Factors affecting the design of hydrogen separators based on densemetallic membranes

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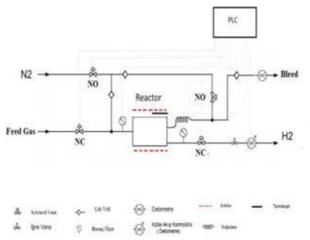
Pure hydrogen is needed for a number of applications; annealing furnaces, semiconductor processing, LED, photovoltaic manufacturing etc. Perhaps the most important in this respect is power generation via PEM fuel cells.

Dense metallic membranes in principle provide 100% pure hydrogen. This is irrespective of the purity of the gas to be processed. In fact, the fraction of hydrogen in the feed gas varies quite enourmously. It may be industrial grade hydrogen with a purity of 99% or higher. Or syngas produced from steam reforming of natural gas or coal where the fraction may be in the neighbourhood of 75 % or so. Hydrogen produced from renewable sources e.g. biomass gasification, the fraction may be 40%. In gas network, currently the fraction aimed for is not more than 20 % hydrogen.



Hydrogen separator, layout

Hydrogen separator, HS-V1, 1 nl/min.
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Hydrogen separation in dense metallic membranes involve dissolution–diffusion mechanism. Pd is almost always present in the mebrane either as alloying element or surface coating which help split hydrogen into atomic form which is then dissolved in the membrane and diffused across the thickness where, aided by Pd again, combine into molecular form. The presence of species such as H_2S and CO in the feed gas is important as it might poison the membrane. Therefore, the choice of separation membranes would depend on the species present in the feed gas. It may also be pointed out that membranes are operated under conditions where hydride formation is avoided as this, in most of the times, lead to volume changes and distortion which adversely affect the durability of the membrane.

For a given conditions, i.e. operating temperature and inlet and outlet pressure, the hydrogen flux across the membrane depends on the permeability of the mebrane as well as its thickness. Currently all hydrogen separators makes use of tubings as membrane material where the wall thickness is around 100 μm or so. Thinner tubings would be highly desirable or it may be necessary to switch to thin film membranes such as those could be deposited via magnetron sputtering.