GREENHYDROGEN

renewable high purity gases

HYDROGEN

Overview

Hydrogen was isolated and identified in 1766 by Henry Cavendish, and it was he who conclusively established that water is a compound of hydrogen and oxygen, although the name hydrogen (Greek for water former) is credited to Lavoisier in 1783.

Hydrogen is the lightest element, colourless, tasteless, odourless and flammable. It is present in water and in all organic compounds. It burns in oxygen or air with a near colourless flame and since its products of combustion are water plus nitrogen, if burnt in air, it has great potential to reduce atmospheric pollution, compared to hydrocarbon based fuels. In gaseous form its low weight gives is a density one-fourteen of air whilst in crystalline form it's the lightest of all crystalline substances (lighter then marshmallow).

Hydrogen is thought to be the most abundant element in the universe and is the third most abundant on earth after oxygen and silicon. Its abundance can be seen by noting it has been estimated that every cubic centimetre of dark interstellar space, essentially void of any other known matter, contains a few atoms of hydrogen *(ref Steven Weinberg: The first three minutes).* Although it has a simple electron configuration, one proton/electron and no neutrons, it can exist in over 40 different forms due to; the existence of atomic, molecular and ionised species in the gas phase, its three isotopes and its nuclear spin isotopes. Terrestrial hydrogen also contains a very small amount, ~ 0.0156%, of deuterium atoms and this does cause variability in its atomic weight. The three isotopes are; hydrogen, heavy hydrogen (deuterium) and tritium, which is radioactive and made artificially. The gas is diatomic and can exist with two nuclear spins, parallel (ortho-hydrogen) and antiparallel (para-hydrogen). At 0 K hydrogen is 100% para but as the temperature increases the ortho content increases until at room temperature the mix is 75% ortho and 25% para. Liquid hydrogen is 99.8% parahydrogen.

Hydrogen can be prepared using a number of different processes including; hydrolysis of metal hydrides, electrolysis of water and the reaction of steam with hydrocarbons or coke. The first of these is convenient for small sale production, the second for the production of high purity gases and the third is the most common method as used for large scale production. Electrolysis is also used in the chlor-alkali industry where hydrogen is a by-product but it lacks the purity of hydrogen derived by simple electrolysis of water.

Hydrogen does not obey the perfect gas laws making property prediction more complex.

Properties

Property	Units	Value
Formula		H_2
Relative atomic mass		1.007825
Atomic radius	Å	0.79
Molecular weight		2.016*
Density of liquid @ -250 C	gm cc^{-1}	0.067
*Density of gas @ 21.1 C	kg m^3	0.083
*Relative density of gas @21.1 C	Air=1	0.07
Melting point (MP)	K	13.957
*Boiling point (BP)	K	20.39
Enthalpy of fusion at MP	kJ kg^{-1}	58.04
Enthalpy of vaporization at BP	kJ kg^{-1}	228.17
LEL in air	Vol %	4
UEL in air	Vol %	75
ATEX gas group		IIC

Property	Units	Value
CAS Number		1333-74-0
Critical temperature	K	33.19
Critical pressure	bar	13.13
Accentric factor		-0.22
Gas Cp @25 C	kJ $kg^{-1}K^{-1}$	14.268
Gas Cv @ 25 C	kJ $kg^{-1}K^{-1}$	10.144
Ratio of gas specific heats	---	1.407
Heat capacity of liquid @ -253 C	kJ $kg^{-1}K^{-1}$	9.457
Solubility in water	ppm	1.53
Viscosity of gas @ 25 C	micropoise	88.05
Thermal conductivity of gas @25 C	W $m^{-1}K^{-1}$	0.17064
Auto ignition temperature	C	400
Enthalpy of (gas) combustion @ 25 C	kJ kg^{-1}	119,950

Note:
1) Indicates properties at 101.325 kPa*
2) Properties are given at room temperature