GEN IV International Forum℠
Expertise | Collaboration | Excellence

GIF VHTR Hydrogen Production Project Management Board

Summary / Objectives:

The objective of the GIF VHTR Hydrogen Production Project Management Board is to provide a collaborative environment among the signatories for the development, optimization and demonstration of economical large-scale hydrogen production processes that do not emit greenhouse gases through the use of nuclear energy. The main processes considered by the signatories include Sulphur-Iodine (S-I), High Temperature Steam Electrolysis (HTSE), Copper-Chlorine (Cu-Cl) and Hybrid Sulphur (HyS). The signatories include Canada, EU, France, Japan, Korea and the USA. China has been an observer, waiting to join the group formally, but contributing strongly to the developments. The S-I process has been demonstrated for short term operation by China, Korea and Japan. EU, France and the USA have been very active in HTSE. Canada has been focusing on the Cu-Cl Cycle with plans for demonstration of an integrated lab-scale system in 2021. This webinar will provide an overview of these activities and their relevance to mitigating global warming.

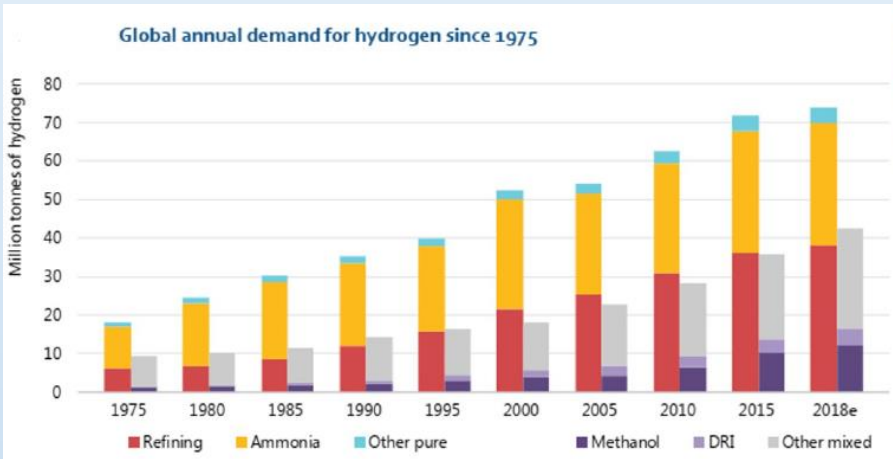
Meet the Presenter:

Dr. Sam Suppiah is currently the manager of the Chemical Engineering Branch and the Facility Authority for Tritium Facility Operations at the Canadian Nuclear Laboratories (CNL), Chalk River, Ontario. He earned his chemical engineering degree and PhD from the University of Birmingham, UK, and worked for a contracting company and British Gas Corporation in the UK before joining AECL (now CNL). He is a Professional Engineer in Ontario, and a certified Project Management Professional (PMP).

He has more than 35 years of expertise in the areas of Heavy Water and Tritium, Catalysis, Electrolysis Technologies, Fuel Cell Technologies, Nuclear and non-Nuclear Battery Technologies, Hydrogen Production from High and Medium Temperature Thermochemical Processes, Steam Electrolysis and Energy Storage. His current focus at CNL in the area of hydrogen production is in the development of the hybrid copper-chlorine cycle. This development is approaching lab-scale continuous operation demonstration in 2021. Dr. Suppiah has been leading collaborations in many of the above areas with industry, institutes and universities. He is the Canadian delegate for and the current Chair of the GEN IV VHTR Hydrogen Production Project Management Board. He is also a board member of the Canadian Hydrogen and Fuel Cell Association (CHFCA). He has been a regular presenter at IAEA's technical meetings and other national and international meetings on hydrogen production.

Current & Future Demand & Use of Hydrogen:

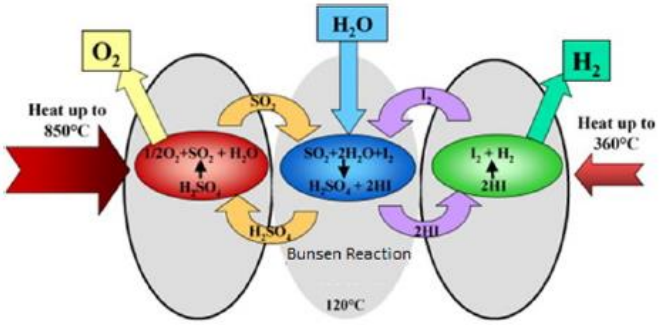
The demand of hydrogen over the years has been growing with the expanding population of the world because it is a raw material used to produce fertilizers and various other materials. It's only expected to grow faster with increasing living standards, the demand for hydrogen is forecast to grow very rapidly. In the future, to minimize the greenhouse gas emissions from heavy duty vehicles, a shift will have to be made to hydrogen fuel all.



