THE SPECIAL FEATURES OF MEASUREMENT OF DEGREE OF HYDROGEN DISSOCIATION IN PLASMA CONDITIONS

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Introduction

Hydrogen energy is the future energy called upon to substitute the current energetic system. Energy of fossil fuels should be substituted for other forms of energy. During the transition period atomic power plants will be used to produce hydrogen. Safety of atomic power plants depends on many factors including construction elements capable of operating inside a reactor.

In selecting materials for manufacture of fuel elements and construction elements for the first wall of a reactor a special attention is paid to their interaction with plasma especially hydrogen plasma.

This work describes the computerized setup that allows the research into interaction of hydrogen plasma with different materials.

Experimental installation

A microbalance vacuum plasmochemical installation is designed for research the kinetics of atomic and molecular gases interaction with solids (metals, refractories and composite materials) by thermogravimetry with stepless variation of temperature up to 1500 K. The pressure range is 1 to $1*10^5$ Pa. The balance has sensitivity of $1*10^{-5}$ g.

The system offers combined opportunities for experiments both in closed volume as well as in gaseous phase flow with the sample material being impacted by molecular and atomic gases. Using thermogravimetric technique, both the sample mass and the rate of its variation during the tests can be continuously measured with high degree of accuracy [1, 2].

The main features of installation are as follow:

- a stepless temperature variation from 300 to 1500 K;
- controllability of RF-generator power resulting in the high accuracy variation of the gaseous phase atomization degree (from 0 to 25%);
- automatic monitoring of the sample mass variation which permit to detect both slow and rapid processes;
- the working parameters of the installation are registered and processed trough 34970A Agilent Data Acquisition/Switch Unit on computer.

Fig. 1 shows a schematic diagram of the microbalance vacuum plasmochemical installation. Vacuum system is made of glass and quartz It is connected with the installation units through metal-glass joints. The system is evacuated up to 10^{-4} Pa by a vacuum station 9 connected with the system through a liquid-nitrogen trap 18.

Gas pressure in the system is monitored by membrane manometer 3 as well as by ionization and thermoelectric vacuum meters. The readings of the latter are converted into the respective gases pressures using tables based on the data obtained by McLeod manometer as calibration instrument. The system is provided with a special tank 2 to store purified gas under air pressure. The process pressure is controlled by a needle leak 5 which allows the system gas pressure to be maintained from atmospheric pressure down to $5*10^{-4}$ Pa.

The gases in the working volume are atomized by electrodeless discharge by RF-generator 6 (200 W power). An inductor 7 is positioned at a side hose of the reactor at a distance of more than 15 cm from the sample being exposed. Due to the generator design a stepless variation of operating frequency within 1...10 MHz as well as of output-stage power is possible. Power variation, in turn, permits the gases atomization degree to be varied from 1 to 25 %. Protection from RF-radiation is furnished through inductor shielding by grounded copper net casing. Gas atom concentration is determined by Vredet manometer.

Automatic transducer (McBain microbalance) detects changes in length of a quartz helix 11, placed into the reaction vessel, thus allowing measurements of the sample 15 mass. Thermostatic control of the helix to an accuracy of 0.1 K is furnished by a water jacket. According to [3, 4] the transducer is made in the form of a small flag attached to the quartz filament. The filament deflection from equilibrium state results in changes of photoresistor illumination and in unbalanced current which is brought to a recorder.

The installation offers opportunities in:

- the search for and identification of solid phases in order to determine whether the reaction under study consists of one stage or a sequence of stages which must be revealed; and
- recognition of a sequence of possible states of final solid phase which can remain unrevealed when kinetics is studied from gas liberation or

absorption.

These investigation can be conducted in both molecular and atomized gases. In many processes the substitution of plasmochemical operations (O,N,H,Ar*,He*...) for technological operations carried out in gaseous phase (O_2, N_2, H_2, Ar, He...) offers more complete occurring of the processes combined with 200...300 K decrease of material

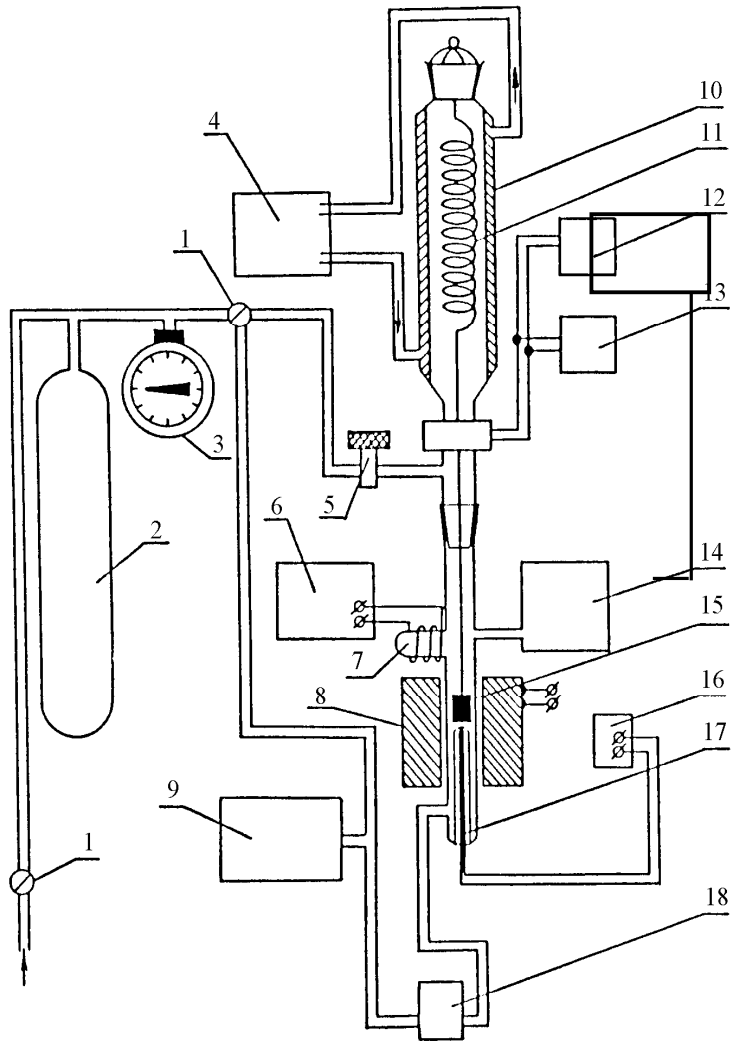

Fig. 1. Schematic diagram of the installation.
1 - vacuum valve; 2 - pure gas tank; 3 - manometer; 4 - liquid thermostat; 5 - needle leak; 6 - a set of devices providing gas atomization (RF-generator; ondometer; device for control and keeping stable power of generator); 7 - inductor; 8 - electric furnace; 9 - vacuum station; 10 - jacket for thermostatic control; 11 - quartz helix; 12 – computer with the 34970A Agilent Data Acquisition/Switch Unit; 13 - power supply; 14 - system for measuring pressure and atomization degree; 15 - sample; 16 - system for temperature variation with a fixed rate; 17 - Pt-Pt/Rh thermocouple; 18 - liquid-nitrogen trap.

treatment temperature at gaseous phase pressure of 1...100 Pa as well as with reduced time .

The experimental data obtained can be used in fundamental research and in development of technologies for fabricating new materials, coatings etc., and in determination of optimal conditions for their production.

References

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