
Role of Membrane Process in Developing Clean Technology

Chung-Hak Lee and Jong-Sang Park

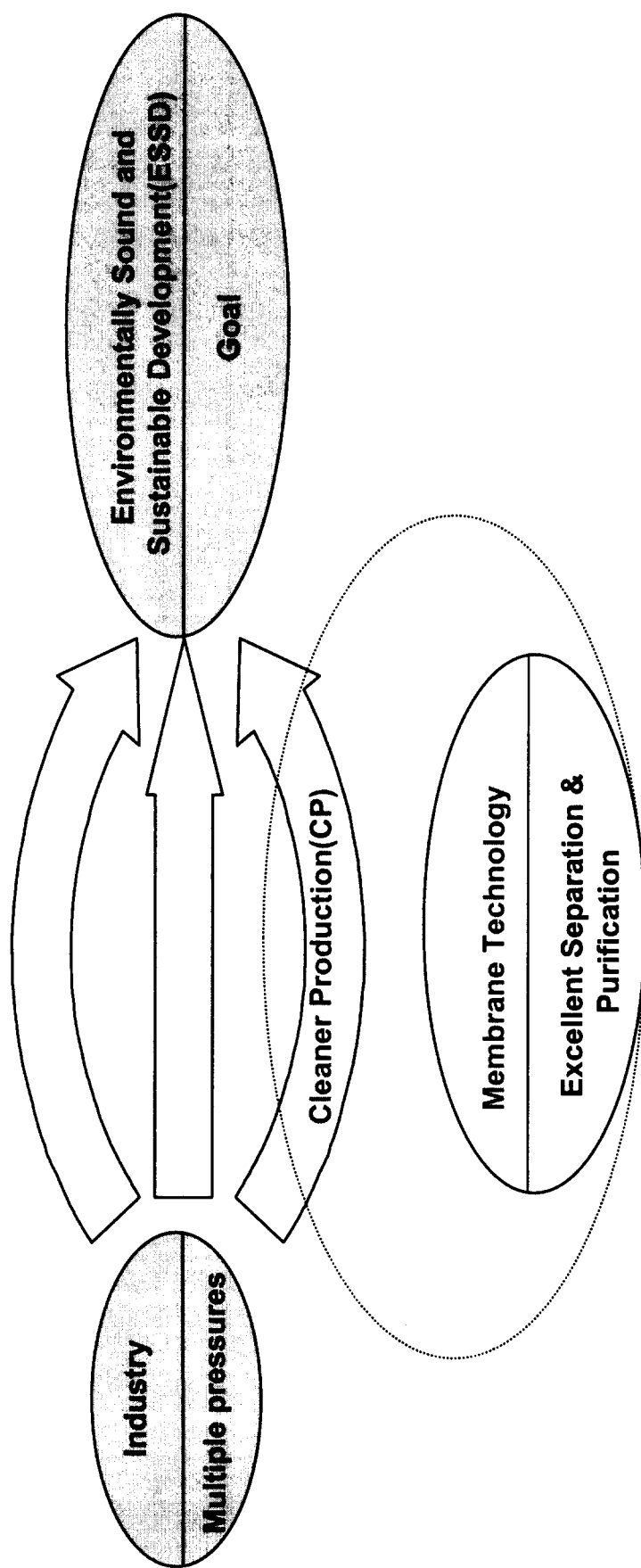
(서울대학교 응용화학부)

