Water Electrolysis for Hydrogen Production: Technologies and Applications

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The European Commission has set an ambitious climate target plan for the next decades. The plan aims to reduce greenhouse gas emissions to at least 55% below 1990 levels by 2030 and reach climate neutrality (net-zero greenhouse gas emissions) by 2050. In this framework, hydrogen, as an energy vector, can play a key role by contributing to the decarbonization of several sectors. Therefore, hydrogen has the potential to be used in several applications: from industry (steel production, refinery, and ceramic) to transport (heavy transport, railway, naval, and public) and power generation (power-to-X and fuel cells). However, sustainable hydrogen production is still under investigation worldwide. In this regard, the production technology chosen for hydrogen production is strongly linked with the specific hydrogen application and the relative environment. Nowadays, hydrogen is mainly produced via steam methane reforming (SMR) with the relative carbon emissions associated to the process. This is usually referred to as "grey hydrogen". An alternative to the SMR process is represented by water electrolysis; this process uses electricity to split water into hydrogen and oxygen with, potentially, zero carbon emissions. When the electricity used for the electrolysis process comes from renewable energy sources, the produced hydrogen is usually called "green hydrogen". In the last decades, the research on electrolysis technologies has strongly increased leading to the commercialization of mainly alkaline and proton exchange membrane (PEM) electrolysers. Several other electrolysis technologies are under study and start to appear on the market: solid oxide electrolysis cells (SOEC), anion exchange membrane (AEM), and proton-conducting ceramic (PCC) cells. However, additional methods for hydrogen production are also considered in the Strategic Research and Innovation Agenda (SRIA) presented by Hydrogen Europe and Hydrogen Europe research in October 2020[1]: hydrogen production from raw biogas, photocatalytic water splitting, biological hydrogen production, solar thermal production of hydrogen, hydrogen production via pyrolysis, and hydrogen production via waste/biomass gasification.

This study aims to provide an overview of several hydrogen production together with existing and possible hydrogen applications.

[1] https://www.hydrogeneurope.eu/wp-content/uploads/2021/04/20201027-SRIA-CHE-final-draft-1.pdf