IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

AGNI-PANKH 16

Jawaharlal Darda Institute of Engineering and Technology, Yavatmal

Vol. 4, Special Issue 3, January 2017

Dehydration of Alcohol by Membrane Process

Ajay V Gawali[1], Miss. Sapna K. Deotale[2], Rupesh S. Chopkar[3]

Assistant Professor Department of Chemical Engineering, A.E.C, Chikhli, India[1, 2]

Student, Department of Chemical Technology, A.E.C. Chikhli, Maharashtra, India[3]

Abstract: The separation of commercial PVA membrane was studied over a board range of concentration for binary alcohol-water systems. Poly-vinyl alcohol membrane has yielded promising results for the dehydration of lower alcohols (ethanol), having high fluxes and fermentation rate. Pervaporation experiments with various concentrations of aqueous ethanol within the operating temperature conditions of 25^{0}C, 50^{0}C and 75^{0}C were successfully completed and finalized with respect to the operating temperatures, a minimum mass fluxes were observed at concentrations of 10-20%(v/v) aqueous ethanol solvents despite the fact that maximum viscosity of the solvent occurs at 50% (v/v) thus challenging the viscosity additively rule. Results drawn using polymeric for poly-vinyl alcohol (PVA) membranes were promising, suggesting high permeation with high mass flux. All pervaporation tests were conducted at every 1 hour intervals. The mass fluxes data collected was originally the units of kilograms per hour which was then used to kilograms per hour per square of meter (kg/m^2.hr), however, the mass flux often falls within the range of 0.1-1.8 kg/m^2.hr at 50^{o}C. The permeation rate was in the units of (mol/m^2.sPa). However, the permeate rate often falls within the range of 2.09E-04-3.27E-03 mol/m^2.sPa.

Keywords: polyvinyl alcohol, ethanol, pervaporation test, solvent, etc.

I. INTRODUCTION

Membrane processes in recent decades have been made more economically competitive compared with conventional separation technologies such as distillation, solvent extraction, crystallization, absorption, and adsorption.
This paper is based on the dehydration by pervaporation of water/ ethanol mixtures using polymeric (PVA) poly-vinyl-alcohol membrane. The study focuses on the influence of the operating conditions have on the water/ethanol permeation and the mass flux fluctuations, when the alcohol concentration in feed and temperature were increased. New materials from stable operation will also be studied.

The pervaporation process has been found effective for separating liquid mixtures, such as dehydration of solvent, water-alcohol mixtures and other volatile organics, especially azeotropic systems and wastewater purification (Tsuyumoto et al, 1995), Selective evaporation is a process where one component of a liquid stream is extracted by a membrane. In its simplest from, is energy efficient combination of permention and evaporation.

II. METHODOLOGY

A. Materials:
Ethanol (99.9 Purity, SD fine), distilled water will be used for all experiments.

B. Sample preparation:
Aqueous Ethanol solutions (v/v) of; 0%,10%, 20%, 50%, and 100% were prepared and experiments with these aqueous solutions were conducted at a range of temperature; 25^{o}C, 50^{o}C and 75^{o}C. The experimental data gave mass fluxes and were converted to permeance; these were then applied to the principles and theories of membrane production focusing on key properties like permention and selectivity.

C. Sample preparation of Ethanol-Water (%)

Sr. No.	Ethanol (%)	Water (%)	Sr. No.	Ethanol (%)	Water (%)
1	0	100	6	50	50
2	10	90	7	60	40
3	20	80	8	70	30
4	30	70	9	80	20
5	40	60	10	90	10

III. ANALYSIS

The composition of the permeate is to be obtained by doing analysis by UV spectrometer, Ethanol concentration determines by the optical density measurement, using a UV Spectrophotometer at a wavelength of 290nm. The calibration curve is to be prepared by measuring absorbance of samples of varying ethanol concentrations. The ethanol concentration of the unknown samples is to be then obtained by measuring the optical density and reading the ethanol concentration directly from the calibration curve.)

IV. EXPERIMENTAL SETUP

The pervaporation apparatus used in the present study consist of a membrane module. The results addressed in

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
IARJSET
International Advanced Research Journal in Science, Engineering and Technology
AGNI-PANKH 16
Jawaharlal Darda Institute of Engineering and Technology, Yavatmal
Vol. 4, Special Issue 3, January 2017

this section have been determined according to the experimental methods as described in below.