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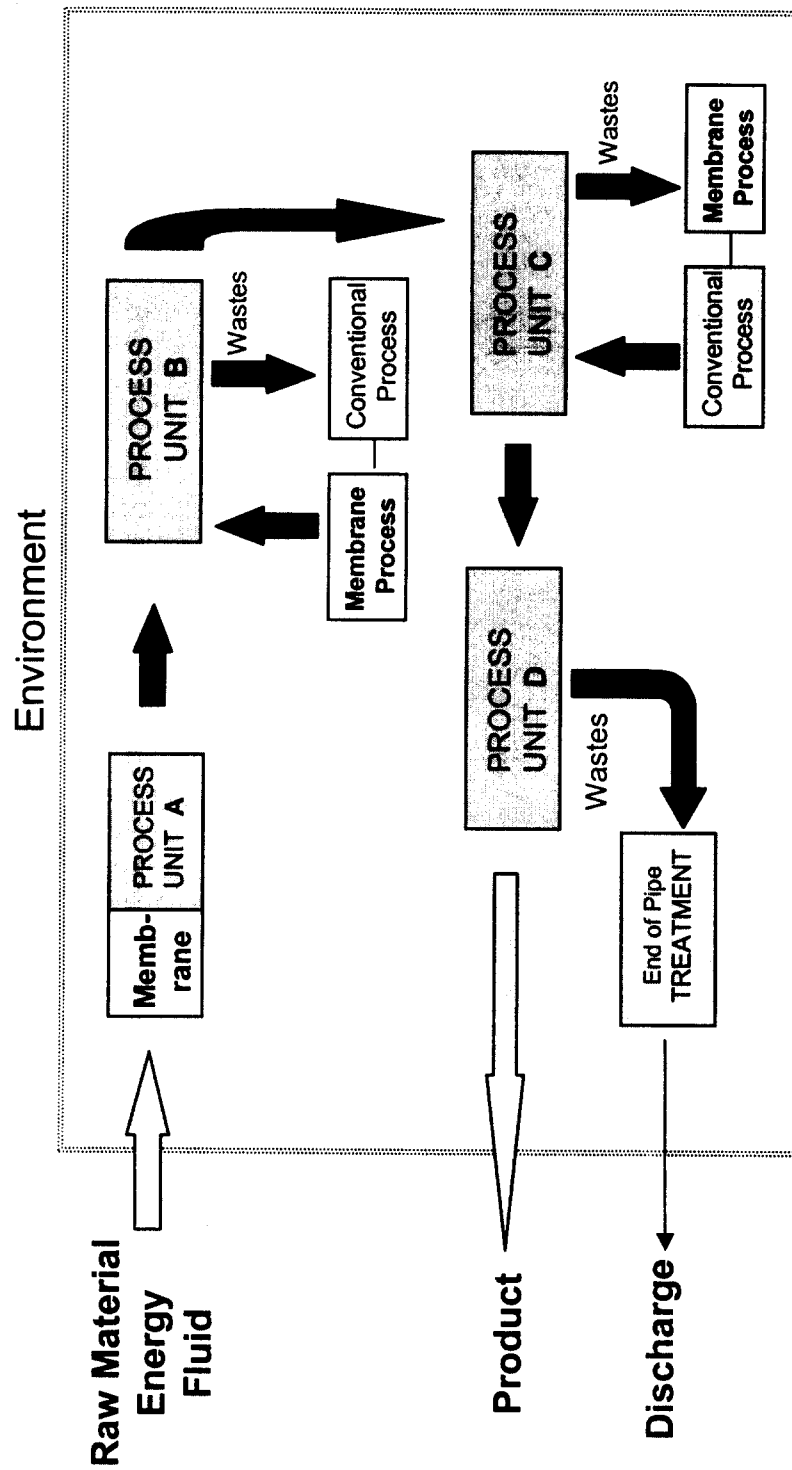
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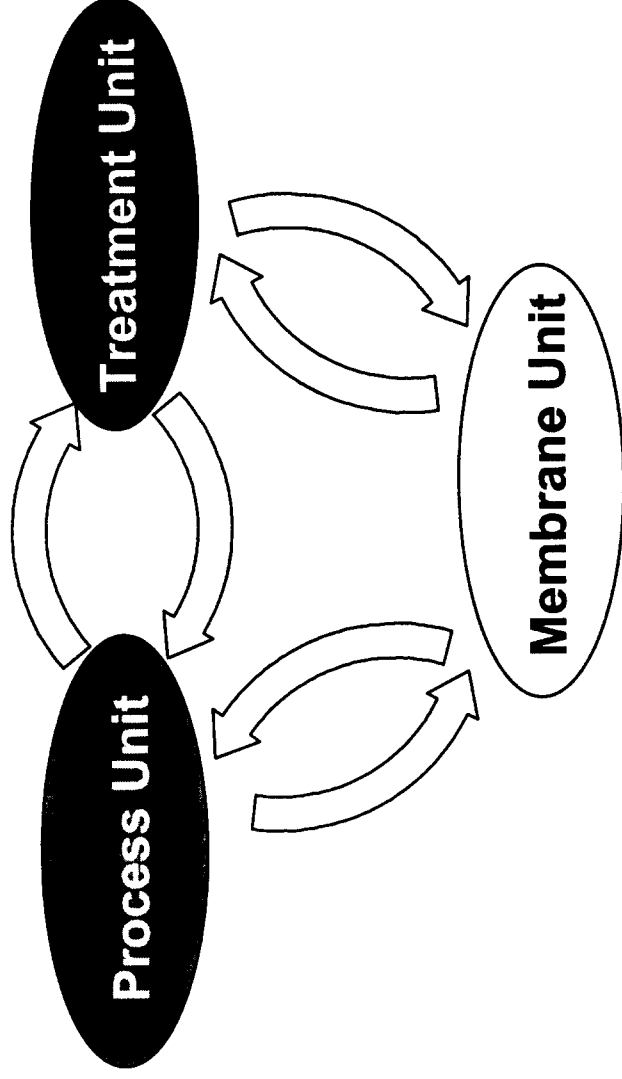


