**Hydrogen Storage in LOHC and the Chances for Energy Supply, Mobility and Society**

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**Highlights**

* Hydrogen Storage in LOHC; 2,1 KWh/Kg.
* Examples for the developed and used Equipment.
* Decentral energy supply, effects on society, chances for mobility
* Examples for energy efficiency due energy networks

**1. Introduction**

Due to the ongoing observed developments and trends of our climate, it can no longer be denied that human impact on global cycles cause our planet great, perhaps even irreparable damage that future generations will have to bear. We therefore need to think about regenerative energy technology goals and decentral energy supply, for the preservation of mankind and the planet.

This presentation will therefore focus exclusively on the Hydrogen LOHC storage method for the use as energy supply of the future, but also the chances for mobility and society.

When we think about our future, we have to live independent from fossil resources. Therefore, hydrogen is the most favourable for a certain basic energy supply. Hydrogen is available in water but at the same time, we do not want to consume it, rather to put it into a cycle. Hydrogen as a basis for chemical processes is very energy-rich at 33 - 39.41 KWh/Kg calorific value, but it also has some disadvantages in energy storage. It has the lowest density of all gases and difficult to store. The classical storage method, to achieve the necessary density, therefore used are the compression up to 70 MPa or the cryogenic state (liquid hydrogen). Unfortunately, the high pressure and/or the extreme cooling requirements are problematic and cost-intensive. Last, but not least, there are still safety considerations regarding to compressed hydrogen and also to free hydrogen.

**2. Methods**

The new method of hydrogen storage technology – presented - eliminates all these problems and concerns by storing the hydrogen in chemically bound form on a LOHC (Liquid-Organic-Hydrogen-Carrier). Of necessity, this chemical must be chemically very stable so that the thermally driven separation of the hydrogen (recovery) does not destroy the molecules. At the same time, the molecules should not produce any toxins (i.e. no nitrogen, chlorine, etc.) if they should be burned as residues and only the pure aromatics remain. To prevent the toxicity di-benzene-toluene was chosen. Here 18 atoms hydrogen can dock and also “REACH” documentation (safety documents) exist for this chemical. The energy that can be stored in it is 2.1 KWh/litre, which is roughly equivalent to the amount of hydrogen in 70 MPa containers. Another advantage is, the liquid is absolutely safe against ignitions.

The presentation shows the whole system but also some special apparatuses and further equipment used.

**3. Results and discussion**

With this energy storage technology, with an exothermal reaction process (250°C, waste heat), you now have a liquid that fits exactly into our heating oil and petrol infrastructure. The LOHC is oil-like and therefore readily pumped. The disadvantage that needed to be overcome was the relatively high temperature (300°C) necessary for dehydration. This was the focus of recent research which showed it was possible to reduce the required temperature to approx. 130°C using a clever combination of parameters (patent pending). This means that LOHC technology can now be used in many different ways as dehydrogenation can now be carried out with the waste heat from a fuel cell, which we use to convert hydrogen into electricity. But in addition, sunlight or other waste heat sources can be used.

One example of this is in sewage treatment plants. Here the oxygen can be used for the purification process of the sewage and the waste heat for drying sludge, while the hydrogen is stored and used for energy consumption elsewhere (equipment run with hydrogen, hydrogen filling station, etc.). It quickly becomes clear that other business models are also possible and, for example, a sewage treatment plant can become an energy seller.

There are also possibilities in urban or industrial environments always in combination with hydrogen storage:

1. Oxygen for efficient combustion processes or for steel mills
2. Waste heat for local and distributed heating supply but also for cooling devices in summer
3. Waste heat utilisation for seawater desalination, for thermal production processes (extraction, rectification, reaction) and for cooling or for greenhouses in winter
4. Boosting the geothermal capacity with LOHC waste heat: Build the reactor into the upflow of geothermal energy. The Carnot efficiency could thus be increased from 16 - 20% to approx. 50%. And the remaining residual heat could still be used in heat networks.

**4. Conclusions**

The described new energy storage method allows to store huge amounts of energy just in tanks and is a big chance for decentral energy supply but also can be used for mobile applications like ships, trucks, or cars. Furthermore the shown LOHC-System can be a basis for high efficient energy networks and may be a basis for the change of the society (participation or identification)

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