Development of catalytic membranes for direct synthesis of Hydrogen Peroxide

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Motivation

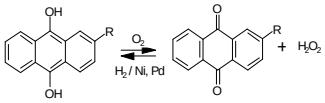
- Hydrogen peroxide may be produced by direct reaction of H_2 and O_2 on a heterogeneous catalyst

$$O_2 + H_2 \longrightarrow H_2O_2$$

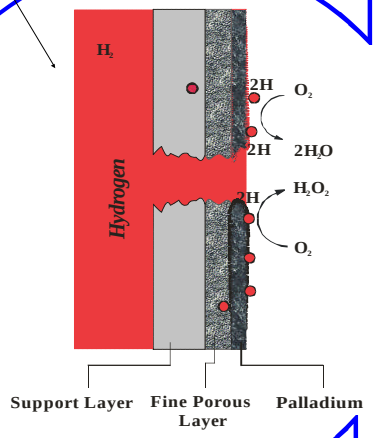
- Reaction is thermodynamically favourable
- Low temperature and high pressure have positive effect on yield
- Tubular ceramic membranes (TCM may be employed as a new type of heterogenous catalyst. They are composed of support layer, fine porous layer and active noble metal e.g. Pd. They offer following advantages:
- *No direct contact between H_2 and O_2 thus safer operation*
- *Reaction rate is not impeded by the solubility of H_2 in liquid medium*
- *Easy scale-up*
- *Efficient gas liquid contact on the solid surface of a TCM*

Conventional process

Hydrogen peroxide is mainly manufactured via Antrachinone process:



- Large investment cost
- Only suitable for large production units
- High cost of redox couple and solvent system
- Number of side reactions in the system
- Energy demanding purification and separation

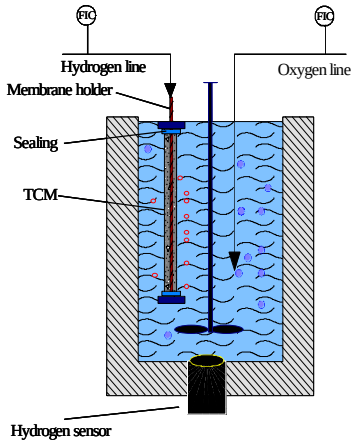


Expected benefits of the project

- Possibility of employing this simple process in various industrial oxidations (propene to propylene oxide, benzene to phenol, linear alkanes to corresponding alcohols)
- In some oxidation processes even quite diluted solutions of hydrogen peroxide are sufficient for the reactions to proceed
- Simplicity of the reaction lineup and easy scale-up allowing the on site use of small units without the need for peroxide separation or purification.
- Possible to use in wastewater management
- The long term goal of the project is to perform production of hydrogen peroxide and the consecutive oxidation in a single membrane reactor
- Significant cost reduction of the production

Experimental setup

- Stainless steel pressure vessel
- Working temperature up to 250 °C
- Working pressure up to 10 bar with glass jacket and up to 70 bar with stainless steel jacket



Technical Objectives

- Selection of the suitable materials for support and the fine porous layer of TCM.
- Development and optimisation of the synthesis of TCM for the hydrogen peroxide production
- Optimisation of the reaction conditions mainly, temperature, partial pressure of the reactants, additives and reaction media
- Achieving uniform and well defined structure of the noble metal on the surface of the fine porous layer of the TCM.
- Scientific assistance in a development of a commercial process

Achievements

- The apparatus has been assembled
- Method for analyzing the reaction mixtures has been selected
- The automation of analytic assay of peroxide is in progress
- Preliminary decomposition tests with different inorganic support materials have been performed
- Membranes containing Pd layer on the surface have been prepared

Example of TCM (Support: alfa-Al_2O_3, coated with Palladium by CVD).

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