The Aim : To examine the present address of Membrane Technology for Cleaner Production and to seek the right direction of membrane based R & D and Education toward CP development.

The Location of Membrane Process for CP

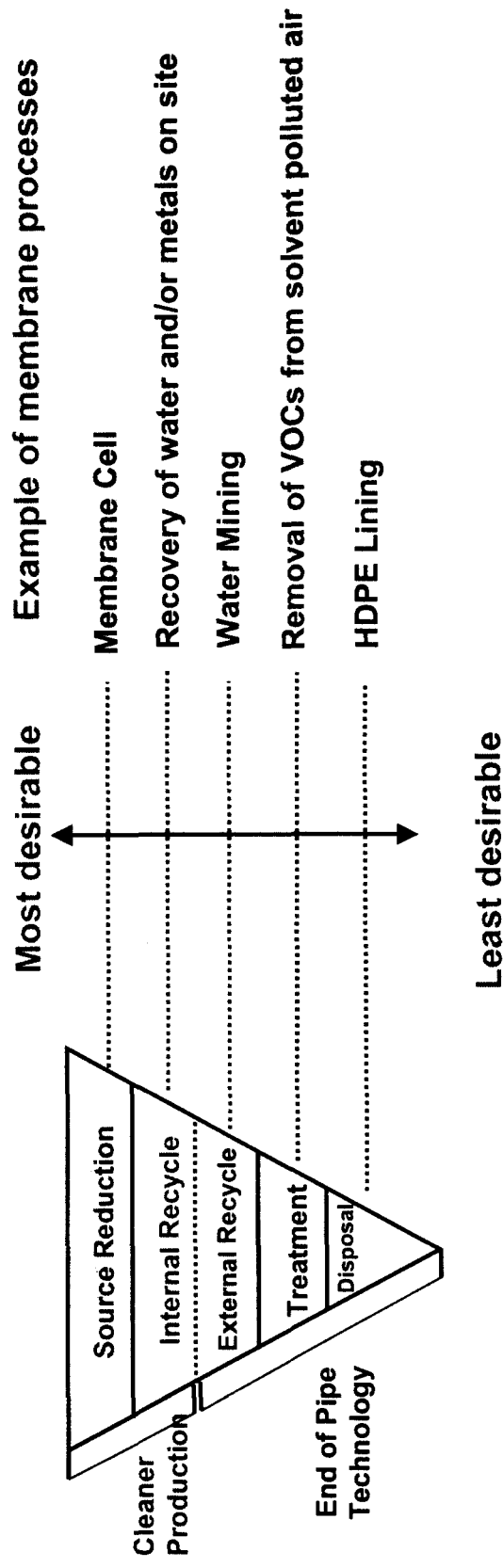
- Source Reduction or Internal Recycling -





