NEW TYPES OF MEMBRANES FOR ELECTROLYZER

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ABSTRACT

This article discusses about the use of nonwoven fabric as membranes for electrolyzer for hydrogen and oxygen production. The goal is to find and measurement of such materials which are suitable for use in electrolyzers and will also be more affordable than commercially available membranes.

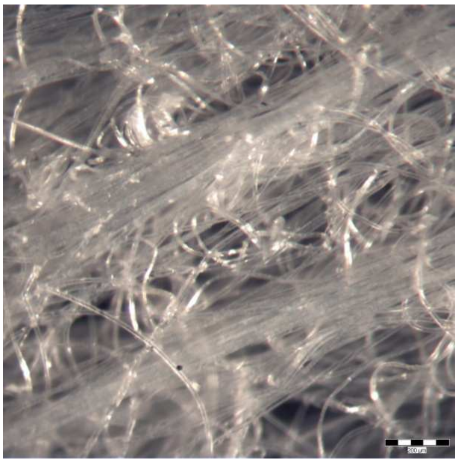
1. INTRODUCTION

In this article we will deal with the production of hydrogen by decomposition of water into hydrogen and oxygen. Hydrogen can also be produced by other ways, for example processing of natural gas, but is not as environmentally beneficial as electrolysis. In addition, by using of electrolysis we are producing very clean hydrogen. Watter is decomposed in machine called Electrolyzer. For our measurements has been designed a simple laboratory electrolyzer with two electrodes, separated by an appropriate membrane. Distance of electrodes is 2 cm and area of each is 25 square centimeters. Electrolyzer was filled for the measurement of 1 MOL KOH electrolyte into 80% of its height.

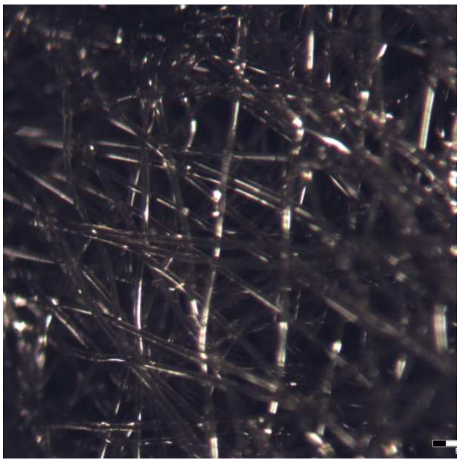
2. ANALYSIS

On the electrolyzer membrane we have a few basic requirements. The primary requirement is the absolute impermeability of produced gases and thus prevent formation of explosive mixture. It is also required sufficient strength and stability of parameters in a strongly alkaline environment. The membranes for electrolysis must also have ionic conductivity, which is necessary for decomposition of water into hydrogen and oxygen. Commercially produced membranes satisfactory this requirements, but due to their high cost are less available and their use would greatly raised the price of terminal equipment. For membranes were used non-woven fabric selected from the company BTP from Brno, concretely fabrics the PDC 95, PEG 50, VPK PES / SOL, then the membrane from DEC company and last Sontara® membrane from DuPont company. Measurement of each membranes was realized in electrolyzer under given conditions at constant current 400 mA for 24 hours.

During the measurements were continuously monitored the level of electrolyte in the electrolyzer to avoid its loss and consequently to influence the measurements. Electrolyte was also continuously being changed, owing to its gradual degradation during measurement. One of the negative properties of non-woven fabrics is their permeability to gases. This negative feature in our case is partly eliminated by sealing of part of the membrane, which is not immersed in electrolyte, into gas impermeable plastic foil. In the final case we don´t separate two gases, but only the individual bubbles of gas dispersed in the liquid. Very important in this case is the density of fiber membranes. The following pictures are photos of each membrane under a microscope at a magnification of 90x.

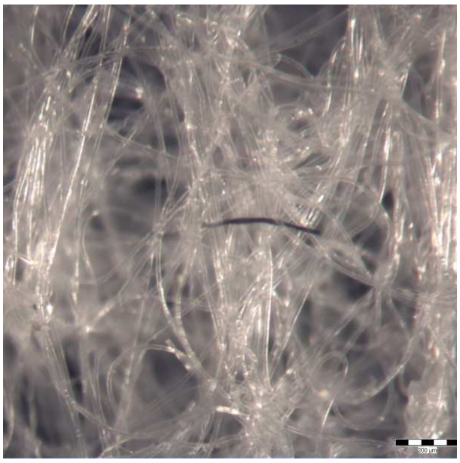


Pic. 1 - DEK white

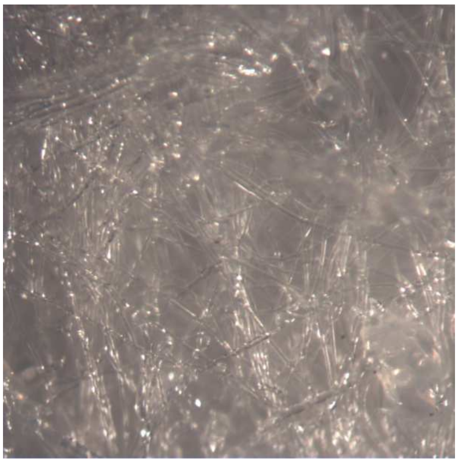


Pic. 2 - PEG 50

Pic. 3 - Sontara® Dupont



Pic. 4 - PDC 95



Pic. 5 - VPK PES/SOL

You can see at the pictures that the greatest fiber density of the membrane VPK PES/SOL from BTP company. The lowest density has the membrane PEG 50 from the same company. Fiber density of other membranes is approximately the same. Generally speaking, if the fiber density is higher, the gas impermeability of membrane will be better. Another important factor is the membrane resistance. It means how specific membrane increases voltage of electrolyzer if the current is constant and also how they reduce reduce the overall efficiency of electrolyzers. The following graph shows measurement of electrolyzer voltage in time for various membranes.

