International Journal of Chemical and Analytical Science
ISSN: 0976-1206
Short Communication
www.ijcas.info

A Brief Insight into the Science of Nanofiltration and Membrane Separation Processes

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Nanofiltration is the next generation science and technology of the domain of environmental engineering. A scientist's vision and also an environmental scientist's vision are innovative, un-paralleled and far-reaching. Nanofiltration will open up new avenues in future in the field of membrane separation processes. In this insight, the use of membrane separation processes, especially ultra filtration and reverse osmosis in advanced industrial waste water treatment and effluent treatment is discussed with visionary effect. The problems and difficulties of adapting membrane processes, which are already established in many industrial and laboratory operations, to the effective treatment of industrial effluents are deliberated with intricate details. The vision of application of membrane separation processes is brought to the forefront of the scientific community.

Keywords: Dyes, Nanofiltration, Membrane, Mass Transfer, Separation

INTRODUCTION

In recent years and in recent times it has become more and more imperative and apparent that conventional effluent water treatment processes such as biological conversion, sedimentation, flocculation etc. are often unsatisfactory when large quantities of industrial wastes and effluents which contain large amounts of highly toxic, biologically non degradable or high oxygen demanding constituents have to be treated. The main concern is the heavily industrialized areas where a new technique of wastewater treatment is envisioned.

Although modern technology has made a large and many sophisticated processes available capable of solving many wastewater problems, most have serious disadvantages. Some of the negative disadvantaged processes are: rectification or sorption techniques are extremely expensive; incineration often causes air pollution problems and many chemical precipitation processes produce large amounts of sludge the disposal of which can pollute water sources.

For many industrial effluents and wastewater, however, there are procedures available which are not only highly efficient but also economical. These examples are membrane separation processes, especially reverse osmosis, ultra filtration and to a lesser extent electro dialysis. During the last two decades, membrane separation processes have gained immense and increasing publicity and today this procedure is well established and used as standard procedures for many laboratory and industrial mass separation problems.

For the treatment and mitigation of industrial effluents, membrane separation processes offer significant advantages over most other procedures. Waste water components, for example, are not degraded or chemically altered and valuable products, such as certain metal ions, proteins or other organic materials can be recovered and commercially utilized.

Vision and doctrine of nanofiltration as an effective membrane separation process: Nanofiltration is a technique in the domain of chemical engineering or environmental engineering which crossed vast and significant frontiers. It is the next generation science and technology as an effective membrane separation procedure.

The vision of membrane separation processes will unfold new generation technologies of environmental engineering. This process has been found to be more effective than many other membrane separations. Difficulties are ahead but achieving success is not a distant reality.

The vision of nanofiltration as a visionary process is wide and diverse. In recent years, an important application area is nanofiltration of textile dyes. It has assumed immense and versatile importance. The vision of a scientist is emboldened and enhanced with the advent of new nanofiltration technologies and membrane engineering science.

Extensive research pursuit in the field of nanofiltration of dyes: Gomes et al (2007)[1] discussed and researched extensively on integrated nanofiltration and upflow anaerobic sludge blanket treatment of textile wastewater for in-plant reuse. The filtration characteristics of simulated dyeing effluents containing Acid Orange 7, sodium sulphate and a pH buffer made of acetic acid and sodium acetate is described using a commercially available nanofiltration membrane. The original membrane filtration properties were characterized with deionized water to provide a baseline of membrane performance. Ogunlaja et al (2009)[2] evaluated the efficiency of a textile wastewater treatment plant located in Oshodi, Lagos, Nigeria. An analysis is that the major part of textile processes is based on chemical reactions carried out in aqueous heterogeneous systems which eventually generates effluents of extremely variable composition and constitute an environmental risk of major concern. This study, focused on investigating the characteristics of effluent from textile industry which generates about 1577m^3 wastes per day and the effectiveness of the wastewater treatment technique practiced.

A report by Central Pollution Control Board, India (April, 2007)[3], details advance methods for treatment of textile industry effluents. The report gave an overview of the different advanced methods for treatment of textile industry effluents as well as for recovery of water/salt in the process. The performance of these advanced treatment as also their economic analysis, benefits and constraints have been discussed in this report.

