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Materials for hydrogen pipelines

Unlike methane, hydrogen has been known to interact with metals. under certain conditions and this could well limit the materials suitable for construction of hydrogen pipelines. Existing mild steel pipelines have had a good record in this respect, and only under conditions where atomic hydrogen is formed can penetration of the steel lattice occur. This phenomenon has been termed 'intergranular embrittlement'. Molecular hydrogen inside pipelines, at normal temperatures and pressures (< 2000 psi), will in most cases be inert.

However, if the hydrogen is very pure then attack at the surface of the metal will take place. For example, the hydrogen evaporated from cryogenic storage vessels used in the USA's space effort has been found to attack welded sections of these vessels. This effect has been termed 'hydrogen environment embrittlement' and presently is the subject of intensive research work by NASA. The term 'environment' is used because the hydrogen-metal interaction only occurs at the metal surface.

It has been found that the degree of attack depends upon the nature of the metal and on the prevailing conditions. Aluminium and copper alloys and some stainless steels are not susceptible to attack whereas alloys of nickel or titanium are highly susceptible. Furthermore, attack is most severe at ambient temperatures and under high pressures. On the other hand, an oxygen impurity of as little as 0.6% can completely inhibit hydrogen attack, probably by preferential adsorption onto the metal surface.

It thus appears to be extremely important for this phenomenon to be carefully researched, but it is reassuring to note that the extremely good record of existing pipeline towards failure indicates that material compatibility may not be a major problem in implementing the hydrogen economy.