6 CONCLUSIONS

Through this study, the unifying goal of improving the understanding of electrolysers was accomplished. The experiments that were carried out contributed to a better grasp of the optimal conditions under which electrolysers perform to their full potential, produce a greater quantity of hydrogen, and study the production rates as well. Additionally, it assisted in the confirmation of a great deal of theoretical understandings.

In general, electrolysers are dependable pieces of equipment that do not call for consistent maintenance because they contain almost no moving parts. On the other hand, the fact that these devices are completely silent and highly modular makes them an excellent choice for decentralized applications that are near residential, commercial, and industrial areas. It was essential, when viewed through this lens, to investigate how the problem of the non-renewability of the resources can be bypassed using hydrogen, given the current significance of the concept of "green hydrogen" and the worldwide efforts to reduce pollution caused by fossil fuels.

Although there are multiple types of electrolysers, it was very interesting to work with proton exchange membrane. This is due to several reasons. According to a report by Mekhilef et al. [39] efficiency of proton exchange membrane electrolyser (PEMEL) is 50-60%. Incorporating surfactants towards the working fluids or functionalizing nanoparticles may enhance nanofluid stabilization for PEM electrolyser. The efficiency of a PEM system is anticipated to increase to between 67% and 74% [40]. PEM electrolysis has the benefit of reacting rapidly to the fluctuations typical of renewable energy production. Because the equipment is low-maintenance and produces high-quality gas, this technology is frequently applied to distributed systems. It inverts the principle of the fuel cell and requires no liquid electrolyte.

In this study, the PEM electrolyser device was tested under varying power values and elevated temperatures. In addition, same conduction was done for three individual water types, each having different pH and conductivity values. Through recording the time taken for each of the waters that were acting as an electrolyte, it was possible to conclude regarding the water type that would yield the highest efficiency.

Just as the literature stated, there were several concepts that were reconfirmed through the experiments. Firstly, the polarization curve helped us understand the correlation of voltage, current, and temperature. Higher voltage at elevated temperatures showed higher current yield. This was seen for all three types of water, with water type 1 and 2 performing better.

Secondly, the hydrogen production graph showed the correlation of time with the other factors. Generally, it took lesser time to produce the same volume of hydrogen when the power values and the temperatures were incrementally raised. Water 2 had performed better than the others, taking the least amount of time to produce the same volume of hydrogen.

Thirdly, when it came to energy efficiency, the comparative behaviours were similar. Water type 2 was the most efficient. Except for two specific power values, water type 1 was slightly better than water type 3. It was conclusive that with increased temperature, there is increase in efficiency.

Lastly, after generating graphs for the Faraday efficiency curve for all the three water types, it showed that for all of them, the efficiency was about 100%. The values for Faraday efficiency were higher than energy efficiency since Faraday efficiency calculations takes into consideration the losses due to gas crossover. What gas crossover means is that there could also be unwanted reactions when electrons or ions are involved. These losses show up as heat or as chemical waste. Some of the electrons separated from hydrogen at the anode leak through the membrane and directly reach the cathode. In a perfect world, the electrolyte membrane would be an ideal insulator and prevent this from occurring. Following Figure 4.17, under each specific power value, the Faraday efficiency seems to decrease by a small margin. We see that water type 2 has performed better than the other types.

From the graph, we also see that water type 3 has performed better than water type 1. Water type 3, the Sigma-Aldrich 270733, regardless of its less acidic properties, is a very clean water. It is used for High-performance liquid chromatography (HPLC) and therefore, it is used for very sensitive instruments. This implies that water type 3 would not have performed poorly regardless of its basic nature. The non-spontaneous nature of water decomposition reactions must be investigated future in depth, and additional experiments must be carried out, to achieve a better knowledge of how this happened.

Water type 2 shows the best performance (high current, hydrogen production, energy, and Faraday efficiencies) probably due to lowest conductivity which means it has the lowest concentration of ions in water which can influence the H^+ conductivity of the membrane.

In conclusion, PEM Water Electrolysis is a very promising method, using proton exchange membrane as the electrolyte that permits the transfer of protons from anode to cathode when electricity applied from outer circuit. Despite the maturity of the electrolysers, there is still a long way to go regarding improvements in energy efficiency, given the fact that the cost of the hydrogen produced is very closely related to the consumption of electricity during the process. If the shortcomings are readily optimized, PEM electrolysers will provide a sustainable solution for the future clean production of high pure hydrogen.

7 KOKKUVÕTE

PEM-i vee elektrolüüs on väga paljutõotav meetod, mis kasutab prootonivahetusmembraani elektrolüüdina, mis võimaldab elektri kasutamisel prootonite ülekandmist anoodilt katoodile. Temperatuur, võimsus ja vee kvaliteet mõjutavad PEM elektrolüüsi jõudlust. Uuringus testitud kolmest veetüübist näitab et madalaima juhtivusega veetüüp saavutab parimat jõudlust (suur vool, vesiniku tootmine, energia ja Faraday kasutegur), mis tähendab, et sellel on madalaim ioonide kontsentratsioon, mida mõjutab membraani H+ (prooton) juhtivust.