HYDROGEN SOURCES FOR LOW-TEMPERATURE PORTABLE FUEL CELLS

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Introduction

The tasks connected to development of hydrogen-air fuel elements and safe systems of hydrogen storage concern to the major problems of hydrogen energy.

One of variants of maintenance with a feed of low-temperature hydrogen-air fuel cells is use compact metal-hydride accumulators of high-purity hydrogen of repeated action. Such cartridges should isolate and absorb hydrogen at an ambient temperature and not high superfluous pressures. Another way of hydrogen obtaining is application of chemical generators of the hydrogen based on thermal decomposition of hydrides or on reaction of interaction of metals and hydrides with water. For creation of hydrogen sources of thermolytic type it is possible to use composites on the basis of hydrides of aluminium or magnesium and aminoboranes, and for creation of hydrogen generators of hydrolytic type – the activated aluminium, magnesium and its hydride, boron hydrides and aluminium hydrides of metals.

Results and discussion

As a hydrogen-accumulating material for metal-hydride cartridge of hydrogen we have chosen the intermetallic compounds of $LaNi_5$ type. Advantages of this family of materials are not the highest sensitivity to impurity of oxygen and a moisture, that allows to use technical or hydrolytic hydrogen for refueling, and an opportunity of equilibrium pressure regulation of formed hydride by replacement of a part of alloy components.

For maintenance with a feed of a portable fuel cell with power of 2 W we are made 2 types of metal-hydride cartridges of hydrogen.

The hydrogen portable accumulator of the first type (Fig. 1) has the slide valve. Such cartridge provides with a feed of 3-hour continuous work of a portable fuel cell. However the cartridge works only in a small interval of temperatures: at temperature reduction the speed of hydrogen allocation is sharply reduced, and at temperature increase it is strongly increased.

For elimination of this lack in the metal-hydride cartridge of the second type a microreducer is inserted and the sorbent with higher equilibrium pressure is used (Fig. 2). The lead tests of such portable metal-hydride accumulator of hydrogen have shown, that it provides with a feed of 5-hour work of a fuel cell with power of 2 W at an ambient temperature from 0 up to 50°C.

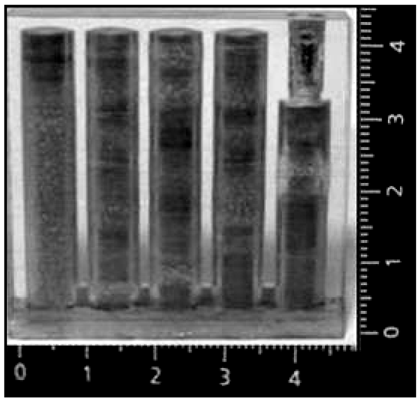

Fig. 1. Portable hydrogen cartridge of repeated action.

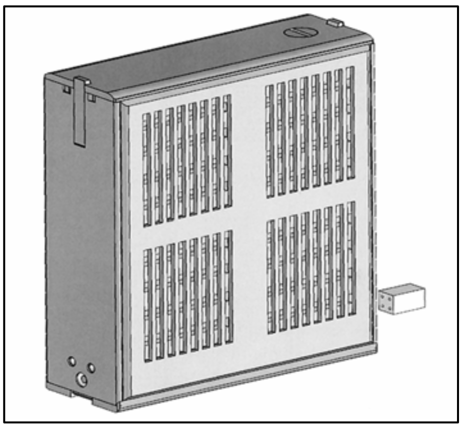

Fig. 2. Portable hydrogen cartridge with a fuel cell from 8 MEB.

For charging of portable metal-hydride accumulators of hydrogen the metal-hydride system of repeated action is made (Fig. 3). The basic characteristics of system are submitted in the table. The system represents the composite cylinder filled by hydride-forming intermetallide and supplied with a manometer, 2 gates of thin adjustment and adaptations for refueling simultaneously of 3 hydrogen sources. The system resource without repeated saturation by hydrogen from a cylinder or electrolytic cell allows filling with hydrogen not less than 100 portable sources of hydrogen.

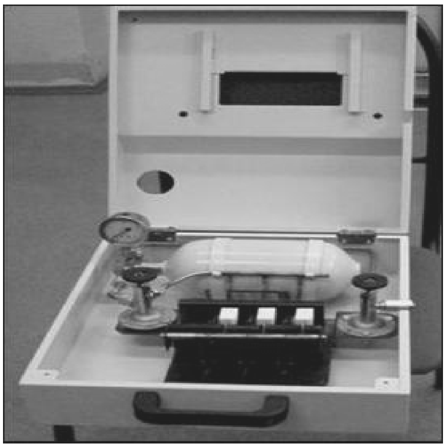

Fig. 3. The charging device for a cartridge.

Table 1. Characteristics metal-hydride system of refueling of cartridges.

Capacity on hydrogen	600 l
The sizes	39x34x16 (cm)
Weight of the device	5.5 kg
Saturation by H_2 at 10 atm	30 mines
Isolation of H_2	3–4 atm
Hydrogen purity	99.999%

For creation of hydrogen cartridges of hydrolytic type some types of hydrogen-generating materials are developed. In one of them the composite obtained by mechanochemical treatment of MgH_2 with the additive of carbon (graphite, soot, nanofibers) is used. This composite interacts with water and water solutions at an ambient temperature with speed comprehensible for creation of a portable source of hydrogen.

The interaction reactions of magnesium hydride with solutions of organic (glycolic, malonic, citric, and succinic) and inorganic (phosphoric and sulfuric) acids and their acid salts too can use for controllable isolation of hydrogen. The most full and adjustable isolation of pure hydrogen can be achieved by dosed out submission of sulfuric acid solution to magnesium hydride. The composite, obtained by mechanical grinding of a mixture of aluminium powder with the additive of Ga-In alloy and interacting with water practically completely at room temperature within several minutes, too can be used for creation of disposable sources of hydrogen.

Designs of hydrogen generators of the hydrolytic type are developed, allowing isolating hydrogen at room temperature under pressure up to 4 atm (Fig. 4).

The mechanical treatment of AlH_3 with small additives of various hydrides and carbon nanomaterials receives the composites isolating hydrogen at heating up to 100–150°C. It is shown, that on their basis the creation of portable generators of hydrogen is possible. In such generators it is possible to provide required speed of isolation of hydrogen and its pressure by temperature change.

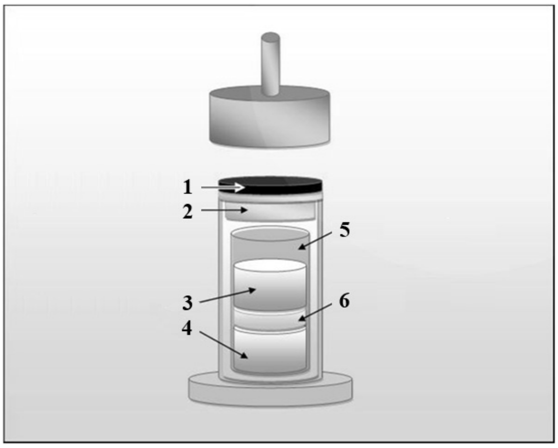

Fig. 4. The basic circuit of the hydrogen generator of hydrolytic type: 1, 2 - rubber and teflon gaskets; 3, 4 - fillers; 5 - glass from grid; 6 - working material.

Conclusions

1. The optimal compositions and the field-performance data of the hydrogen-accumulating and hydrogen-generating materials are determined.
2. The portable metal-hydride hydrogen accumulators of repeated action and the hydrogen generators of cartridge type are created.

Acknowledgement

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