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THE ACOUSTIC EMISSION FOR MONITORING THE HARDNESS OF THE COLD METAL TRANSFER WELD

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Abstract

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The article deals with the quality monitoring of the weld joint Aluzinc surface at the overlap point. The corrosion resistance layer research in the anaerobic fermenter (bioreactor) used to be the article's subject. Moreover, the main purpose is focused on the qualitative modification of the degraded samples properties in the specified bio-environment in the experimental measurements. We used the material hardness decrease in two predetermined areas through the use of acoustic emission method as a key factor.

Keywords: galvanic corrosion, BIO reactor, CMT welding, acoustic emission

INTRODUCTION

The conception of the corrosion is focused on metals and also on other materials that corroded by the effect nature or technological factors, nowadays (e.g. plastic material corrosion, glass corrosion, concrete corrosion). Protect of the metal products against natural factors can be provided by different methods. The most applied of them are the material selecting, the adjustment of corrosion environment and the using of the protective surface coating (Talbot *et al.*, 2010).

The thesis is oriented on monitoring anticorrosive layer AluZinc AZ150 and decrease quality of this layer as a result of the corrosion degradation. The AluZinc layer quality is monitoring based on the hardness modification.

This innovation thesis is significant because of using acoustic emission method for continual analysis and purposeful visualization of corrosion during the test. The primary aim is to demonstrate application possibilities of this method for the purpose innovating current measuring methods.

MATERIAL AND METHODS

The classical construction material used for technical practise is zinc steel plate DX51D + AZ150. The ferrite-pearlite steel class 11 with base carbon per cent is the basic part. The passivation elements' combination pursuant to chemical structure of slag bath is mainly surface protect. The passivation layer thickness is 30 µm.

Sample Preparing in the Bioreactor

The samples prepared by the CMT method were tested in aggressive gaseous environment of six fermenters (they are cylindrical duplicators vessels with used capacity 0.12 m^3). The welded samples by the CMT method were fixed by the hempen string on the bottom of the vessel cover. The whole size of these samples got only to the gaseous environment, meaning the surface substrate, during the anaerobic fermentation by the 26 days. The production and the quality rising biogas were monitoring during this exposition. The product analyses of corrosive weld degradation was realised after the experiment.

Acoustic Emission

The acoustic emission means physical effect during that we can observe acoustic signals broadcasted by the mechanical, heat or chemical subjected by the solid and it also includes diagnostic method based on this effect. The acoustic emission is performed in the source of acoustic emission during the energy disengaging caused by inner and outer powers. The acoustic emission formation is generated by nonreversible dislocated and degradation processes in the material microstructure and macrostructure, also by cavity processes in the hydro dynamical systems, by the turbulence during the pipe-line liquid fading, dielectric degeneration etc. Energy is transformed to the mechanical tension impulse. This impulse is dilating throw the material such as elastic tension longitudinal or transverse wave.

Test Process

The measurements were effected with two overlap CMT weld samples. Primarily they were composed by the two different materials – zinc-coated steel plate and aluminium. The aluminium plate was removed because of getting corrosive effected surface that was placed between two materials. The first sample, marked as sample 1, was corrosive degraded. The second, marked as sample 2, was corrosive nondegraded. These two samples were tested for hardness surface zinc layer according to grade of hardness HBR by the calibrated hand analogue desktop scleroscope Rockwell. The response of tested material to the pressure caused by scleroscope was measured during the getting data of hardness.

The process of pumping globule to the material was monitoring by the nondestructive method of acoustic emission. For assessment of detailed characteristic were tested samples 1 and 2 bedded by two AE sensors. In the Fig. 1 is schematically illustrated location of AE sensors and tested samples 1 and 2.

RESULTS AND METHODS

There were 40 verification measurements in two parts of tested sample, Fig. 1, within the frame of experimental measurement. Gained data were analysed and then was value median selected for successive processing, Tab. I. Each of measurement included continual acoustical emission scanning. The summation method of depiction was used by the DaeShow programme.

SPECIMEN 1 – corrosive degraded.

SPECIMEN 2 – corrosive nondegraded.

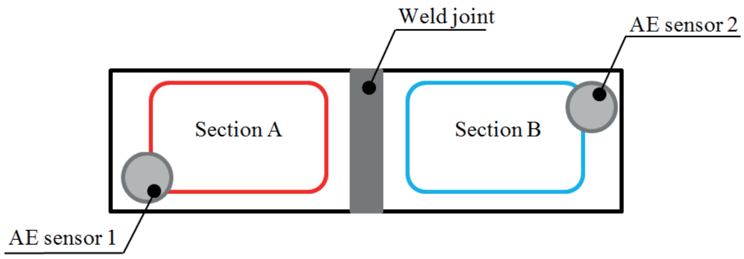
Every visual logging of acoustic emission was perused. Representative sections, based on literature fact (Černý, 2014; Dostál *et al.*, 2011), were selected for efficient pursuance qualitative material modifications caused by corrosion degradation. It includes section A and section B.