- Membrane Unit is so closely linked to Process Unit(direct integration) or to Treatment Unit(hybrid system)
- To be successful in CP development with membrane, we need a comprehensive knowledge of not only membrane itself but also Unit Processes surrounding it and should integrate all of them holistically
- This point deserves special emphasis in the Education of Membrane Technology for CP development

Waste Management Hierarchy



- Membrane technologies are currently being used for all of the categories in Waste Management Hierarchy
- Source Reduction is the most desirable option from both environmental and economical points of view



International Cleaner Production Information Clearinghouse



January 2000



developed by

**United Nations Environment Programme Technology,
Industry and Economics (UNEP TIE)**

Cleaner Production Programme Tour Mirabeau, 39/43-quai André Citroën, 75739 Paris
Cedex 15, FRANCE

<http://www.uneptie.org/>



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" Statistical Analysis of ICPIC Case Studies "

- **Manufacturing (426)**
- **Wholesale and Retail Trade (16)**
- **Hotel and Restaurants (15)**
- **Real Estate, Renting and Business Activities (8)**
- **Miscellaneous Cases (5)**
- **Construction (4)**
- **Other Community, Social & Personal Service Activities (3)**
- **Electricity, Gas and Water Supply (2)**
- **Transport, Storage and Communication (2)**
- **Financial Intermediation (2)**
- **Health and Social Work (2)**
- **Agriculture, Hunting and Forestry (1)**
- **Mining and Quarrying (1)**
- **Public Administration and Defence (1)**

-> Total 488 Case Studies

" Statistical Analysis of ICPIC Case Studies "

Manufacturing Sectors

- Paper and Paper Products (70)
- Chemicals and Chemical Products (59)
- Coke and Refined Petroleum Products (59)
- Food Products and Beverages (48)
- Textiles (40)
- Basic Metals (23)
- Radio, Television and Communication Equipment (19)
- Tanning and Dressing of Leather (18)
- Furniture and Manufacturing NEC(not elsewhere classified) (14)
- Publishing, Printing and reproduction of Recorded Media (14)
- Fabricated Metal Products (11)
- Non-Metallic Mine Products (10)
- Other Transport Equipment (8)
- Electrical Machinery and Apparatus(6)
- Wood and of Production of Wood and Cork (2)

-> Total 426 Case Studies in Manufacturing Sectors

International Cleaner Production Information Clearinghouse(UNEP)

- **Total about 488 cases of CP from around the world**
- **Being in operation on an industrial scale**
- **Membrane cases(37): about 8 % of the total cases**

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Membrane Family for Cleaner Production

Membrane Type	Counts	%
Ultrafiltration	12	32.4
Reverse Osmosis	8	21.6
Electrolysis	5	13.5
UF + Electrolysis	3	8.1
ED	3	8.1
MF	2	5.4
UF + RO	1	2.7
MF + NF	1	2.7
Others	2	5.4
Total	37	100

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- **The family of Membrane Process is now very diverse and offers a wide range of separation capabilities. But currently available CP-related membrane technologies are dependent mostly on few processes, i.e., UF, RO, Electrolysis.**
- **Pressure-driven membrane processes make up almost 65 %**