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Received 12-01-2012; **Accepted** 22-04-2012

Hassain et al (2008)[4] dealt with nanofiltration process of dye removal from simulated textile wastewater. The rate of dye removal by spiral wound nanofiltration membrane in film thin composite MWCO=90 Dalton, was evaluated for four classes of dyes acidic, disperse, reactive and direct in red and blue dyes medium. Dye absorbance was measured by spectrophotometric method (2120 Standard Method 1998). Avlonitis et al (2008)[5] discussed simulated cotton dye effluents treatment and reuse by nanofiltration. An excellent performance for the TRISEP (4040-XN45-TSF) nanofiltration membrane was found. This type of membranes can achieve complete decolorization of the cotton dye effluents and they reduce the total salt concentration more than 72%.

Pazdizor(2009)[6] integrated nanofiltration and biological processes for textile waste water treatment. The implementation of the biological anaerobic –aerobic system in separated reactors to the nanofiltration concentrate treatment was presented. The concentrate was obtained during the nanofiltration of the textile wastewater containing azo dye Reactive Red 120. Babu et al (2007)[7] in a phenomenal review described textile technology in the perspective of cotton textile processing with an impact on waste generation and effluent treatment. This review discusses cotton textile processing and methods of treating wastewater effluent in the textile industry. Industrial textile processing comprises pretreatment, dyeing, printing and finishing operations. These production processes not only consume large amounts of energy and water, but they also produce substantial waste effluents and waste products. Their phenomenal review combines a discussion of waste products from textile processes, such as desizing, mercerizing, bleaching, dyeing, finishing and printing with a discussion of advanced methods of effluent treatment, such as electro-oxidation, bio-treatment, photochemical and membrane processes. Torabion et al (2007)[8] discussed the efficiency evaluation of textile basic dye removal from water by nanofiltration. The aim of their research was to study the efficiency of textile dyes removal by a commercial nanofilter NF 90 (Dow Film Tec). Dye rejection was studied using basic dye (Basic Chrysoidie Cryst Yellow Gold 0.4%) with its relevant additive. Experiments in this research were continued until the fouling time of the membrane. Each experiment in the research was repeated after washing to evaluate the efficiency of the washing process. The efficiency of dye removal at the beginning of the experiment was 99.59%. After 48 hours from the beginning of the experiment the membrane removed dye at 97.98% which was still significant.97.98% removal equals the presence of 10 units of dye in permeate water.

Fersi et al (2008)[9] discussed treatment of textile plant effluent by ultrafiltration and/or nanofiltration for water reuse. Membrane processes are seriously restricted in efficiency by membrane fouling. So this phenomenon was discussed. The ultrafiltration(UF) was used as a pretreatment for nanofiltration(NF) procedure. A comparison between direct NF and UF/NF combination performances was carried out.

Brief insight into the field of nanofiltration and the wider domain of membrane separation processes: An environmental scientist's vision and objective is awesome and innovative. This innovation urges him to open up new dimensions in the frontiers of research. Research possibilities and research geasibilities are wide and unparalleled. Progress in environmental science ushers in a new dimension in the domain of nanofiltration or other membrane separation of dyes[10,11]. The world of unknown is unfolded. The target and optimism in this area of science is vastly enhanced. The future is bright and enhancing. Continuous research struggle in this area of environmental engineering has brought fruitful results in the scientific community. The vision will herald new domains in environmental engineering and science.

Future vision/doctrine and future flow of research thoughts: The vision of future in the domain of membrane separation processes is wide and clear.[10,11] The research and pursuits has tremendous ability. Nanofiltration and other membrane separation processes will herald in a new era of intense intuition in the domain of environmental engineering science. The scientist's vision will be enhanced only when the research integrity and research intuition is followed. Nanofiltration and other membrane separation processes will usher in a new era of research prosperity.

ACKNOWLEDGEMENT

The author acknowledges the support of management of Salalah College of Technology, Salalah, Oman. The author is also extremely indebted to Professor Bhaskar Sengupta of School of Planning, Architecture and Civil Engineering, Queen's University, Belfast, United Kingdom, under whose supervision the author did research work in the field of ozonation of dyes.

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Source of support: Nil, Conflict of interest: None Declared