18.5.2.1 Electrolyser

Electrolysers are needed to produce hydrogen and oxygen gas from water by using electric power. Electrolysis is used in many industrial processes apart from hydrogen production. Two technologies for low-temperature water electrolysis are available today:

- Alkaline electrolysers
- Polymer electrolyte membrane (PEM) electrolysers.

In addition, high-temperature steam electrolysers are under investigation, which are in general good for higher efficiencies (see [33]).

Special electrolysers can release the gases already under pressure without using an additional compressor. PEM electrolysers can have efficiencies of 80 to 85%. They are commercially available, but are very expensive because only a few units are sold and expensive materials (membrane, catalysts) are needed. Presently, there is no important market for PEM electrolysers in the kW range. However, larger alkaline electrolysers for use with wind or water power plants are commercial and in operation. Reference [34] gives an overview on a research project on electrolysers operated by wind turbines.

18.5.2.2 Gas storage

Three major technologies for hydrogen gas storage are available today:

1. Pressure tanks (low pressure up to 30 bar, medium pressure up to 200 bar and high pressure up to 700 bar).
2. Metal hydrides with adsorption of hydrogen.
3. Liquid hydrogen storage (only for large scale applications).

Low-pressure tanks can be used in conjunction with pressure electrolysers. Specially designed electrolysers [35] produce hydrogen and oxygen at 30 bar without any compressor and therefore a minimum of energy loss due to compression. Medium-pressure tanks or bottles can be fitted to compressors. Today, hydrogen mechanical compressors with a high efficiency for small gas volumes are hardly available. Presently, no compressors for hydrogen with flow rates below approximately 10 Nm^3/h are available.[14] Another technology for gas compression is thermal compression with metal hydrides. The pressure in a metal-hydride storage unit increases significantly with an increase in temperature. As different metal alloys have different pressure/temperature curves, gas compression in a multi-stage process is possible. High-pressure gas bottles from composite materials are under development and in operation in R&D and demonstration projects.

Metal hydride is an interesting material for hydrogen storage. The hydrogen is adsorbed within the highly porous metal hydride. In fully loaded metal-hydride tanks, 1 to 2% of the overall weight is hydrogen. The volumetric energy density of metal hydrides is comparable with a 200 bar pressure bottle. The pressure in a metal-hydride tank depends

[14] Nm^3 is the typical dimension for a gas amount. It is a gas in a volume of 1 m^3 at a pressure of 1 bar and a temperature of 0°C.