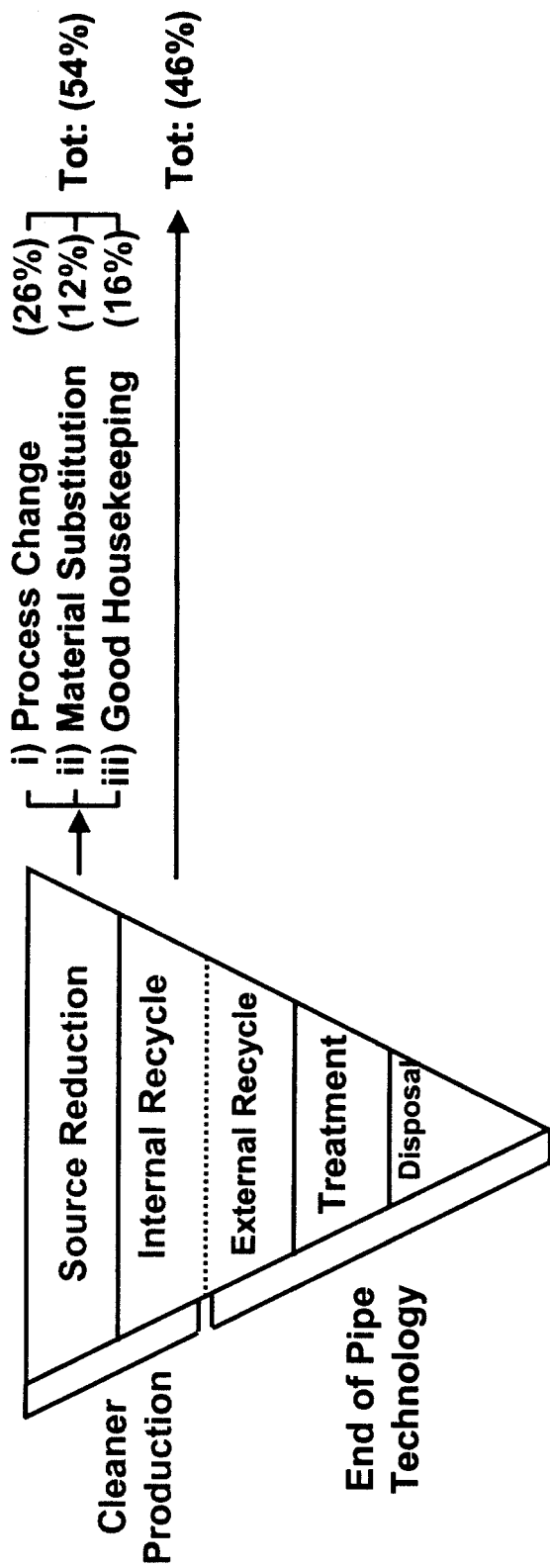


Fig.2. Waste management hierarchy and percentage of each element for cleaner production options. (): based on all the technologies in ICPIC case studies

