THE ELECTRIC ENERGY STORAGE

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ABSTRACT

According to Kyoto targets about air protection, it is necessarily to use sources optimally and not to increase excessively concentration of greenhouse gas in atmosphere. We can say that accumulation of energy, for example from renewable sources is essential for efficiency improvement of production. Today we accumulate only through pump storage hydro plants and in limited amount through heat water (also thermal accumulation is accumulation of energy). Here are described another tools for accumulation in energetic.

1. INTRODUCTION

Renewable plants represent a considerable of power and in the case of windy farms these can be from 10 to 100 MW and more. In distant localities, where most of windy power plants are situated, is necessary to build new conduits with sufficient capacity.

In Czech Republic, the expansion of renewable sources, wind and photovoltaic power plants particularly, started in the year 2002 and after approval of law about renewable power sources, which enacted a duty to buyout the electricity for fixed prices in period of 15 years, the amount of power plants increased. The Czech Republic is obliged to produce 13% of overall energy consumption from these sources by the year 2020. This represents an annual yield of 7 TWh energy.

Another possibility can be in using air blast storage for production of compressed gas and its later usage for electricity production. However, these solutions are not very suitable for the Czech Republic because the large area is required for storage. [5].

Advantages of accumulation I seem to be the accumulation using so called flow batteries, eventually to the hydrogen systems.

2. PROBLEM SOLVING

2.1. HYDROGEN – OXYGEN SYSTEM

These systems will be used in the future. Because the efficiency of conversion back to electric energy is very low - about 45 per cent. If we will connect wind power plant as source of energy to electrolytic process, producing hydrogen and oxygen will be very interesting.

This system seems to have two possible applications:

a) Producing hydrogen and oxygen, and their sale (mainly for medical usage)

b) Producing hydrogen and oxygen, their storage and later usage for electricity production and its sale

Electrolysis is a process, in which on cathode releases hydrogen and on anode oxygen, this reaction is consuming water and electric energy. Water is not so much conductive, therefore hydrate oxide with aqueous solution electrolytes are used mostly with solution hydrate of potassium or hydrate of sodium.

Problems in Storage of Hydrogen

The characteristics of hydrogenous cause a fact, that its storage in large capacity is not simple. Concerning high fluidity and exiguousness atoms the hydrogen runs out along the edges of crystallise structures ordinary metal alloys, in addition the hydrogen causes their embrittlement.

The principle the storage of hydrogen can be divided into these three systems:

a) in gaseous phase

b) in liquid phase

c) storage by the help of metal-hydride reservoirs or by other chemical adducts

Advantage System with Hydrogen

- System does not contain mechanism of rotation, only has electrodes which does not service for long time.
- The Fuel Cells needs the very clean fuel.
- System has not problem with emission.
- They can work while we need low load.
- Do not produced noise, except the pump, compressor and so on [4].

The last mentioned system seems to be very prospective form of hydrogen storage. Its advantages are especially large mobility, user friendly.

From the group of hydrides, which are able to accumulate hydrogen can be mentioned e.g. *Ferro titanium alloys metals rare earths*.

2.2. VRB – EES (VANADIUM REDOX BATTERY)

The VRB-ESS is a electric system storage on a based on the patented vanadium-based redox regenerative fuel cell [8].

Redox Flow battery is based on principle of the conversion of electric energy to chemical reaction of vanadium with sulphuric acid. Vanadium is (chemical) element, which occurs in 5 valences.

Vanadium is included in V_2SO_4 solution in charged state. If the battery is charged, Vanadium converts to V_5SO_4. The principle of VRB-ESS is shown in figure 1:

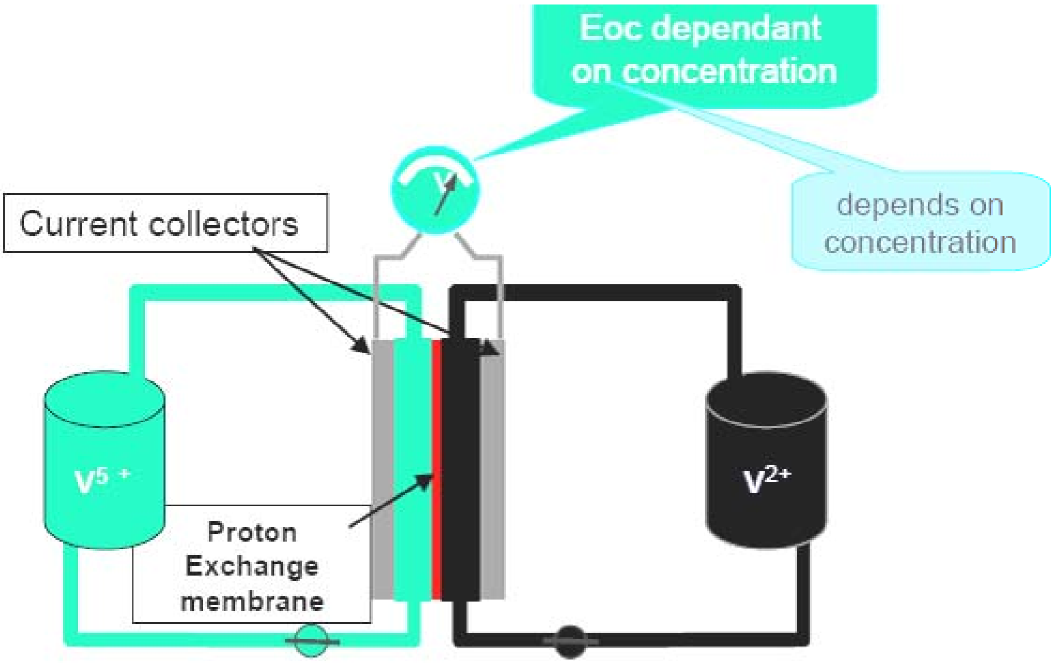

Figure 1: Schematic of VRB-EES [9]

