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Polymer Membrane Technology

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Abstract: ***This feature article provides a comprehensive overview on the development of polymeric membranes having advanced or novel functions in the various membrane separation processes for liquid and gaseous mixtures (gas separation, reverse osmosis, pervaporation ,N/F,U/F, microfiltration) and in other important applications of membranes such as biomaterials, catalysis (including fuel cell systems) or lab-on-chip technologies. Important approaches toward this aim include novel processing technologies of polymers for membranes, the synthesis of novel polymers with well-defined structure as 'designed' membrane materials, advanced surface fictionalizations of membranes, the use of templates for creating 'tailored' barrier or surface structures for membranes and the preparation of composite membranes for the synergistic combination of different functions by different (mainly polymeric) materials. The structures and functions of these polymer membranes are evaluated with respect to improved or novel performance, and the potential implications of those developments for the future of membrane technology are discussed.***

Key word- **Advanced polymer membrane process, Membrane module, Property of ptfe & pp, Wastewater treatment.**

I. INTRODUCTION

Membrane technologies have now been industrially established in impressively large scale. The markets are rather diverse from medicine to the chemical industry and the most important industrial market segments are 'medical devices' and 'water treatment'. This will be briefly explained by giving an overview on the main membrane processes and separation mechanisms. Even when ceramic, metal and liquid membranes are gaining more importance, the majority of membranes is and will be made from solid polymers. In general, this is due to the wide variability of barrier structures and properties, which can be designed by polymer materials. Current (1st generation) membrane polymers are biopolymers (mainly cellulose derivatives) or (less than 20 major) synthetic engineering polymers, which had originally been developed for different purposes. The typical membrane structures and manufacturing technologies will be briefly summarized. The development of synthetic membranes had always been inspired by the fact that the selective transport through biological membranes is enabled by highly specialized macromolecular and supra molecular assemblies based on and involved in molecular recognition.

II. ADVANCED POLYMER MEMBRANE TECHNOLOGY PROCESS

In the context of micro system engineering largely driven by technologies originally developed for the semiconductor industries a wide variety of methods had been established to create micro- or even nanostructures in or from established engineering polymers. With respect to membranes, the 'top down' fabrication of pores in barriers made from plastics may be considered a rather straightforward approach. Especially, attractive would be the possibility to control the density, size, size distribution, shape and vertical alignment of membrane pores, because this is not possible with all the other established membrane formation technologies .Two different types of commercial membranes close to such an 'ideal' structure are already available, track-etched polymer 4 and anodically oxidized alumina membranes. Even when the latter materials are clearly of inorganic nature, they should be briefly covered because such membranes belong to the state-of the- art which could be improved by innovative polymeric materials and because such membranes can also be used as supports or 'templates' for the preparation of novel membranes with a selectivity determined by polymeric materials. Track-etched polymer membranes are prepared from polycarbonate or polyethylene terephthalate films with a thickness between 6 and 35 mm. The process involves two main steps: (I) the irradiation with accelerated heavy ions, and (ii) a controlled chemical etching of the degraded regions .The resulting membranes have a rather low porosity or pore density, in order to reduce the probability of defects, i.e. double or triple pores. Under those conditions, the pore size distribution can be very sharp. Such membranes are commercially available with pore sizes from about 10 nm to several micrometers. There is some evidence that the pore geometry for the smaller pore size track-etched membranes may deviate from an ideal cylindrical shape what can be explained by the chemistry behind the manufacturing process .In research labs, these manufacturing technologies Have been further modified in order to obtain more specialized membrane structures, e.g. cone shaped track-etched polymer membranes. Nevertheless, these membranes have their principal limitations because the preparation of pores with diameters in the lower nanometer range is not possible. The established 'is porous' membranes have become favorite support materials for the investigation of novel (polymeric) barrier membranes as well as for exploring completely novel Separation principles based on functional polymers.

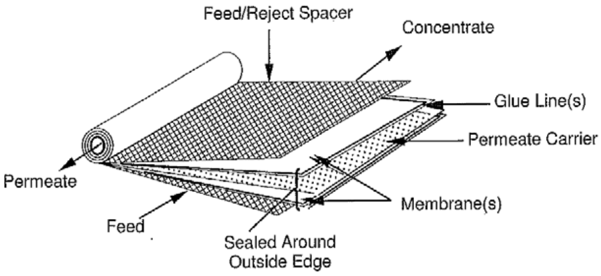
III. MEMBRANE MODULES

Membrane filters are usually manufactured as flat sheet stock or as hollow fibers and then formed into on of several different types of membrane modules. Module construction typically involves potting or sealing the membrane material into an assembly, such as with hollow-fiber module. These types of modules are designed for long-term use over the course of a number of years. Spiral-wound modules are also manufactured for long-term use, although these modules are encased in a separate pressure vessel that is independent of the module itself.