A. Pervaporation Analysis

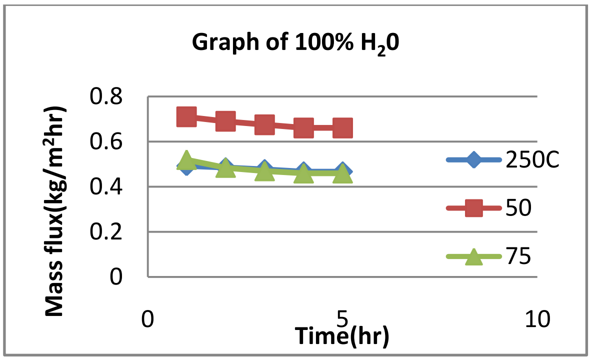

Figure 1: Graph of mass fluxes based 100% (V/V) H_2O

TABLE 2: EXPERIMENTAL DATA AT 100% (V/V) H_2O

Temp (^{0}C)	Mass Flux (kg/m^2.hr)	Permeation rate (mol/m^2.s.Pa)
25	0.4670	2.16E-04
50	0.6606	1.27E-03
75	0.4667	8.45E-04

Figure 1 shows that the same mass flux patterns, the initially decrease in all the fluxes between the 1st hr and 2nd hr, which eventually reaches a steady state at the 3rd hr. The highest mass flux continued to be at 50^{o}C, and the lowest flux occurs at 25^{o}C followed by the curve obtained at 75^{o}C. One important observation was that the mass fluxes decreases and permeation rate increase as compared to the data values displayed in Table 2.

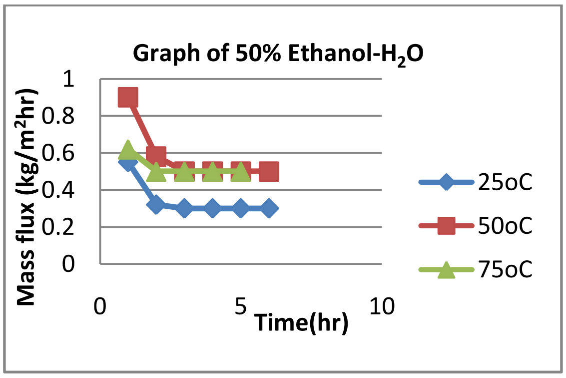

Figure 2 Graph of mass fluxes based on 50% (v/v) aqueous ethanol

TABLE 3: EXPERIMENTAL DATA ON 50% (V/V) AQUEOUS ETHANOL

Temp (^{0}C)	Mass Flux (kg/m^2.hr)	Permeation rate (mol/m^2.s.Pa)	% H_2O
25	0.3386	8.82E-04	100.00
50	0.5497	1.44E-03	99.06
75	0.5186	1.36E-03	99.77

Figure 2 shows that the same mass flux patterns as all other figures, showing an initial decrease in mass fluxes between 1st hr to 2nd hr of the experiments before attaining a steady state after the 3rd hr. Once again the highest mass flux occurs at the temperature of 50oC, but now the least mass flux occurs at 75^{o}C instead of 25^{o}C. The overall mass fluxes together increases slightly as concentration increases from 50% to 100% (v/v). One important observation from figure 1 and 2, is that all these figures relate temperature as a function of transported mass fluxes.

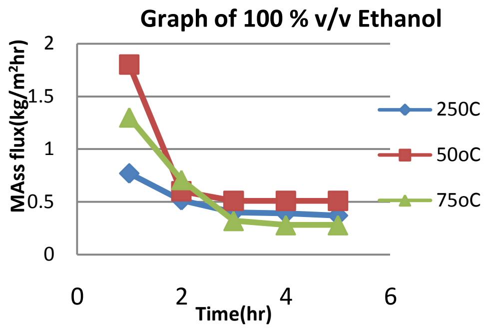

Figure3: Graph of mass fluxes based on 100% ethanol solution

Figure 3 is the shows that the all the steady state mass fluxes obtained from the pervaporation tests against various concentrations of aqueous ethanol. From the graph, a drop in mass fluxes between 0-10% (v/v) is due to the decrease in water concentration (ethanol concentration increases). However, an opposite phenomenon for the mass fluxes concentration of water (ethanol concentration increases). Thus suggesting that flux behavior is neither a function of water nor ethanol concentration alone but as a solvent concentration besides temperature.