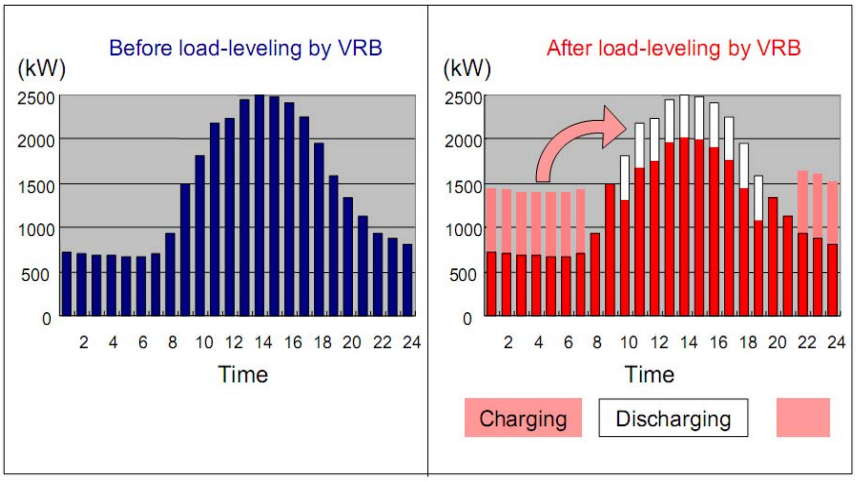

Figure 2: Compesation energy in installation bto the King Island [2]

Following half-cell reaction are involved in the vanadium redox cell:

For negative elektrolyte:

$$V^{5} + e^{-} \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftarrows}} V^{4} \qquad (2.1)$$

For negative electrolyte:

$$V^{2} \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftarrows}} V^{3} + e^{-} \qquad (2.2)$$

The VRB-ESS utilizes vanadium ions in both half-cell electrolytes. Therefore, cross-contamination of ions through the membrane separator has no permanent effect on the battery capacity, as is the case in redox flow batteries employing different metal species in the positive and negative half-cells. The vanadium half-cell solutions can even be remixed bringing the system back to its original state. [1].

The open circuit cell voltage in a concentration of 2 moles per litter for each vanadium species is 1.6 V when it is fully charged. The relatively fast kinetics of the vanadium redox couples allows achieving high Coulomb and voltage efficiencies without expensive catalysts. The same current is passed through all of the cells as they are arranged in series. Such systems have many admirable properties including high efficiency, long cycle life, ease of scalability and negligible environmental impact [1].

The battery can operate with varying temperature of -25 to +50 Celsius. This system does not contain lead, zinc or cadmium. A life-cycle assessment approach of the environmental impact of both Vanadium Redox and lead-acid batteries for use in stationary applications, indicates that the VRB contributes between 7-25% of emission of key environmental impact components (CO2, SO2, CO, CH4, NOx) during its life cycle, when compared with lead-acid batteries [8].

VRB cooperate with SCADA interface. Modbus, Profibus, Canbus or other interfaces are available for interconnection to auxiliary systems.

2.3. EESTOR – SUPER CAPACITOR

Figure 3: EESTOR Cells [6]

EEstor is company based in USA. This is the new energy storage system. Unfortunately, information is not available, only from web sites. [6, 7]

Producer claims [7]:

- Non-explosive
- For a 52 kWh unit, an initial production price of $3,200, falling to $2,100 with mass production is projected. This is half the price per stored watt-hour as lead-acid batteries, and potentially cheap enough to use to store grid power at off-peak times for on-peak use and to buffer the output from intermittent power sources such as wind farms.
- No degradation from charge/discharge cycles
- 4-6 minute charge time for a *152 kg*, *33 liters*, *52 kilowatt hour* (187 MJ), *31 farad*, *3500 volt unit*, assuming sufficient cooling of the cables.

3. CONCLUSION

Accumulation system based hydrogen is very perspective. We can produce hydrogen and oxygen. These substances can be further used in transport industry (hydrogen) or medicine (oxygen). They are highly pure, mostly over 99 per cent (10 ppm and better - 1 per cent is 10,000 Parts per Million). The accumulation, respectively this production of hydrogen and oxygen will exert at nuclear reactors – Fast Breeder Reactor (FBR), cooled by sodium. The only problem is their storage, because the cryogenic system is heavy on energy and metal-hydrids are not enough efficient.

VRB-EES is better to smaller system, because is running economically. It has not necessary source of water such as hydrogen storage system. Disadvantage is declared 11Wh/kg is really low value. For example classical Ni-Cd batteries have approximately 60 $Wh.kg^{-1}$. One the other hand, the indisputable advantage is that it cans cyclise 10.000 times. REDOX battery can be used especially as an uninterrupted – Power Supply (UPS).

I think, the main trend will be storage into super capacitor – for example EESTOR. They have large capacity, a great efficiency, reasonable size and acceptable price. The other advantage is modular method. If we put on parallel capacitor bank we will have capacities greater.

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