UDC 537.634:620.179.17:620.193:669.788

The effect of hydrogenating conditions on magnetoelastic acoustic emission in low carbon steel

Skalsky V. R., Dr.Sci., Prof., Department Head
Hirnyj S. I., Ph.D., Scientist
Pochapskyy Ye. P., Ph.D., Senior Scientist

Karpenko Physical-Mechanical Institute
(5 Naukova Street, Lviv, 79060, Ukraine)

Magnetoelastic acoustic emission (MAE) phenomenon has been employed in the studies of hydrogen electrolytic charging of low carbon structural steel. It was established that MAE method is very sensitive to the process of electrolytic hydrogen charging. Despite the fact that the concentration of hydrogen in the metal was not determined, there were very prominent (about twofold) differences between the intensities of MAE signals before and after electrolytic charging (Fig. 1). Also, for the low cathodic currents, there were delays in time required, most probably, for the removal of the corrosion products from the steel surface and for providing the conditions for the sufficient amount of hydrogen to be absorbed by the near-the-surface volume of the sample.

The experiments raised many questions which are to be addressed in the near future:

- Why the MAE parameter ΣA_i decreases with an increase of cathodic current (effect of hydrogen seems stronger for 50 mA than for 150 mA – see Fig. 1)?
- What is the threshold of hydrogen content in the material for MAE method to sense it?
- What should be the parameters of the time changed magnetization $B(t)$ to produce the maximum sensitivity of MAE method to hydrogen?

In order to answer these questions, MAE method has to be more deeply explored regarding its possible application in nondestructive diagnostics of the structural materials, especially those that are close to their designed lifetime and those that are exploited under the influence of a synergistic action of corrosive environment which might result in hydrogen-induced damage and thermo-mechanical stresses. It is important to emphasize that the cathodic current densities used in these studies were far from endangering values and could be compared to the electric current densities widely used for cathodic protection of underground of underwater structures. If the MAE method confirms its applicability at these low cathodic currents, it might find its use in detecting dangerous conditions that could cause accelerated aging of the materials.

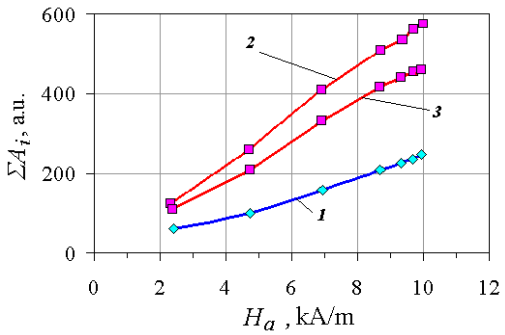

Fig. 1 The effect of the amplitude of magnetic field strength H_a on MAE parameter ΣA_i for the non-charged sample (1) and the samples electrolytically charged at cathodic current 50 mA (2) and at 150 mA, both for 1800 s.