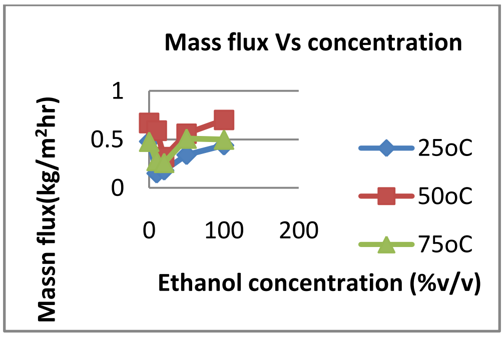

Figure4: Graph of mass fluxes Vs concentration (v/v)

Permeation rate of pure water is constant at operating temperatures of 25^{o}C and 75 ^{o}C and is higher at 50 ^{o}C, such behavior is observed throughout all test even with different concentration of aqueous ethanol. At 50% (v/v) aqueous ethanol, permeation rate is almost identical at operating temperatures of 50 ^{o}C and 75 ^{o}C and is lower at

25 °C, further suggested that both temperature and solvent concentrations were not the only factors that determined the pervaporation rate. Possible factors affecting the permeation rate includes solvent properties (viscosity) and surface properties (tension and structure) of the membrane.

V. DISCUSSION OF RESULTS

All figures (5-10) indicate that flux behavior as a function of solvent concentration and temperature of the operating conditions. All experimental data shows that an initial decreases in mass fluxes of both ethanol and water which eventually stabilized. This phenomenon is known as membrane fouling, as the changes of these fluxes were due to a Poly-vinyl alcohol (PVA) membrane.
This results shows that the dehydration of ethanol under the influence of temperature on the membrane performances i.e. permeation rate and mass fluxes.

VI. CONCLUSION

Pervaporation experiments with various concentrations of aqueous ethanol within the operating temperature conditions of 25°C, 50°C and 75°C were successfully completed and finalized. Results drawn using polymeric for poly-vinyl alcohol (PVA) membranes were promising, suggesting high permeation with high mass flux. It is also predicted from this study that pervaporation rate of aqueous ethanol is a function of temperature and solvent concentrations. All experimental data shows that an initial decrease in mass fluxes of both ethanol and water which eventually stabilized. This phenomenon is known as membrane fouling, as the changes of these fluxes were due to a poly-vinyl alcohol (PVA) membrane.

ACKNOWLEDGEMENT

We would like to thank, respected sir/Mam for giving us such a wonderful opportunity to expand our knowledge. It helped us lot to realize of what we study for. Secondly, we would like to thank our teachers who helped us. Thirdly, we would like to thank our parent who patiently helped us. next, we would thanks Microsoft for developing such a wonderful tool like MS word. It helped our work a lot to remain error-free.

REFERENCES

1. Salem, A.A.Ghoreyshi (2006), "Modeling of water/organic vapor dehydration by glassy polymer membranes", Desalination 193,pp. 25-34.
2. A.W.Verker, P.van Malea, M.A.G.Vorstman, J.T.F.Keurentjes (2001), "Description of dehydration performance of amorphous silca pervaporation membrane", Journal of Membrane Science 193,pp. 227-238.
3. Abburi Krishnaiaha (2008), "Pervaporation separation of ethanol-water mixtures through sodium alginate membranes, Desalination 229,pp. 68-81.
4. Brian Bolto, Manh Hoang, Zongli Xie (2011, "A review of membrane selection for the dehydration of aqueous ethanol by Pervaporation", Chemical Engineering and Processing 50, pp. 227-235.
5. Cabasso, I., Liu, Z. and Makenzie, T.(1996), "The Permselectiivty of Ion-Exchange Membranes for Non-Electrolyte Liquid mixtures. II. The Effect of Conterions (Separation of Water/Alcohol Mixtures with Nafion Membranes)", J. Membrane Science, pp. 92-109.