Developing tailored materials for the industrial production of AEM electrolyzers through a statistical approach

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Hydrogen-related technologies, such as water-based electrolyzers, are recognized as one of the most promising solutions to overcome the continuous increasing of the energy demand, but more research is needed to their mass application [1]. In this context, new materials research and development play a main role as the materials currently most established have several critical issues, including: the use of relatively expensive but high efficiency materials, such as Platinum in proton exchange membrane (PEM) electrolyzers and Copper in anion exchange membrane (AEM), or metals that are poorly durable but inexpensive, such as Nickel and derivatives for AEM electrolyzers [2]. Some intermediate solutions between these two limited configurations can be considered, such as through the design of composite or multilayers, however, the benefit/cost ratio must be careful considered since, for example, end-of-life costs also must be taken into account, and this may be greater as the material is composed of several phases. With the aim of limiting these critical issues and optimizing the performance of AEM electrolyzers, in this research analytical mathematical models related to the selection of anode, cathode, and membrane materials have been developed through multivariate analysis.

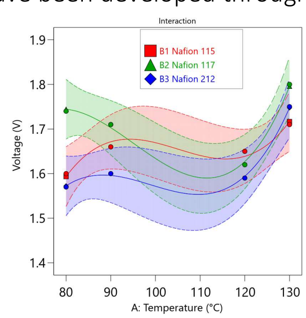

Figure 1. Interaction plot related to Voltage @ 1 A cm^{-2} depending on working temperature and materials' membrane.

Firstly, the activities have involved an extensive and detailed literature search, both on academic and commercial data. Subsequently, an objective evaluation and selection of such solutions has been done through a multidisciplinary approach involving not only data from literature but also already collected dataset and laboratory tests (chemical and technological). This phase has been conducted through a rational approach based on multivariate data analysis (ANOVA) capable to (i) derive objective results from literature data and (ii) to minimize the number of laboratory tests and samples to be tested. Thereafter, this approach would save resources by obtaining the maximum amount of information possible to support the generation of robust and predictive mathematical models [3]. The selection of materials in this way will aim to gather the most suitable materials based on objective criteria, such as environmental and economic sustainability, production efficiency, possibility of industrial scale-up, etc. that will enable the development of electrolyzers that are increasingly efficient and sustainable.

References

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