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Membrane-assisted separation of hydrogen peroxide containing solutions

Autor: Alicja Gos

Nr albumu: 253276

Promotor: dr hab. inż. Paweł Sobieszuk
Współpromotorzy: Dipl. Chem. Manfred Kraut
Dr. Katja Haas-Santo

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Introduction

Conventional way of producing hydrogen peroxide is indirect synthesis through auto-oxidation (AO) process which requires complex and expensive reactor system and is impossible to implement on site production. Due to its advantages over AO-process, direct synthesis became an alternative that is gaining more interest. Its drawbacks are side reactions and need to apply extra steps to concentrate and purify the final product. Therefore new separation methods are analysed to gain more suitable solution of hydrogen peroxide for its applications.

Purpose and scope of work

The purpose of this work is development and research of membrane-assisted separation process of hydrogen peroxide containing solutions.
Scope of this work includes:

- description of membranes, membrane separation processes and pervaporation
- development of membrane-assisted separation process
- tests of membrane-assisted separation process of hydrogen peroxide containing solutions with organic solvent and demineralized water
- examination of the final concentration of hydrogen peroxide containing solutions

Experimental set-up

Through the development of membrane-assisted separation process, the experiments were performed in the pervaporation unit using different membrane modules. The reactors varied in internal dimensions of plates as well as material of their plates and frames. They were made of stainless steel and PVC. Two types of membrane materials were tested - polyacrylonitrile membrane and perfluorinated membrane reinforced with poly(tetrafluoroethylene) fibre.

Separation of hydrogen peroxide in water-ethanol solution

Based on previous experiments, the investigation of hydrogen peroxide in water-ethanol solution separation was carried out in stainless steel reactor using perfluorinated membrane reinforced with poly(tetrafluoroethylene) fibre. Feed flow, retentate flow and vacuum pressure were controlled during conducted experiments. For each test mass of collected permeate was weighted. Concentration of hydrogen peroxide was measured in collected samples (permeate, solution in the feed tank at the beginning and at the end of experiment).

Test number	Vacuum pressure $[mbar]$	Average flow $[g/min]$	Mass fraction $[-]$	Permeate flux $[g/(s \cdot m^2)]$	H_2O_2 flux $[g/(s \cdot m^2)]$	Selectivity $[-]$
III	57	22,0	0,0285	2,85	0,0812	1,61
XXIII	52	9,1	0,0305	1,91	0,0584	1,61

Table 1: Parameters of experiments with the highest values of hydrogen peroxide mass fractions in permeate obtained

Collected data was used to calculate flux for hydrogen peroxide in permeate, mass fraction of hydrogen peroxide in permeate and feed and selectivity of separation process for hydrogen peroxide over solvents (water and ethanol). The highest concentrations of hydrogen peroxide in permeate obtained in conducted experiments were: 2,85% and 3,05%. Tests' parameters are presented in the Table 1.

Conclusions

Based on conducted experiments perfluorinated membrane reinforced with poly(tetrafluoroethylene) fibre was not only more durable, but also more stable during the separation process than polyacrylonitrile membrane. It was found that data collected during experiments with stainless steel reactor with one bigger membrane surface (25 cm^2) were more repetitive than for tests with PVC reactor with three smaller process surfaces (4,5 cm^2). Hysteresis loops which occurred for experiments conducted with decreasing and increasing vacuum pressure during successive experiments were also less significant. It was found that during pervaporation process conducted on perfluorinated membrane reinforced with poly(tetrafluoroethylene) fibre to separate hydrogen peroxide water-ethanol solution, obtained concentration of hydrogen peroxide was higher on the permeate side than on the retentate side of membrane. The highest obtained concentration of hydrogen peroxide in permeate was 3,05%.