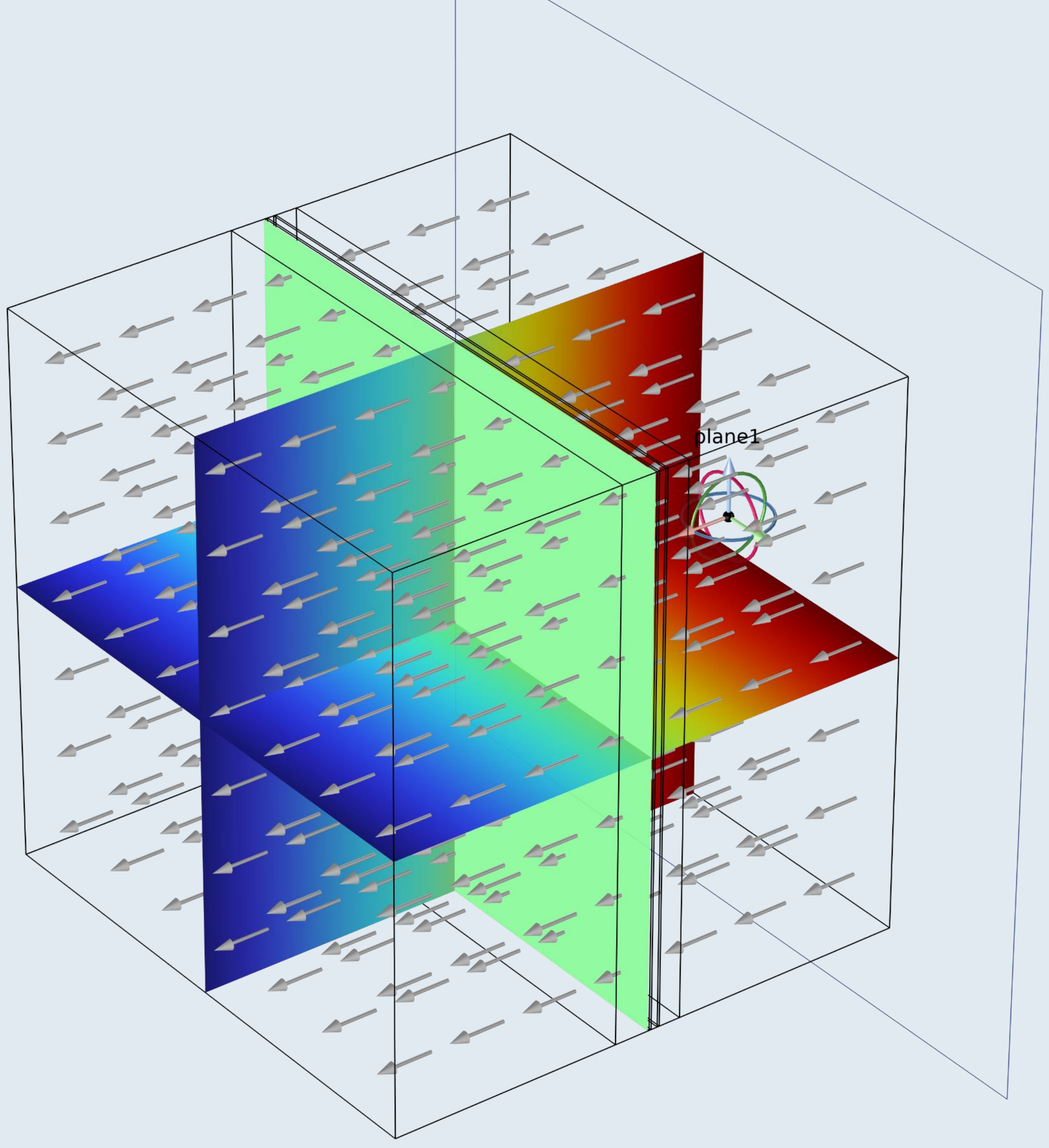

Comparison of AEL and AEM electrolyser technologies

I-V curves of classical alkaline electrolysis are compared with zero-gap configuration and anion exchange membrane electrolysis.