Anticorrosive layer AluZinc is decreasing qualities due to corrosion environment, facts based on literature (Černý *et al.*, 2014). Material assault was caused mainly by point corrosion and pitting corrosion. The pitting corrosion also arouses decrease of thickness layer and hardness because of rising pores.

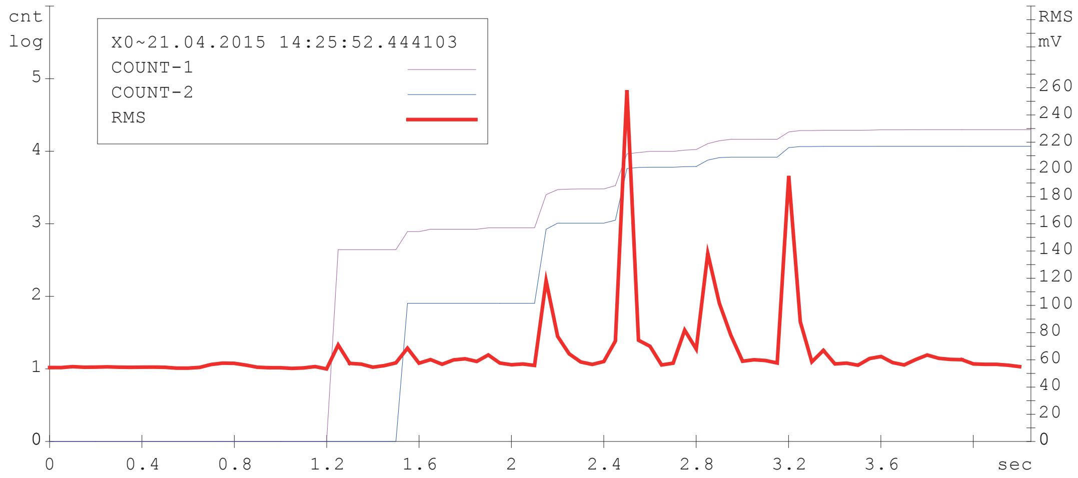
The diagram 1 shows high acoustic emission intensity. The value of maximum RMS takes 260 mV. This high activity is caused by eminent quality,

I: *Arithmetic average of measured hardness values HRB.*

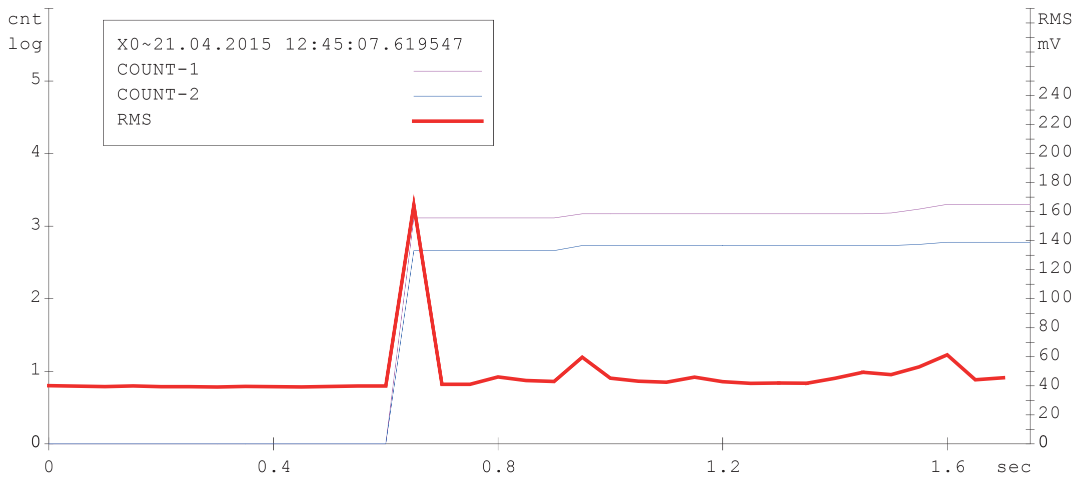
SECTION	SPECIMEN 1		SPECIMEN 2	
	HARDNESS HRB	AVERAGE	HARDNESS HRB	AVERAGE
A	48	45.2	45	46.4
	39		47	
	47		47	
	45		46	
	44		48	
	44		44	
	50		46	
	46		47	
	44		48	
	45		46	
B	42	41.4	46	46.5
	41		48	
	41		46	
	42		46	
	40		46	
	39		47	
	42		46	
	42		47	
	43		46	
	42		47	



1: *Acoustic emission sensors and measuring sections of samples 1 and 2 placement*



