HYDROGEN GENERATION BY INTERACTION OF THE ALUMINIUM ACTIVATED BY GALLIUM ALLOYS WITH WATER

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Introduction

Now for creation of hydrogen generators of cartridge type, in basis of action of which the interaction reaction with water is, as perspective material it is considered the activated aluminium [1–3]. At hydrolysis of 1 g of the last it is isolated 1.245 l of H_2. However in this process it is the extremely difficult to control speed of hydrogen isolation.

The surface of aluminium is always covered with a thin and dense film of oxide the thickness of which makes 20–200Å. This film protects metal from oxidation by air oxygen and interaction with water. There are some methods of mechanical and chemical activation of aluminium. So, aluminium as a superdispersed powder very quickly and totally interacts with water with hydrogen isolation and formation of oxide or hydroxide aluminium. Amalgamated aluminium reacts with water and oxygen easily, but use of mercury is unsafe because of toxicity. The addition of gallium-indium alloy results in destruction an oxide film on an aluminium surface and intercrystalline corrosion that causes high reactionary ability of a composition. Thermodynamic instability of the activated aluminium in relation to water allows obtaining hydrogen with high speeds. It occurs as a result of developing reaction the intensity of which depends on structure of an alloy, state of borders of grains, distributions of additives between a body and borders of a grain. These factors determine also mechanical properties of all metals and alloys [4]. Besides the amount and composition of the entered metals-activators, dispersion of a powder and reaction temperature are rendered the essential influence on interaction kinetics of the activated aluminium with water.

The aluminium activated by gallium-indium alloy represents a powder consisting mainly from aluminium grains of the needle-shaped form which surface is covered with liquid phase of Ga-In melt or contains Ga-In adsorptive layers [3]. Such powder does not have the film of oxide and possesses by high reactionary ability.

Results and discussion

The interaction of aluminium with water is accompanied by heat isolation, and the composition of a solid product depends on a ratio of reagents and reaction temperature:

$$2Al + 6H_2O = 2Al(OH)_3 + 3H_2 + 16.3\ kJ/g$$
$$2Al + 4H_2O = 2AlOOH + 3H_2 + 15.5\ kJ/g$$
$$2Al + 3H_2O = Al_2O_3 + 3H_2 + 15.1\ kJ/g.$$

The reaction speed depends on temperature and is inversely proportional to quantity of water entered into a reactor (Fig. 1 and 2).

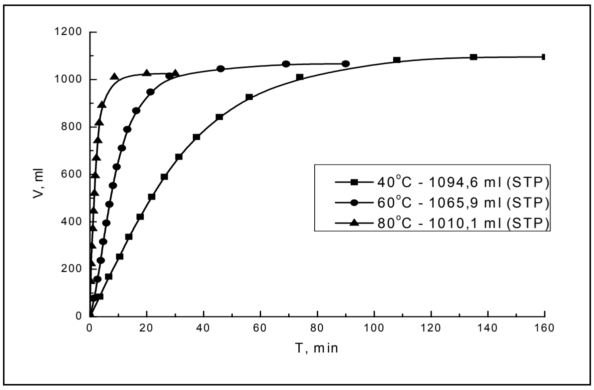

Fig. 1. Dependence of speed of hydrogen allocation on temperature.

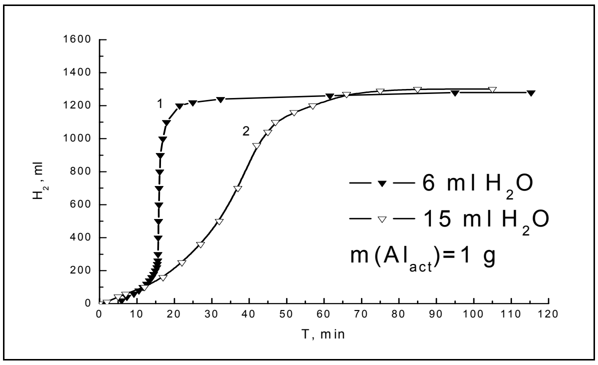

Fig. 2. Dependence of speed of hydrogen allocation on water quantity.

In conditions of thermostating on the data X-ray phase and thermal analyses byerlyte and boehmite are the basic components of products reaction, and with temperature growth the portion of aluminium oxihydroxide increases, and the portion of hydroxide aluminium decreases (Tabl. 1).

The interaction speed of the activated aluminium with water is investigated at various temperatures, energy of activation is designed

(E_a = 56.6 kJ/mole). Theoretical calculation of reaction speed during the initial moment of time in a wide interval of temperatures allows speaking about exponential dependence of reaction speed on temperature (Fig. 3).

Table 1. Composition of reaction products at different temperatures of reaction.

T, °C	$Al(OH)_3$	AlOOH	H_2O	$Al(OH)_3$/ AlOOH
20	47	13	40	3.6/1
40	41	18	41	2.3/1
60	22	29	49	1/1.3
80	14	39	47	1/2.8

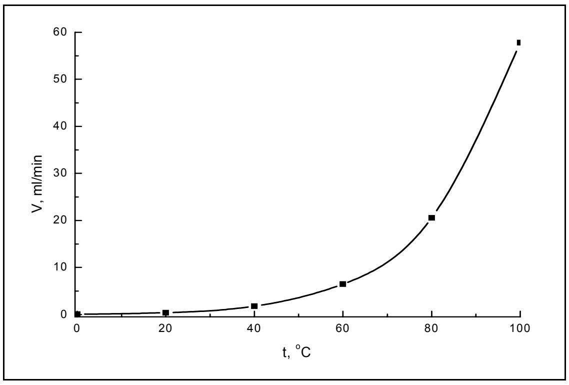

Fig. 3. Dependence of reaction speed during the initial moment of time from temperature.

Hydrogen isolation is investigated at dosed introduction of water into a reactor. The reception opportunity of necessary quantity of hydrogen is shown at submission in a reactor of the certain quantity of water, and also an opportunity of renewal of reaction by addition of a new portion of water (Fig. 4).

It is experimentally established, that the minimum quantity of water, necessary for full hydrolysis, should be in 1.5 times more, than stoichiometric value, and the volume and weight of a powder formed at hydrolysis approximately in 3 times more than volume and weight of an initial reagent.

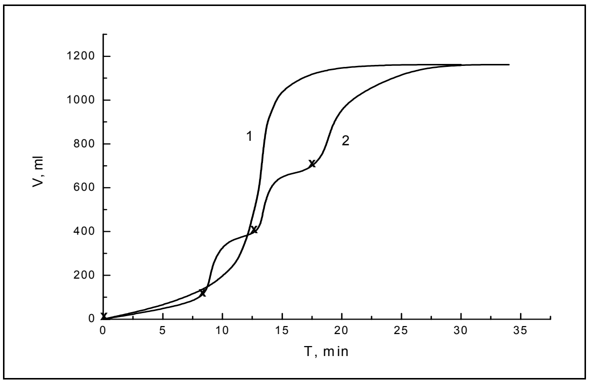

Fig. 4. Addition of water in a reactor at unitary submission (1) and by portion (2).

Conclusions

1. The opportunity of hydrogen reception is established by oxidation reaction of aluminium activated by gallium-indium alloy with water.
2. It is proposed to adjust speed of hydrogen isolation by quantity change of the water entered into a reactor.

References

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