ON THE CHEMICAL STORAGE OF HEAT ENERGY

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It was demonstrated 35 years ago that many hydrydes of metals and intermetallic compounds are promising materials for storage of solar heat energy. This is due to the very high values of the heat of formation of hydrides as well as to the reversibility of the hydriding-degidriding reactions [1]. Corresponding articles and patents have been shortly appear [2, 3]. The data of these publication were sometimes non-adequate (non-realistic). For example, the synthetic and cycling problems for MgH_2 (theoretical energy capacity Q = 3060 kJ/kg) were not taken into account; data for TiH_2 (Q =2430 кДж/кг) correspond to the integral heat of hydrogen desorption, which really occurs via step-wice mechanisms in the range 570-1000 K and not at 873 K, as it was pointed out, etc.

The real data concerning Q valuea are presented in the thirth column of the table. It is clearly seen that metal hydrides (Section 3) are much more effective than the salt system eutectics (Section 1). In addition, the last are usable only for the short-time heat storage (to be exact, only for the trasmission of the heat to the low-temperature level). One can propose that the decomposition of carbonates and hydroxides (Section 2) results in greater heat storage effect than the decomposition of metal hydrides. However, this advantage is virtual. Firstly, the kinetics of the reverse reaction is non-satisfactory; secondly, the elimination and storage of the gaseous decomposition products also present some problems [4, 5]. As for metal hydrides, the corresponding problems do not exist: the desorbing hydrogen can be accumulated by another (low-temperature) hydride; from such a hydride (when the reverse process is started) hydrogen desorbs spontaneously and can be trasmitted in the reaction zone (zone of the heat generation).

Only a relatively small part of alloys and intermetallic comounds can absorb hydrogen reversibly – without degradation (hydrogenolysis); as a result, their choice is obviously no great. However, here we can use exactly the processes of degradation and the reverse reactions of alloys regeneration (Section 4). In this case, the possibilities of manipulation of the alloys conposition are practically unlimited. Therefore, the temperature of the heat storage process can be varied on a broad scale.

System, reaction	T, K at 1atm	Q, kJ/kg
1. Low-times storage (melting of salt eutectics)		
$CaCl_2 \cdot 6H_2O$	307	175
$NaCl\text{-}NaNO_3$	570	200
$CaCl_2\text{-}LiNO_3$	541	180
2. Prolonged storage (chemical reactions)		
$CaCO_3 \leftrightarrow CaO + CO_2$	1160	1620
$Ca(OH)_2 \leftrightarrow CaO + H_2O$	805	1330
$Sr(OH)_2 \leftrightarrow SrO + H_2O$	950	728
3. Formation-decomposition of metal hydrides		
$ZrCoH_3 \leftrightarrow ZrCo + 1.5H_2$	660	815
$ZrCr_2H_{3.5} \leftrightarrow ZrCr_2 + 1.75H_2$	500	510
$Mg_2NiH_4 \leftrightarrow Mg_2Ni + 2H_2$	525	1150
$\gamma\text{-}TiH_{1.53} \leftrightarrow \beta\text{-}TiH_{0.87} + 0.33H_2$	917	820
4. Reactions of metal hydrides		
$3MgH_2 + MgCu_2 \leftrightarrow 2Mg_2Cu + 3H_2$	512	965
$TiH + TiNi \leftrightarrow Ti_2Ni + 0.5H_2$	980	417
$ScH_2 + 2Mn \leftrightarrow ScMn_2 + H_2$	1100	950
$14LaH_2 + LaNi_5 \leftrightarrow 5La_3Ni + 14H_2$	1093	840
$CeH_2 + AlCo \leftrightarrow CeCoAl + H_2$	1215	735

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