Green hydrogen is a promising fossil fuel replacement for reaching the net-zero emissions goal by 2050. Water electrolysis, powered by renewable sources produces green hydrogen. Three types of water electrolyzers exist at low temperature: alkaline (AWE), proton-exchange membrane (PEMWE) and anion exchange-membrane (AEMWE) water electrolyzers as shown in figure 1.

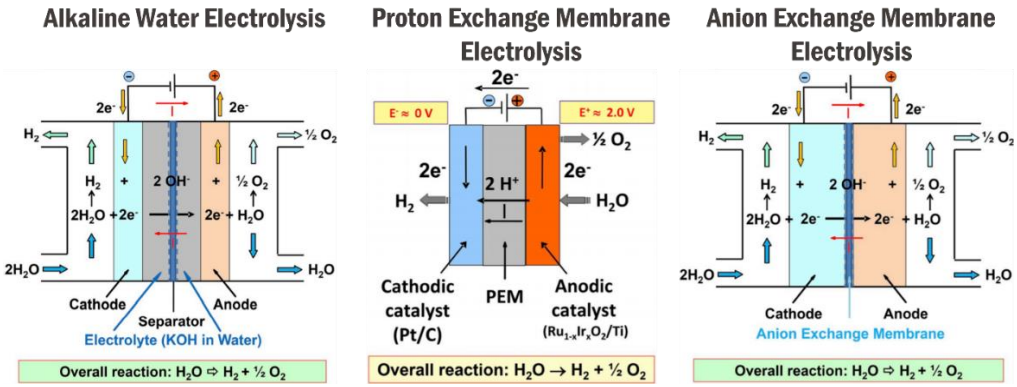

Figure 1: Three types of low temperature electrolyzers: AWE, PEMWE and AEMWE, shown from left to right

AEMWE is the most recent electrolyzer type among the three and will be the focus of the semester project. Similarly to AWE, AEMWE is known for using cheap Ni and Fe based catalysts in alkaline media. As in PEMWE, AEMWEs also use membranes for separating the anode and the cathode to increase produced hydrogen purity and cell performance. In fact, AEMWE combines cheaper catalysts with higher performance from AWE and PEMWE respectively. However, since it is still a new technology, AEMWE suffers from shorter lifetime and higher degradation rates. Table 1 summarizes the characteristics of AWE, PEMWE and AEMWE.

	AWE	PEMWE	AEMWE
Electrolyte	20-40wt% aqueous KOH	Proton exchange ionomer	Anion exchange ionomer
Cathode	Ni, Ni-Mo Alloys	Pt, Pt-Pd	Ni, Fe, Mo, Co Alloys
Anode	Ni, Ni-Co Alloys	RuO_2, IrO_2	Ni, Fe, Co Oxides
Separation	Diaphragm	PEM	AEM
Current Density [$A.cm^{-2}$]	0.2 - 0.4	0.6 -2	0.2 - 1
Gas Purity [%vol]	> 99.5 %	> 99.9999 %	> 99.99 %
Response Time	sec	ms	ms
Lifetime [h]	60,000 - 100,000	20,000 - 60,000	10,000
Technology Status	Mature	Commercial	R&D

Table 1: Summary table for AWE, PEMWE and AEMWE characteristics

The goal of the semester project is to perform electrochemical impedance spectroscopy (EIS) simulations of a 3D AEMWE in COMSOL and validate the results with real experimental data. The role of the student is to improve the already existing model by considering the effect of a two-phase flow on the AEMWE electrochemical performance. A sensitivity analysis will be performed to determine the most important parameters that contribute to the AEMWE performance.

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