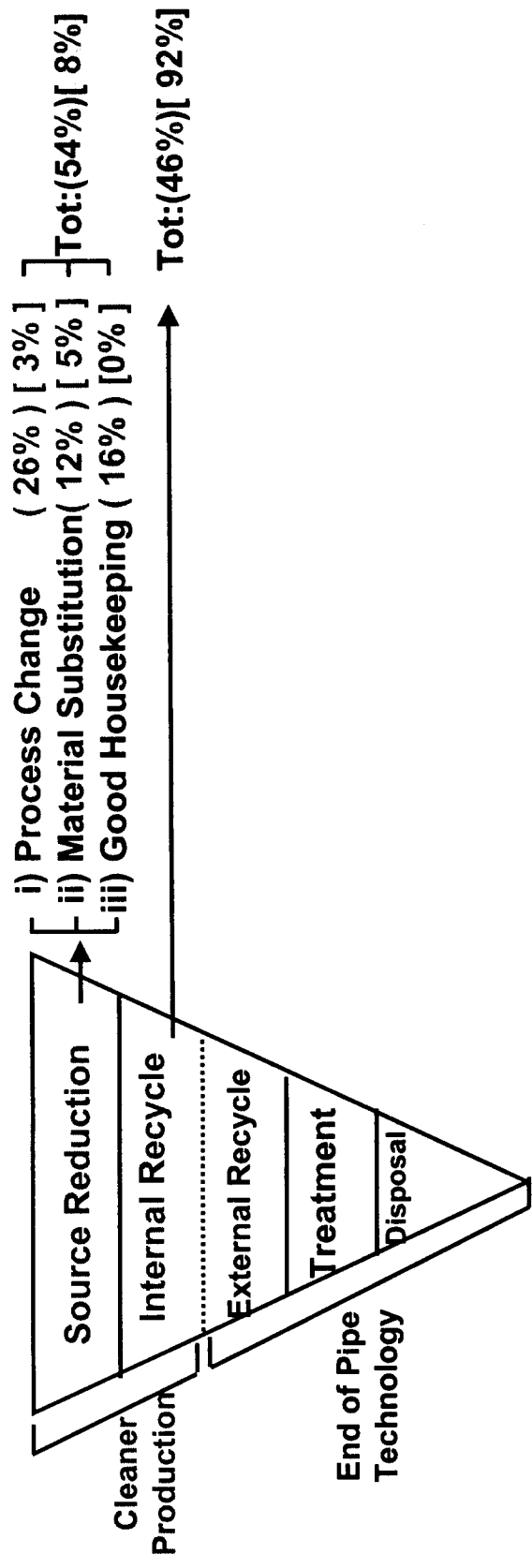


Fig.2. Waste management hierarchy and percentage of each element for cleaner production options.
 (): based on all the technologies in ICPIC case studies
 []: based on only membrane technologies in ICPIC case studies

Most of CP cases with memalbranes remains at the stage of Internal Recycle

Why?

- Membrane process is intrinsically a physical separation and thus hardly induces Chemical or Biochemical Reactions which are necessary for most manufacturing processes.

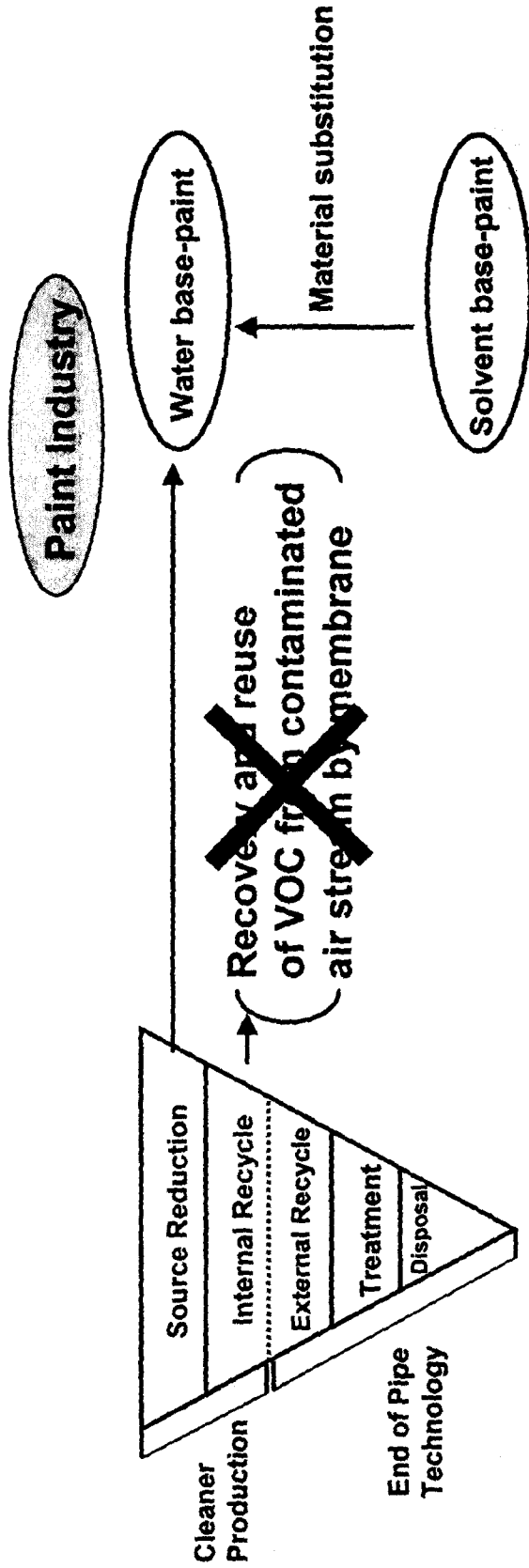
Cure !

