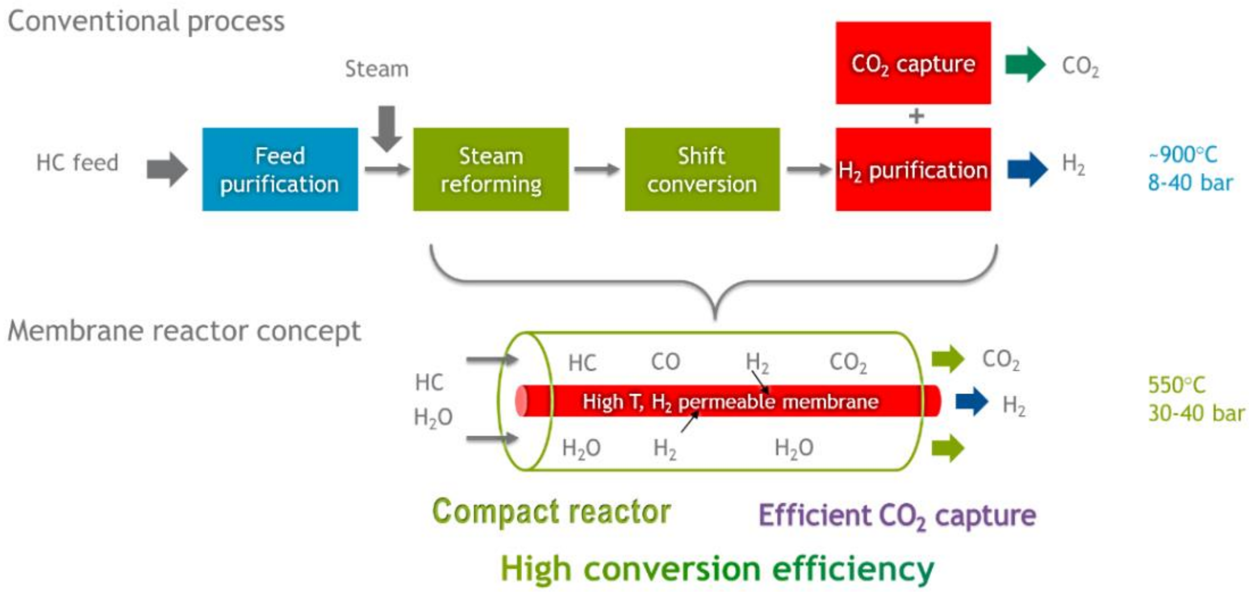
Palladium membranes technology developments for decarbonization: industry perspective