A. Hollow-Fiber Modules

Most hallow-fiber modules used in drinking water treatment applications are manufactured for MF or UF membranes to filter particulate matter. These modules are comprised of hollow-fiber membranes, which are long and very narrow tubes that may be constructed of membrane materials described previously. The fibers may be bundled in one of several different arrangements.

B. Spiral-Wound Membrane Module



C. DEPOSITION MODE

Membrane filtration systems operating in deposition have one influent (feed) and one effluent (filtrate) stream. These systems are also commonly called “dead-end” or “direct” filtration systems and are similar to conventional granular media filters in terms of hydraulic configuration. In deposition mode, contaminates suspended in the feed stream accumulate on the membrane surface and are held in place by hydraulic forces acting perpendicular to the membrane, forming a cake layer.

IV. POLYMER MEMBRANE OPERATION

- pressure driven operations
  - Microfiltration
  - Ultra filtration
  - Nano filtration
  - Reverse osmosis
  - Gas separation
  - Pervaporation
- concentration driven operations
  - dialysis
  - osmosis
  - forward osmosis
- operations in electric potential gradient
  - electro dialysis
  - membrane electrolysis
  - electrophoresis
- operations in temperature gradient :membrane distillation

V. PROPERTIES OF PTFE & PP MEMBRANE

PTFE:

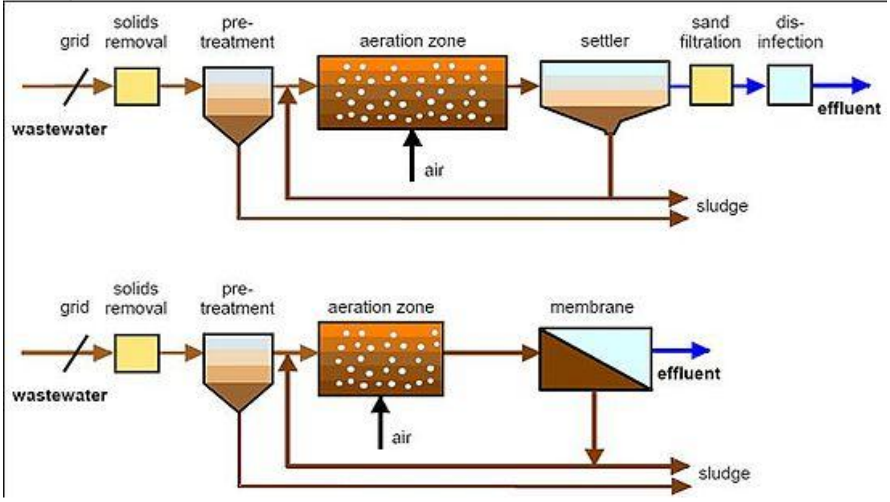
1. Better filter efficiency
2. Lower resistance
3. Widely application

PP:

1. Easy handling
2. Easy handling
3. Purity

VI. APPLICATION: MEMBRANE BIOREACTOR IN WASTE WATER TREATMENT

Two MBR configurations exist: internal/submerged, where the membranes are immersed in and integral to the biological reactor; and external/side stream, where membranes are a separate unit process requiring an intermediate pumping step.



A. Internal/submerged

The filtration element is installed in either the main bioreactor vessel or in a separate tank. The membranes can be flat sheet or tubular or combination of both, and can incorporate an online backwash system which reduces membrane surface fouling by pumping membrane permeate back through the membrane. In systems where the membranes are in a separate tank to the bioreactor individual trains of membranes can be isolated to undertake cleaning regimes incorporating membrane soaks, however the biomass must be continuously pumped back to the main reactor to limit MLSS concentration increase. Additional aeration is also required to provide air scour to reduce fouling. Where the membranes are installed in the main reactor, membrane modules are removed from the vessel and transferred to an offline cleaning tank.

B. External/side stream

The filtration elements are installed externally to the reactor, often in a plant room. The biomass is either pumped directly through a number of membrane modules in series and back to the bioreactor, or the biomass is pumped to a bank of modules, from which a second pump circulates the biomass through the modules in series. Cleaning and soaking of the membranes can be undertaken in place with use of an installed cleaning tank, pump and pipe work.

VII. SUMMARY

From it’s beginning, the field of membranes had been very interdisciplinary. It involves the inspiration by biology, modeling of membrane transport, chemical synthesis and structure characterization for membrane materials, membrane materials sciences and engineering, membrane formation and modification, membrane characterization, module design, process engineering, integration of membrane processes into industrial processes as well as economical, ecological and safety issues. This ‘cross-fertilization’ had been most fruitful, and a world-wide community of ‘membranologist’ had been established over the last decades. Today, a sound basis for the growth of membrane technology is based on the impressive technical achievements, the acceptance in various industries, and the integration of courses and programs on membranes into the university education. Most important, the membrane industry itself has a profound perspective as it is illustrated by the growth rates, the steadily increasing diversity of applications, and the growing number of technically feasible membrane processes.

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