- To construct a 'Hybrid System' to supplement the weak points of the membrane process,
- To make revolutionary changes with respect to structures, materials, etc., to be easily integrated into the process streams.

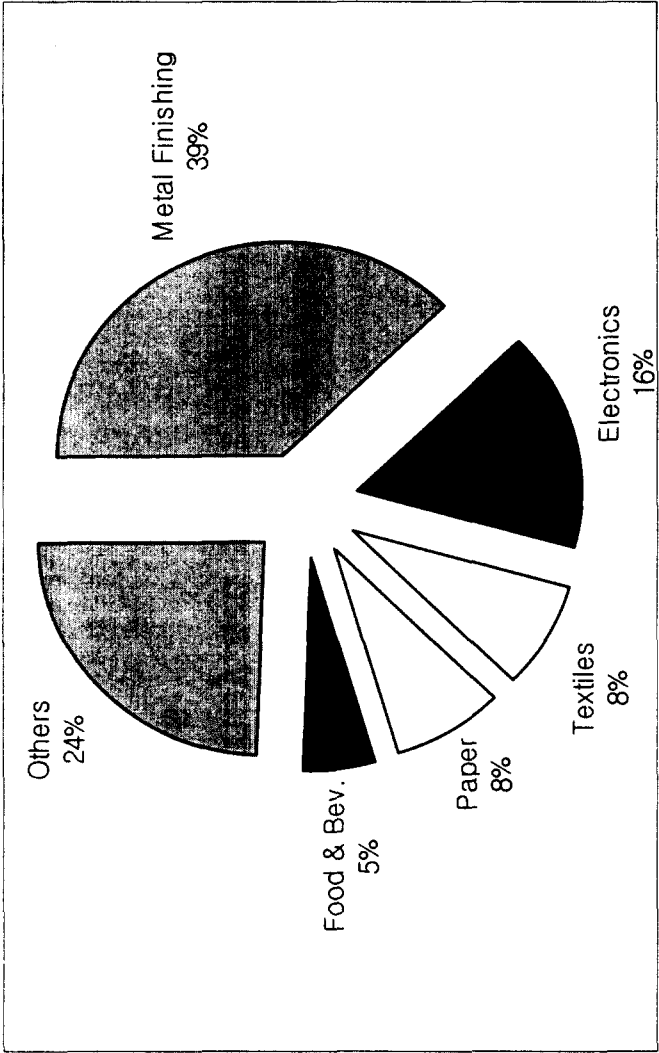
"Cleaner" today is not "Cleaner" tomorrow !

" In as much as CP is the continuous application of a better preventive environmental strategy,

CP with membrane at Internal Recycle could be replaced by any other CP at Source Reduction "



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Industrial Sectors where membrane processes are applied as CP

- Industrial sectors which currently take advantage of CP with membranes are limited to few sectors such as Metal Finishing, Electronics, Textile, etc..

