td>
<td>103</td>
<td>233</td>
</tr>
<tr>
<td><strong>External cleaning</strong></td>
<td>necessary</td>
<td>unnecessary</td>
<td>unnecessary</td>
</tr>
</tbody>
</table>

*actual operation

[Estimated by Toray]

**Toray MBR is high-durability, high-permeability and less clogging.**
Test results at Beverwijk (Netherlands) sewage-treatment plant (2003)

Permeability*
(L/m²/time)

Toray MBR offers twice the permeability proven by direct comparison to others.

*actual operation
• Expand sales by utilizing high performance immersed membrane elements

• Win orders of large wastewater treatment projects (size over 10,000 m³/day)

• Strengthen marketability in Europe, USA, and the Middle East

• Increase production capability
5. Outline and Strategies of Toray’s Water Treatment Business

Market of Home Water Purifiers (in Japan)

- Market size
  - The market is expanding

  - Desktop type: 5%
  - Built-in type: 15%
  - Stationary type: 34%
  - Direct tap-connected type: 46%

- Market by market channel (2003)
  - Mass retailers: 43%
  - Mail-order/home-call sales: 21%
  - Other retails: 11%
  - Others: 25%

Product types and market channels are becoming diversified

[Estimated by Toray]
• **Increase share in the retailer market which is the revenue base**
  – Expand sales for general supermarkets, DIY stores, home appliance retailers, and camera retailers
  – Strengthen product lineups other than current mainstay item, the direct tap-connected type

• **Sales expansion to market channels other than retailers**
  – Marketing of high-performance products
  – Strengthen sales to department stores, specialty shops, mail-order sales, and home-call sales

• **Advance to overseas market**
  – Develop products equipped with performance and features matching the different water quality conditions of each country
  – Develop global market centering USA and China to include South East Asia and Europe
Focus on seawater desalination and wastewater reuse where the market is expanding and Toray has advantage. Focus on the Middle East, China, and South East Asia.
5. Outline and Strategies of Toray’s Water Treatment Business

**Low Cost Seawater Desalination Process**

- **Conventional seawater desalination process** (recovery: 40%)
  - Installation cost: 46
  - Electric expenses: 36
  - Membrane replacement cost: 5
  - Others: 13

- **Low cost process** (recovery: 60%)
  - Installation cost: 37
  - Electric expenses: 30
  - Membrane replacement cost: 6
  - Others: 11

**Cost reduction**: 16

Achieved 16% of cost reduction

1) Development of unique high-recovery process
2) Development of highly pressure-resistance RO membrane

[Investigated by Toray]
Business Strategies of Water Treatment Systems

5. Outline and Strategies of Toray’s Water Treatment Business

- Receive orders of large scale seawater desalination systems in overseas market
  - Strengthen ability to respond to large EPC matters
  - Collaboration with Suido Kiko

- Develop business in China
  - Utilize local affiliated companies; establish partnership with local engineering companies

- Strengthen technological competitiveness
  - Strengthen Integrated Membrane System (IMS) technologies
  - Strengthen competitiveness in seawater desalination, wastewater reuse market

- Full-scale entry into operation and maintenance business
Merits in IMS and Advantages of Toray’s Water Treatment Systems Business

◆ IMS (Integrated Membrane System)
membrane-based water treatment system by combining membranes with dissimilar functions

<Example>
Waste water

MEMBRANE

MF membrane

RO membrane

reuse

◆ Merits in IMS :
Removes various substances in the water through suitable membranes.
Total system works efficiently enhancing reliability and cost reduction.

◆ Key points of IMS technologies
Integration of membrane selection (hardware) and operating technologies (software)
Brings out Toray’s strength who possess all types of membrane and experience in operating technologies of each membrane
6. Organization and Policies of Research and Development

Research & Development System of Toray’s Water Treatment Business

Subsidiaries

- Toray Membrane America, Inc. (TMA, Toray 51%)
- Toray Membrane Europe AG (TMEu, Toray 90%)
- Suido Kiko Kaisha, Ltd.

Water Treatment Div.
- RO Membrane Products Dept.
- MF&UF Membrane Products Dept.
- Water Treatment System Dept.
- Water Treatment Planning Dept.

Amenity Div.
- Torayvino Sales & Marketing Dept.

Business Div.

Mfg. Div.
- Membrane Production Dept.
- Membrane Technical Dept.

R&D Div.
- Speciality Materials Research Laboratories
- New Frontiers Research Laboratories
- Global Environment Research Laboratories

Technology Center

3 bases structure for research and development

Suido Kiko Kaisha, Ltd.

Toray Fibers & Textiles Research Laboratories (China)
- Water Treatment Research Labs.
6. Organization and Policies of Research and Development

TFRC Water Treatment R&D Laboratories

Toray Fibers & Textiles Research Laboratories (China) Co., Ltd (TFRC)

- Fibers & Textiles Research Center (Nantong)
- Polymer Materials Research Laboratories (Shanghai)
- Water Treatment Research Laboratories (Shanghai)

Operation of Water Treatment Research Laboratories
- Funded research from Toray water treatment-related departments (R&D, assistance for technology marketing)
- Collaboration and joint research study with Chinese universities and government research laboratories
- Develop appropriate water treatment systems for China
- Aim to be global base for water treatment research and development, assistance for technology marketing

General Manager, Dr. Yang Yufang
Currently 10 researchers, planned to increase to 20 during FY March/2007
6. Organization and Policies of Research and Development

R&D Themes of Water Treatment Business

**Membrane Technologies**
- High-performance RO membranes
- New NF membranes
- Low-fouling UF/MF membranes

**Process Technologies**
- High-yield seawater desalination system (MF + RO membrane)
- Membrane Treatment system for drinking water production
- Wastewater reuse system (MBR + RO membrane)

**Microbiological Technologies**
- Prevention of bio-fouling
- New biocide
- MBR sludge control

**Organic Synthetic Chemistry**
- Biochemistry
- Polymer Chemistry
- Nanotechnology
- Chemical Engineering
- Sanitary and Environmental Engineering

TFRC Water Treatment R&D Laboratories

Global Environment Research Laboratories

Water Treatment Technology Development Center
Expansion of Toray’s water Treatment Business

• Appeal the high performance membrane products to the global market
  – Focus on seawater desalination system and wastewater treatment
  – Aim for No.1 in membrane business by 2010
• Expand sales of home water purifiers
  – Strengthen product lineups and develop new market
• Expand water treatment systems business
  – Integrate membranes and process technologies
  – Strengthen IMS technologies
7. Summary

Expansion of Toray’s Water Treatment Business

Expand water treatment business to become the pillar of environment-related business

Net Sales (Billion ¥)

<table>
<thead>
<tr>
<th>Year</th>
<th>Membranes Business</th>
<th>Systems Business</th>
<th>Affiliates, etc.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>35.0</td>
<td></td>
<td></td>
<td>35.0</td>
</tr>
<tr>
<td>2007</td>
<td>42.0</td>
<td></td>
<td></td>
<td>42.0</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td>67.0</td>
<td></td>
<td>67.0</td>
</tr>
<tr>
<td>2015</td>
<td>Over 100.0</td>
<td></td>
<td></td>
<td>Over 100.0</td>
</tr>
</tbody>
</table>

Expand water treatment business to become the pillar of environment-related business
Toray’s membrane utilizing water treatment technologies will contribute to secure sustainable water resources and environment protection.
Descriptions of predicted business results, projections, and business plans contained in this material are based on predictive forecasts of the future business environment made at the present time.
The material in this presentation is not a guarantee of the Company’s future business performance.