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Introduction & Goals

Alkaline Electrolysis (AEL) used in industry for half a century, is a key technology for large-scale hydrogen production powered by renewable energy in the ongoing energy transition.

However, research is done to go from "classical" AEL to zero-gap configuration and alkaline anion exchange membrane (AEM) electrolysers, in which the anions OH^- are transmitted through the membrane and not by the electrolyte (KOH).

Several advantages are claimed by R&D groups around the world. The introduction of bipolar plates, gas diffusion layers for gas removal and selective ion separator changes the way how the gas is produced and evacuated from a cell, and how heat is produced inside the cell. The main objective is to develop models to understand the influence of the components to maximize the current density.

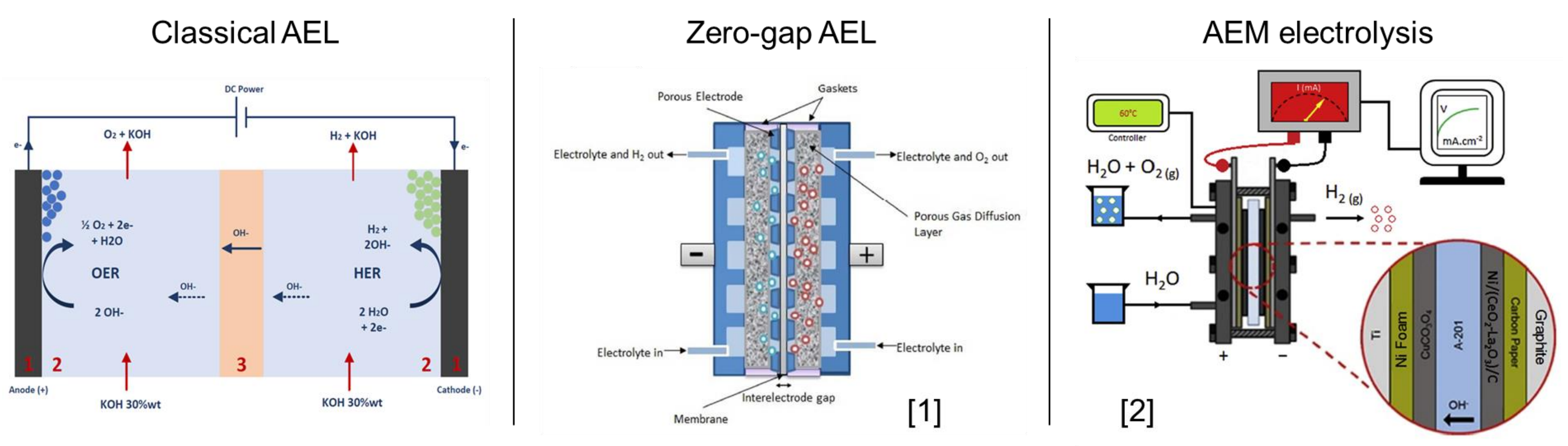

FIGURE 1. Three types of alkaline electrolysers. Zero-gap and AEM electrolysers have a different geometrical arrangement than the classical one.

Methodology

The Water Electrolyser (we) and Euler-Euler Laminar Flow (e-e) Modules were used to model these different types of electrolysers, to highlight the differences in the geometrical parameters and material properties (Figure 1) and their impact on the polarisation curve (I-V, Figure 2).

Electrolyte temperature and conductivity, pressure, porosity of the electrodes and gas diffusion layers are parameters strongly influencing the current density in the separator (diaphragm for classical and zero-gap AEL and membrane for AEM). Simulations were made without gas flow for all configurations, only for the classical AEL gas flow was allowed for comparison.

Results

Figure 2 presents the polarisation curve of the different electrolyser configurations. The parameters of the electrolyte (conductivity, temperature, pressure) and the porosity of the media (electrode, gas diffusion layers) were kept constant for the different configurations. The separator porosity and conductivity were adapted according to literature.

