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Research regarding the hydrogen diffusion in steels

V. MICLOSI, I. TONOIU, G.H. SOLOMON and A. VOICULESCU*

Polytechnic Institute of Bucharest, Bucharest, Romania

** Romanian Institute for World Economy*

Abstract

The steel cool cracking is controlled by repartition of hydrogen in the metal too, i.e. by the possibility of realizing great local concentrations.

The accumulation of hydrogen depends upon the existence of reversible and irreversible traps, or the possibilities of its diffusion, for different conditions of thermic gradient, stress level, the concentration gradient, or the intensivity of the electric field. A good knowledge about these traps is important for the elaboration of materials resistance to fragilization through hydrogen, as well as for the subsequent treatment for dehydrogenation.

Introduction

Many researches on the fragilization of metallic materials due to hydrogen stressed the fact that the penetration technique is extremely efficient for the analysis of the hydrogen diffusion and for emphasizing the captation features.

In the captation process two stages have a capital role:

- diffusion of hydrogen ;
- the accumulation in particular defects of chrystalin nets.

In order to establish rapidly the hydrogen penetration conditions in the presence of an electric field it was imagined the installation presented in Fig. 1.

The equipment allous also rapid establishment of the influences of the chemical composition of steel, the structural state, the granulation etc, on the hydrogen diffusion in the material.

In the Fig.1 is presented the scheme of the installation of electrochemical penetration, with the following components : 1-the metallic sample of the tested steel; 2-non-metalic caps; 3-capillar glass tube with tap; 4-carbon electrode of nuclear purity; 5-glass recipient; 6-plastic tube; 7-stand; 8-experimental calibrated tube

Fig. 1

Experimental details

Procedure

In the closed system, made up of rubber capilar tubes, is introduced mercury, then the tap is closed, so that the air is completely released from circuit.

The charbone electrode is connected to the pole(+) of a stabilized current and the piece, through the mercury, is connected to the pole(-) of the same source.

In the glass recipient is introduced the electrolit sollution, made up of:

- hydrochloric acid 10% ;
- hydrazine 2% ;
- distilled water up to one liter.

The maximum working temperature is 40 Celsius at the atmospheric pressure.

After the time of the passing through the wall of the sample, one finds the accumulation of the hydrogene in the tap zone of the capilar tube. Constantly one watches the bringing to the same level of the two extremities of the mercury circuit, such as the test would be realized at constant pressure ($p=p_{atm}$).

Experimental determination

At a constant width of the sample, taking into consideration only the penetration stabilized regime, we stated the followings:

- a) The hydrogen flow is constant for a constant value of the current.
- b) The increase of the current involves a very important increase of the hydrogen flow; in the investigated field (190–380 mA) we can see an exponential dependence, the exponent value between 2.4–2.7 (Fig.2);
- c) The sudden increase of the current determine an abrupt increase, with a small lag in time of the H₂ flow (of about 10 % of the penetration time value).
- d) At the same width of the steel samples, the differences on the chemical composition determine a decrease of 2.2 times of the H₂ flow, for a similar value of the current (Fig. 3).
- e) the ratio between the H₂ flows, on the investigated materials, are practically constant for the same value of the current.
- f) the increase of the width of the sample determines an important decrease of the H₂ flow

Fig. 2

Fig. 3

Conclusions

1. The presented method is offering possibilities of rapid, efficient and less costly investigation.
2. The experimental stand allows the studying of basic parameters of material, on the conditions of electrochemical change of H_2 .

References

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