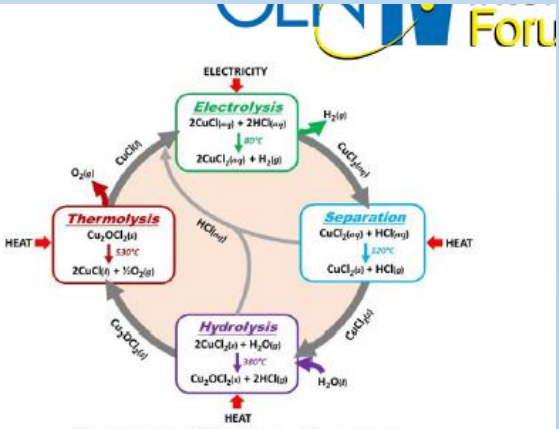
Transportation:
- Heavy vehicles
- Trains
- Ships
- Aviation

Hydrogen from GEN IV Nuclear Technologies:

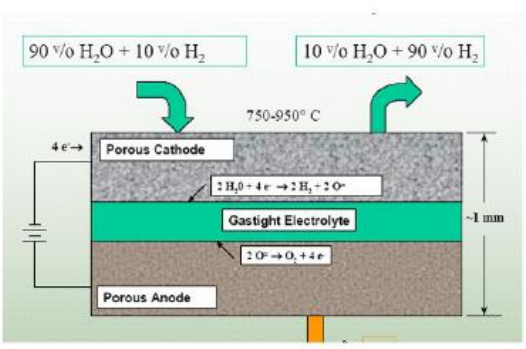
These four hydrogen production processes have been receiving the most attention over the last decade or two, and the hydrogen production PMB member countries (Canada, EU, France, Japan, Korea, USA, China (observer)) are mainly focused on these processes.



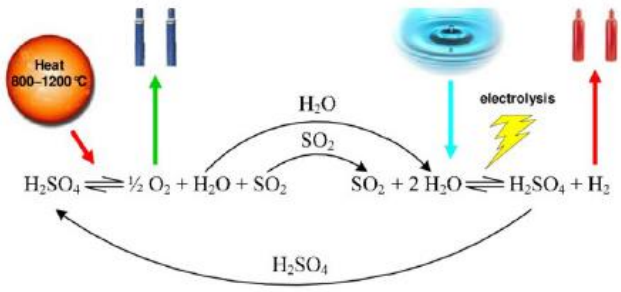
Sulphur-Iodine Process



Copper-Chlorine Process



High Temperature Steam Electrolysis



Hybrid-Sulfur Process

H2 Production PMB Goals and Objectives 1:

The development of the Sulfur-Iodine cycle has been carried out by JAEA of Japan, INET of China and KAERI of Korea. The operation of the integrated Sulfur-Iodine process has been demonstrated. However, materials related issues require resolution for industrial demonstration.

Development of the Sulfur-Iodine Cycle:

- Process evaluation including flowsheet optimization, selection of construction materials with suitable corrosion and mechanical properties and selection of catalysts for SO_3 and HI decomposition.
- Bench-scale experiments to optimize process conditions.
- Pilot-scale plant construction and performance testing to confirm scaling parameters and materials performance.
- Long-term testing for validating catalyst performance and suitability of construction materials.

H2 Production PMB Goals and Objectives 2:

The development of the high temperature steam electrolysis has been carried out by INET of China, KAERI of Korea, CEA of France, INL of USA and EU. The high temperature steam electrolysis technology has reached mature state. The degradation of cell components requires continuing advances.

Development of High Temperature Steam Electrolysis:

- Process evaluation including flow sheet optimization and development of methods for separation of hydrogen from the residual steam.
- Development of advanced materials for electrodes, electrolytes and interconnections, particularly for achievement of low cell and stack resistance and for decreased degradation rates.
- Development of advanced cell and stack designs.
- Experimental testing of promising cell configurations and materials at scales ranging from watts to multi-kW, and in pressurized stack experiments.
- Pilot-scale plant (200 kW) construction and demonstration.
- Theoretical and experimental feasibility studies of high-temperature co-electrolysis of steam and CO_2 while integrating different primary energy sources

H2 Production PMB Goals and Objectives 3:

The development of the Copper-Chlorine (Cu-Cl) cycle has been carried out by CNL of Canada. The Cu-Cl cycle development is approaching lab-scale demonstration. The assessment of the other alternative cycles such as Hybrid-Sulfur process and the economic evaluation has been also carried out by the hydrogen production PMB members.

Development of Copper-Chlorine (Cu-Cl) Cycle and Assessment of other alternative cycles and economic evaluation

- Cu-Cl Cycle evaluation including determination of process options, flow-sheet optimization and selection of materials.
- Cu-Cl Cycle component and bench-scale experiments to define and evaluate key parameters such as thermodynamic properties, rate constants, and equipment selection.
- Integrated testing of lab-scale system for 100 L/h hydrogen production.
- Development of HyS process: SO_2 Depolarization Electrolyser (SDE) development, and laboratory-scale tests and optimization.
- *Technical evaluation of potential alternative cycles with reference to S/I and HTSE regarding methodology, feasibility and process efficiency and economics.*
- *Basic R&D as proof of principle for process development.*
- *Economic evaluation for all hydrogen production processes coupled to nuclear reactors.*

H2 Production PMB Goals and Objectives 4:

The hydrogen production and nuclear reactor coupling has been investigated by the hydrogen production PMB members.

Hydrogen Production and Nuclear Reactor Coupling

- System evaluation and optimization of coupling circuits.
- Develop standards on the separation of nuclear reactor and hydrogen production process.
- Develop methodology and requirements for all safety aspects.
- Develop methodology for system integration.