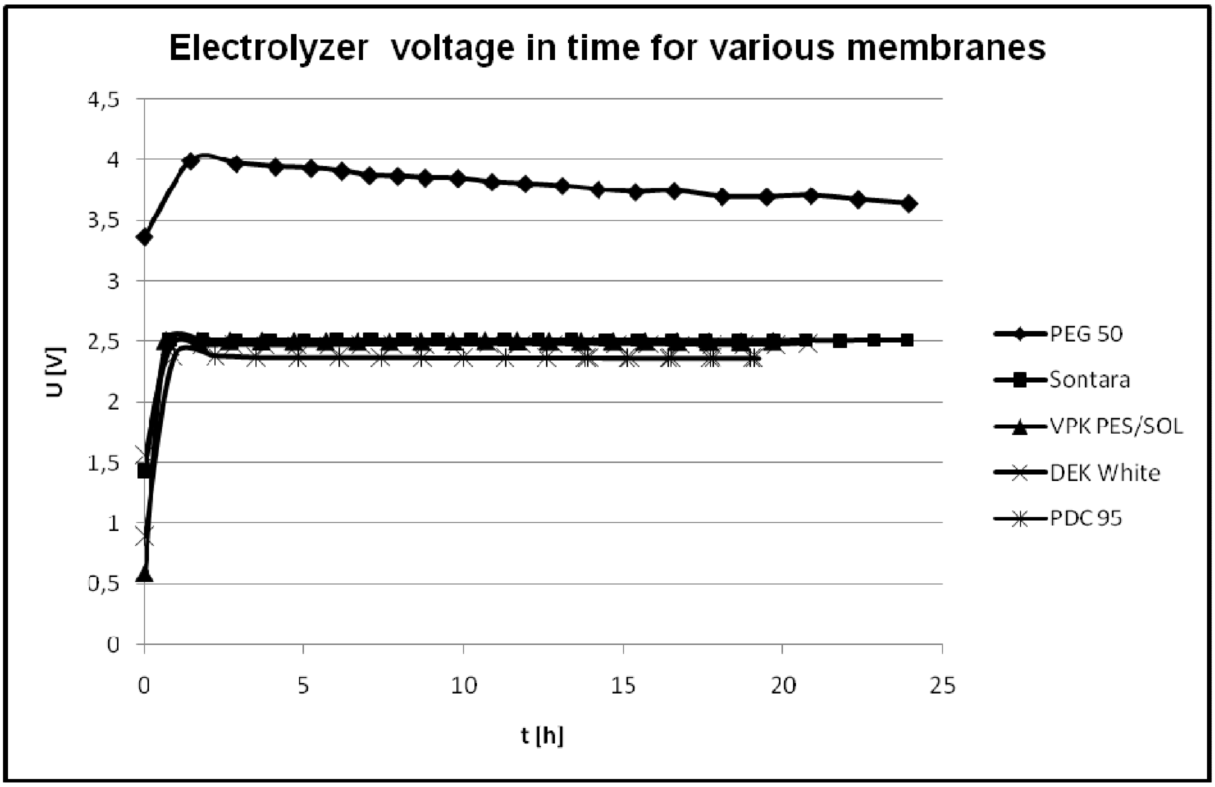


Fig. 1 – Electrolyzer voltage in time for various membranes

Before measurement, each membrane was dipped for 2 hours in the electrolyte to result in a perfect dipping. As the graph shows, the voltage waveform on electrolyzer is at approximately the same for all membranes except membrane PEG 50. This membrane probably contain a certain proportion of conductive additives, which are behaving as another electrode in electrolyzer. This fact causes higher electrolyzer voltage when this membrane is used and the creation of gas bubbles in the surrounding membrane, which was verified visually during the measurements. Gas bubbles also cause a slight nonlinearity of electrolyzer voltage in time, because their layer on the membrane restricts the passage of current and this creates a higher voltage drop on electrolyzer. Electrolyzer voltage with other membranes is in time linear and constant. Lowest voltage 2,38V was achieved by using membrane PDC 95 from the company BTP. For other membrane voltage was around 2.5 V.

3. CONCLUSIONS

Using measurement we ascertained, if is possible to use non-woven fabrics as membranes for electrolyzer. Most of the tested membranes proved to be suitable for this use. The best results were achieved with the membrane PDC 95. By using this membrane electrolyzer voltage was only 2,38V. Subject of further research will be hydrodynamic properties of membranes, especially for the throughput for generated gases.

The advantage of non-woven fabrics is their low price compared with commercial membranes. Using a non-woven fabrics as membranes for electrolyzer would be achieve significant saving in design and manufacture of electrolyzers. So, this equipment has become more affordable than with using commercial membranes.

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