Comparison of Silica Based Reference Electrode Membranes in the Electrorefining Process

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1. Introduction

The purpose of this paper was to investigate the performance of different reference electrode membranes during the electrochemical reduction and electrorefining process in the pyroprocessing. The reference membranes are compared in terms of electrochemical stability and reusability at different conditions regarding temperature, concentrations etc. In this paper, pyrex, quartz and mullite are tested for the reference electrode membrane.

2. Experimental Setup

2.1 Reference electrode setup

The silver wire and the reference electrode solution enclosed in the membrane was utilized as the reference electrode. LiCl-KCl eutectic was chosen as an electrolyte, since it is widely used in the electrorefining processes. The reference electrode solution is made by melting 1 wt% of AgCl into the LiCl-KCl eutectic.

2.2 Experimental setup

The experiments are carried under Argon (99.99%) environment with moisture and oxygen level maintained around 1ppm. The furnace which can go up to 900°C and potentiostat which can provide voltage from -4 to 4V and current range up to 20A are utilized in this experiment to measure the electrochemical data.

2.3 Experiments

The cyclic voltammetry was performed to check the resistance of the membrane indirectly. To measure the cyclic voltammetry, 0.5 wt% of $CoCl_2$ was added in the electrolyte to clearly identify the peaks. The reusability of the three material are compared by checking whether it shows external defect after the experiment and whether it requires desalination process for resuing.

3. Results and Discussion

3.1 The cyclic voltammogram using different reference electrode membranes

The cyclic voltammogram using different membranes are shown in the below figures. The voltammogram using the mullite membrane showed clear signal with little noise. In case of the pyrex membrane, the voltammogram showed distorted signal near the reduction peaks at 650 °C. The voltammogram with quartz membrane had noisy signals at all the potential range at 500 and 650 °C.

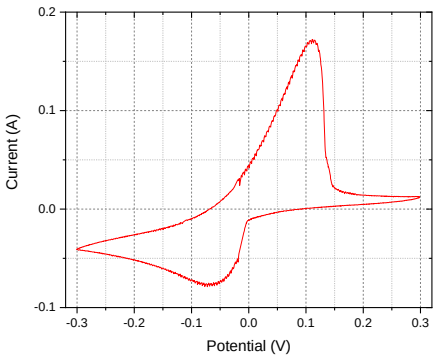

Figure 1. The Cyclic Voltammogram Using the Mullite Membrane

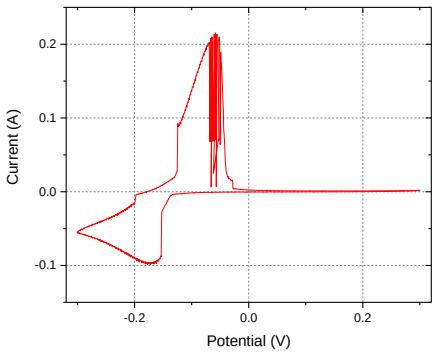

Figure 2. The Cyclic Voltammogram Using the Pyrex Membrane

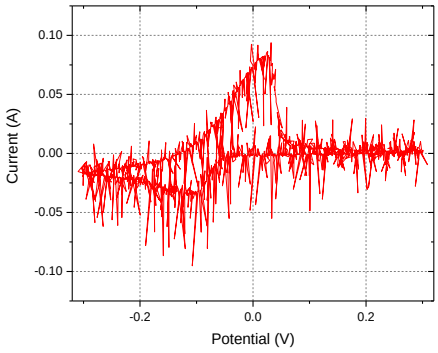

Figure 3. The Cyclic Voltammogram Using the Quartz Membrane

3.2 The reusability of the membrane materials

In case of pyrex membrane, it showed distortions after the experiment. Pyrex undergoes phase change at relatively low temperatures compared to the other two material, which makes it difficult to reuse. The quartz membrane showed no external defects after it has been used, making it possible to be reused. The mullite membrane needed desalination process after being used. The cyclic voltammogram comparing with and without desalination process are shown below.

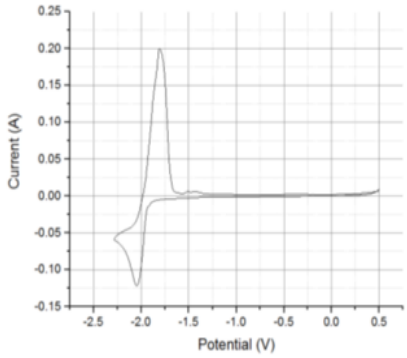

Fig 4. The Cyclc Voltammogram Using New Mullite Membrane

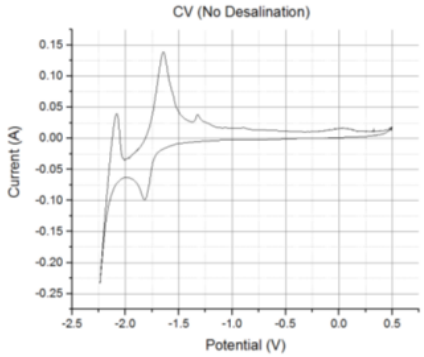

Fig 5. The Cyclc Voltammogram Using Used Mullite Membrane

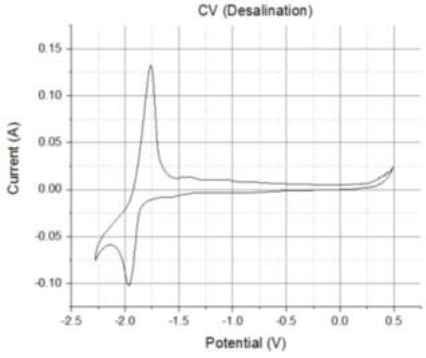

Fig 6. The Cyclc Voltammogram Using Used Mullite Membrane after Desalination

4. Conclusion

The performance of the reference electrode membranes for the electrorefining process was compared. Reference electrode using mullite membrane showed the most stable cyclic voltammogram among the three material. Also, the mullite membrane could be reused after the desalination process. This implies that the mullite membrane might be the most suitable as the reference electrode membrane for the electrochemical processes in pyroprocessing..

REFERENCES

List and number all bibliographical references in 9-point Times, single-spaced, at the end of your paper. When referenced in the text, enclose the citation number in square brackets, for example [1]. It is recommended that the number of references does not exceed five.

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