CP applications with membrane are limited to few industrial sectors



- 1) CP technologies are poorly transferred across the industrial sectors because they are often applicable to a specific production process.**
- 2) Most of CP technologies remain confidential because of strategic interests or copy right protection**

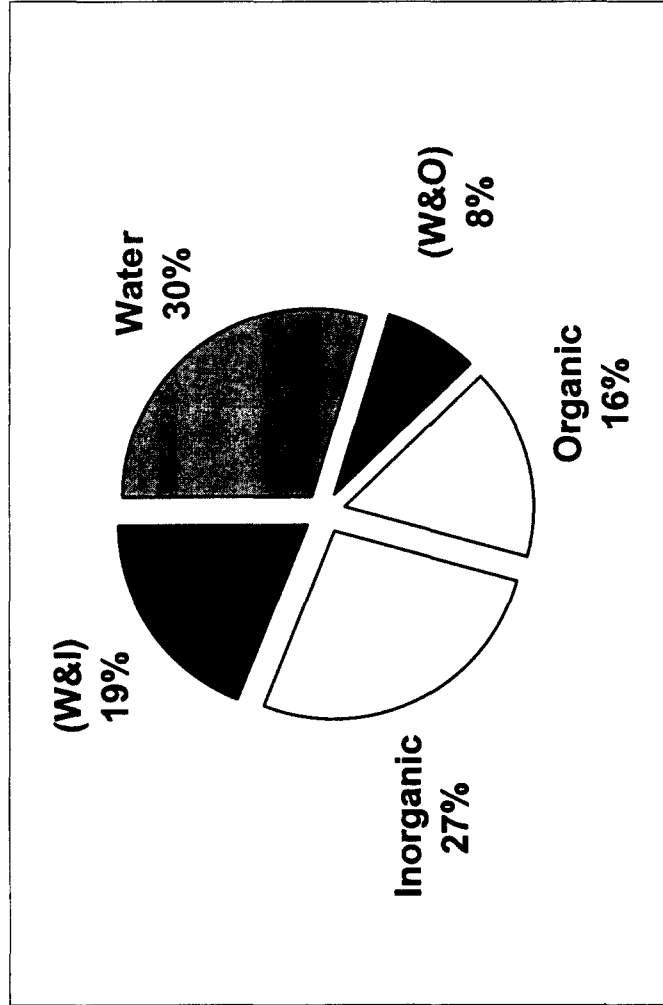
CP applications with membrane are limited to few industrial sectors



- 3) The demand for CP technologies depends heavily on the technological capacity of each industrial sector or company.
- 4) Paradigm shift from pollution control to pollution prevention

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Materials to be recovered by membrane processes



- **Materials :**
 - Water (57%)
 - Inorganics (46%); metals (Cu, Ag, Ni, Cr, etc.), acid, etc.
 - Organics (24%) ; polymer, starch, oil etc.)
 - Water is often reused together with Inorganics (19%) or Organics(8%).
 - The single water-reuse would not be favorable from both an environmental and economical point of view
 - Low cost of water is historically single biggest deterrent to water reuse
- Change of Water-Pricing Policy!!

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Economics of CP with membrane

Does CP always enjoys the " Win-Win " prospect of Environmental Protection and Economic Benefit ?

- in most cases : Yes !

Pay-back period : 3 months to 5 years

- in a few cases : No !

Extra annual costs (membrane operation and maintenance)
outweigh savings (raw materials, water, energy and waste treatment cost)

Conclusions

- **As the demand of CP in industry has continuously increased, membrane technology may have taken the opportunity to further expand its application area. But limits and obstacles still remain in the way of CP from the viewpoints of both policies and technologies.**
- **To promote and implement CP with membrane more efforts should be made with respect to the followings:**

- 1. Holistic approach is necessary, integrating membrane unit into other process and treatment units**
- 2. Put emphasis on the above point in the Education of Membrane Technology for CP**

- 3. Exploit rigorously the membrane technologies for Source Reduction rather than Internal Recycle.**
- 4. Speed up Paradigm Shift from pollution control to pollution prevention in terms of Environmental Management, Policy, regulation and education**