2: *Section A monitoring – before corrosion degradation hardness 49 HRB*



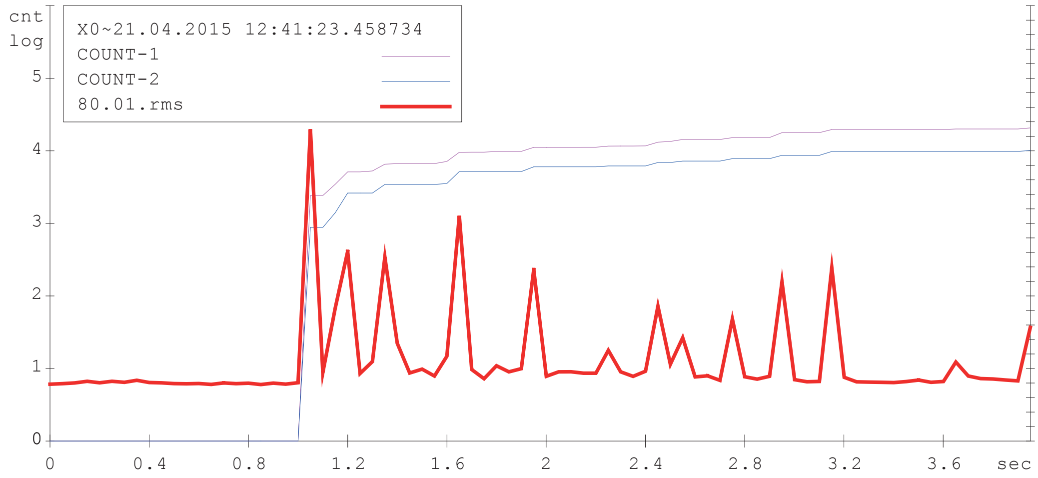
3: *Section A monitoring – after corrosion degradation hardness 44 HRB*

rigidity and hardness tested layer which is not corroding. There was developed rapid destruction of surface layer. This destruction can be comparable with fragile material brakeage, based on literature (Horák *et al*., 2010; Dostál *et al*., 2014).

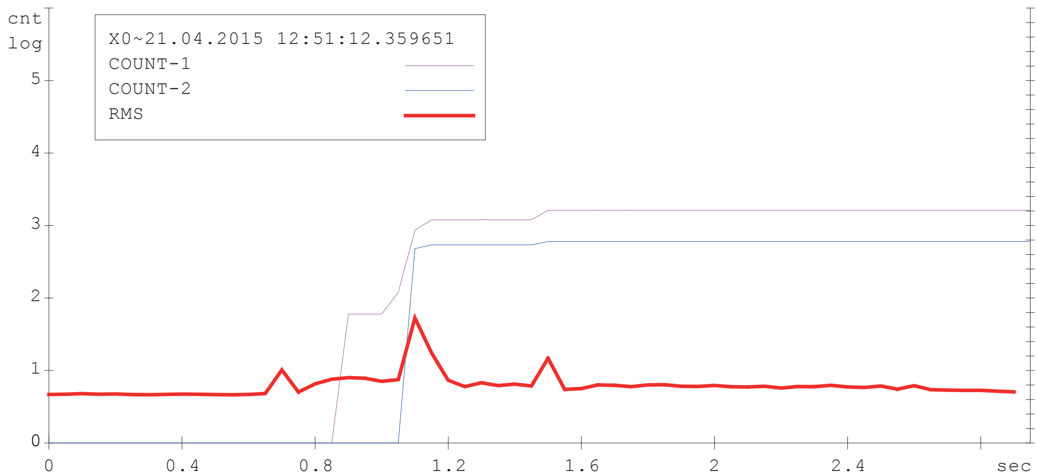
The value of maximum RMS takes 160 mV in this section. We can register reduced acoustic emission activity, which is correlating with lowered hardness after corrosion degradation. This decline is explained by microscopic connecting of corrosive point and dents. The acoustic emission activity lower, the fragile material brakeage is not coming on.

The value of maximum RMS takes 220 mV. The section is specific for the connection of two different materials. The surface layer Aluzinc was not affected during the welding process. The material hardness and activity acoustic emission is practically similar to the section A.

The value of maximum RMS takes 90 mV. The corrosion is the most high powered. The steel is more aggressive affected and anticorrosive protect



4: *Section B monitoring – before corrosion degradation hardness 50 HRB*



5: *Section B monitoring – after corrosion degradation hardness 43 HRB*

is losing qualities rapidly. The corrosive products, assembled in the interspace of zinc-coated and aluminium plate, are affecting material hardness, based on acoustic emission activity and hardness value. The acoustic emission does not analyse considerable activity due to microscopic connecting of corrosive point and dents.

CONCLUSION

There are corrosive difficulties hand-in-hand with the technical progress that direct to the development of new technologies and technological environments, machine performances are rising up by the using higher operating parameters and new, however aggressive substance.

The metal corrosion significantly affects different sections of industrial development and causes sizable damages, that is the reason why so important to dedicate attention to problems is connected with corrosion and mainly to avoid it.

This thesis is verifying observations about quality anticorrosive layer AluZinc AZ150. The acoustic emission application methodology by the monitoring the hardness of material with anticorrosion layer was based on expert tests. Acoustic signals analysis demonstrated straight dependence on hardness modifications and acoustic response. This methodology can be used in corrosive engineering focused on modernization and specification for monitoring decrease of storage life due to corrosive degradation.

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