Aadesh Harale[a,*]
[a] Saudi Aramco, Saudi Arabia
[*] aadesh.harale@aramco.com

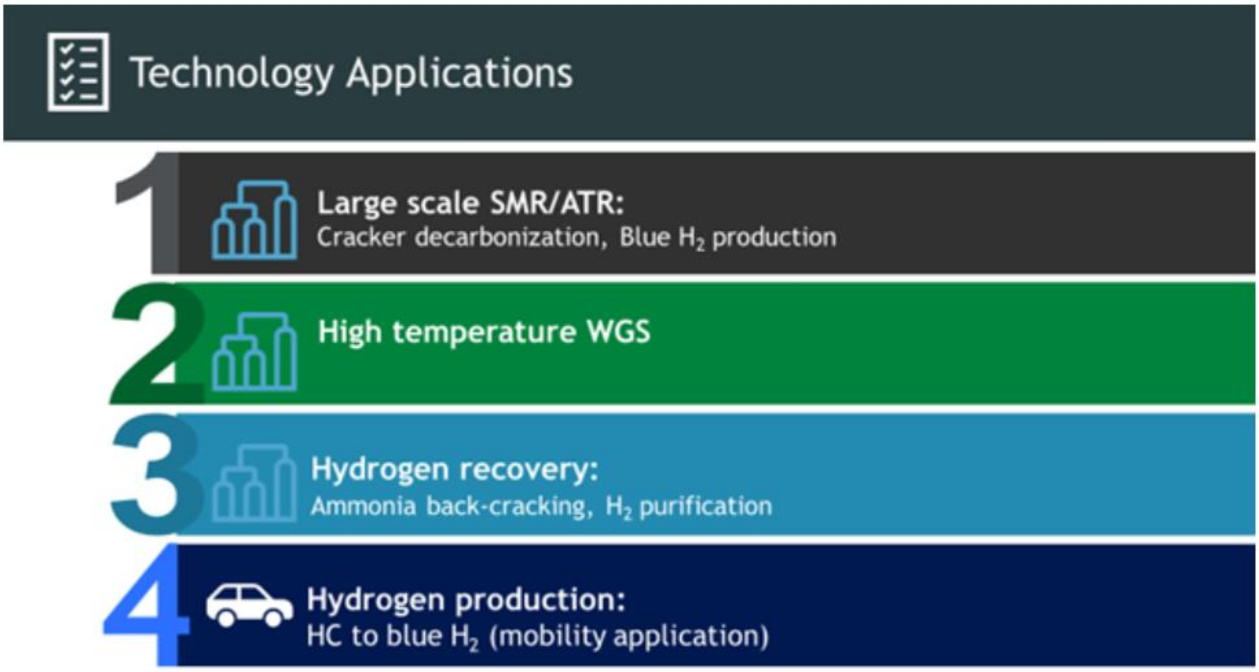
Abstract

With the rising concerns of climate change and greenhouse gas emissions, governments and companies are looking for ways to reduce their energy intensity and carbon footprint. Regulatory pressure on conventional hydrocarbon-based energy systems is expected to increase over the next few decades, encouraging further evolution and penetration of alternative low-carbon and carbon-free solutions. It is important to note that this increasing pressure is stemming not only from the concerns over climate change and greenhouse gas emissions, but also the growing concerns over urban air quality. Renewable energy such as solar, wind and geothermal is often part of the technology portfolio addressing climate change and complementing current approaches using carbon dioxide capture. Hydrogen is gaining traction as a clean energy carrier as it can be produced by, for example, water electrolysis using renewable power. Hydrogen may also be produced from fossil fuels by, for example, coal gasification, biomass gasification, or the reforming or partial oxidation of natural gas or other hydrocarbons. The produced Hydrogen can be a feedstock to chemical processes, such as fuel cells, ammonia production, aromatization, hydrodesulphurization, and the hydrogenation or hydrocracking of hydrocarbons. The hydrogen can also be used as a fuel for decarbonization of industrial assets, for power generation through fuel cell or through combustion in a gas turbine or combustor.



Membrane reformer-based hydrogen production technology is suitable for low carbon hydrogen production or separation. The Figure above shows the membrane reformer concept where a hydrogen selective membrane is integrated with the reforming catalyst bed to continuously remove hydrogen as it is being produced. The simultaneous hydrogen generation and separation eliminates the limitation of thermodynamic equilibrium This process intensification allows the combination of the reaction, separation and purification into one single unit. The process intensification also allows to eliminate several process steps. Membrane reformer system can be configured much more compactly and is also more efficient than the conventional process. Another major advantage of the membrane reformer system is the high concentration of carbon dioxide in the off-gas (concentrations as high as 90%), which reduces the energy and cost penalty associated with CO2 capture.

The palladium membrane reactor as a pre-combustions CO2 capture technology has several applications. Technology is suitable for industrial scale hydrogen production in integrated steam reforming process or with membrane integrated water-gas shift reaction in conjunction with Steam Methane Reforming (SMR) or autothermal reforming (ATR), it can also be used a hydrogen separation/recovery technology or extracting hydrogen from dehydrogenation reactions (ammonia cracking, hydrocarbon cracking). Below figures shows identified applications relevant to Industry interests and these applications are being evaluated.



Presentation will discuss Aramco's research progress in the Pd-alloy based membranes, membrane reactors and process developments for decarbonization of industrial processes. The purpose is to share insights about the status and main challenges related to Pd-based membranes for hydrogen production or separation and large-scale industrial deployment.