

Low Energy Thermal Compression of Hydrogen

In partnership with the U.S. Department of Energy (DOE), Eltron Research & Development Inc. has developed a process technology that separates hydrogen from a mixed gas feed stream. **The two key advantages of Eltron’s multi-layer composite Hydrogen Transport Membrane (HTM) are that it is 10x cheaper than palladium membranes and has 10x better performance.** Additional characteristics make it viable for a variety of process applications. Such features include moderate temperature windows, wide pressure windows and catalyst tolerances to poisons.

Eltron is in early stage development of a technology for high efficiency purification and compression of H₂. In this approach, a modified version of Eltron’s HTM is utilized in conjunction with a metal/metal hydride medium on the permeate side of the membrane. A gas mixture containing H₂ impinges on the surface of the hydrogen permeable membrane, shown schematically in a planar configuration on the left side of the figure below. The hydrogen passes through the membrane while the other components of the gas do not. The H₂ selectivity of the membrane is 100%. The retentate gas can be recycled, if necessary, to achieve near 100% H₂ recovery. The hydrogen passes through the membrane into a flow of metal media, which has high solubility for hydrogen. The metal/ metal hydride media is heated up in the heat exchanger, shown in the middle of the diagram, and the hydrogen is recovered at higher temperature. The high affinity of the metal media for hydrogen provides the driving force for the hydrogen separation. A heat exchanger (HX) is installed between two chambers through which the metal media flows.

The hydrogen partial pressure is very low in the metal/metal hydride mixed media and provides a strong driving force for the H₂ separation and collection. **The hydrogen partial pressure for the two phase mixture is a function of temperature, thus the hydrogen can be removed and compressed by heating.**

Preliminary estimates utilizing the molar hydrogen capacity, the heat capacity of the material, and the thermodynamic hydrogen partial pressures indicate very low energy consumption needed to compress the purified hydrogen to high pressures (tens to hundreds of atmospheres).