Adding gas flow in the classical alkaline configuration lowers the current density due to bubble coverage of the electrodes. A comparison to experiments in the literature allows two more observations. The voltage at which the current density increases for the zero-gap and AEM is about 0.3 V higher than expected. The slope on these configurations is about twice as steep as for the classical AEL, as expected. More investigations need to be done to understand which of the contributing resistances are overrated in the simulations. Moreover, cross diffusion of gases should also be considered to judge the performance of H_2 and O_2 generation (gas purity).

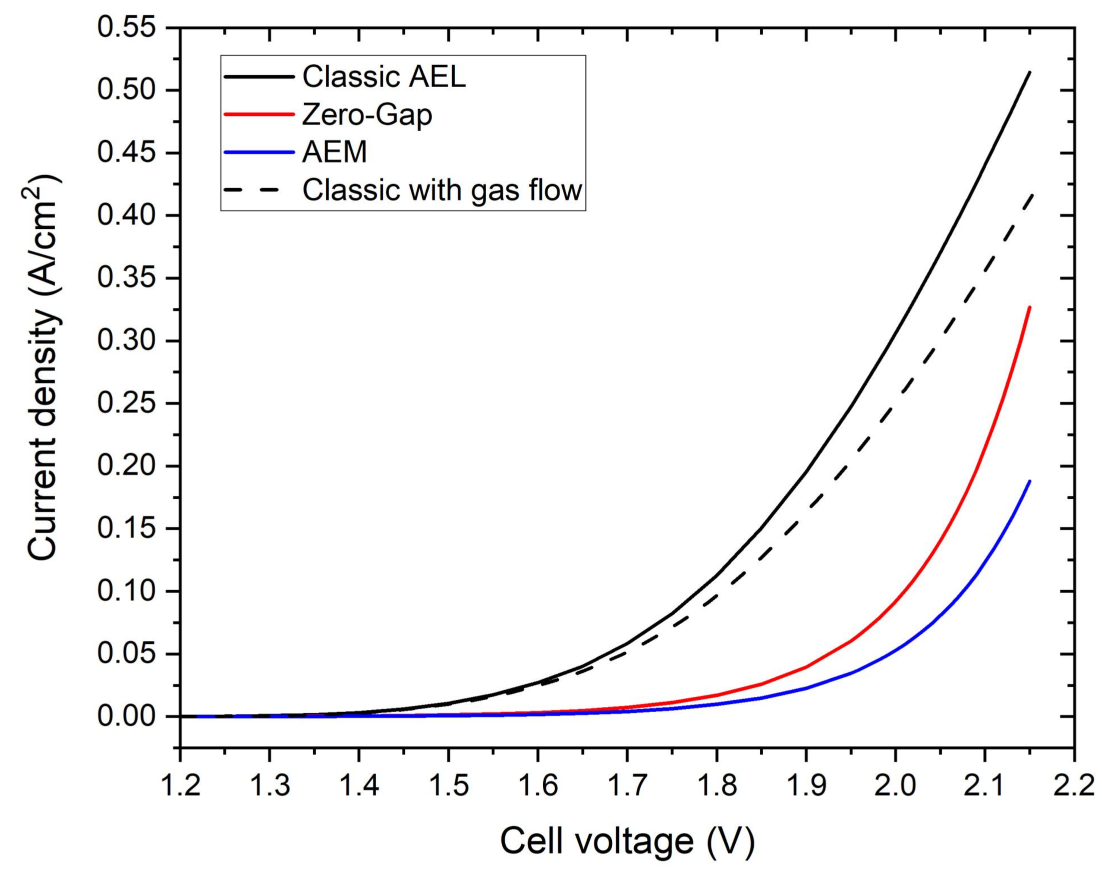

FIGURE 2. Polarisation curve of the different electrolyser configurations, highlighting the effect of the distance between the electrodes and the separator type.

REFERENCES

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