



# MEMBRANES FOR GAS/LIQUID SEPARATION

NCL Innovations: Solutions from CSIR India

# Technology

- A method for preparation of aromatic polyester based membranes from readily available raw materials by conventional methods, with high yield
  - ▣ These membranes can be used for separating various gases (e.g., hydrogen from methane, helium from nitrogen, oxygen from nitrogen etc.)
- A method for preparation of PDMS based thin film composite membranes that can be used for
  - ▣ Pervaporation ( alcohol dehydration, aroma recovery)
  - ▣ Perstraction ( recovery of nonvolatile acids)

# Applications

- Oxygen enriched air for medical applications
- O<sub>2</sub>/N<sub>2</sub> enrichment, biogas processing, H<sub>2</sub> recovery (hydroprocessing purge systems, ammonia & petrochemical plant), synthesis gas (H<sub>2</sub>/CO) ratio adjustment
- Aroma recovery in perfume industry
- Fragrance and flavor separation in food industry
- Removal of organics from water, water from organics, organic / organic separation
- Separation of organic and inorganic acids
- Separation of acids from complex mixtures like fermentation broths

# Market Potential

- ❑ The world wide market demand for membranes has been predicted to reach \$15 billion in 2012, growing at the rate of 8.6% annually\*
- ❑ Global oxygen concentrator market has been valued at \$1.2 billion in 2011 and further growth predicted<sup>^</sup> - illustrating the potential for use of membranes in this market
- ❑ Membranes have great potential to be used in the flavor and fragrance industry. The flavour and fragrance industry in 2010 had revenues of over \$20 billion), and has a high growth rate\*\*

\*World Membrane Separation Technologies Industry Study with Forecasts for 2012 & 2017, Study #2468, April 2009, Page 393- Freedonia

<sup>^</sup> Oxygen Concentrator Market Opportunities, Strategies, and Forecasts, 2005 -2011, Winter Green Research Inc., Dec 2005, Page122

\*\*[http://www.leffingwell.com/top\\_10.htm](http://www.leffingwell.com/top_10.htm)

# Value

- Gas separation membranes
  - Made from readily available raw materials, conventional methods of preparation (low cost), with high yield
  - Can be easily processed (the polymers used are soluble in common solvents)
  - Possess a very good combination of gas selectivity and permeability
  - Very stable at high temperatures
- Pervaporation/Perstraction membranes
  - High fluxes
  - High selectivity
  - Operational simplicity
  - Low energy requirements

# Technology Status, IP Status

- Oxygen enrichment for medical applications: prototype developed and demonstrated at various hospitals in the country
- Other membranes: demonstrated at lab scale for various applications
- On the look out for partners to license/scale up technology
- US patent ([6420511 B1](#)) has been granted – for gas separation membranes
- Ready to be licensed

# Links & References

- ❑ World membrane separation technologies- Industry Study with Forecasts for 2012 & 2017, Study #2468, April 2009, 393 pages- Freedonia
- ❑ Membrane Separation Technologies US Industry Study with Forecasts for 2014 & 2019 Study #2632, May 2010, 375 Pages- Freedonia
- ❑ Oxygen Concentrators: A Dual Market, Tuesday, 06 July 2010-  
<http://www.medicalbuyer.co.in/2007/oxygen-concentrators-a-dual-market-2669-41.html>  
(viewed 06/05/11)
- ❑ A. Chatterjee, Indian Air-Conditioner Market is Hot, *New Delhi Report*, APPLIANCE Magazine, July 2004- <http://www.appliancemagazine.com/editorial.php?article=523&zone=1&first=1>  
(viewed- 09/05/11)

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# Summary

Technology Summary	
Technology title	Membrane for gas/liquid separation
Industry /sector	Medical, food, perfume, chemical industry
Year of development	2002
Related patents (with links)	US patent (6420511 B1)
Technology readiness level	Demonstrated at lab-scale; Prototype demo-ed for O <sub>2</sub> enrichment for medical appl.
Licensing status	No current licenses/Ready to be licensed
Encumbrances	None
Availability	Yes