ubmitted December 2007

Evaluation of Acoustic Emission Signal Parameters for Identifying the Propagation of Discontinuities in Pressurized Tubes

by Romeu Ricardo da Silva,* Domingo Mery† and Sérgio Damasceno Soares‡

ABSTRACT

Acoustic emission tests are highly relevant among nondestructive tests pplied to equipment in the petroleum industry. This paper presents ethodologies for the classification of acoustic emission patterns obtained testing to identify the propagation of discontinuities in pressurized ubes. This work is a continuation of previous research. To estimate the ac-uracy of the classification and give greater reliability to previous results, se is made in this paper of new signals with a greater number of parame-ers, and some new methodologies not used in previous work are presented ere. The new results show the efficiency of the pattern classification tech-iques implemented.

Keywords: nondestructive testing, acoustic emission, pattern recogni-ion, artificial neural networks, discontinuity propagation.

NTRODUCTION

Acoustic emission testing is a very important nondestructive esting method, having been applied for the detection of failures in arious types of equipment in the petroleum industry, such as pres-ure vessels, tanks and pipelines. The main function of these tests is detect and localize faults that present a risk of unstable propaga-ion that can lead to catastrophic fracture of the equipment (Vallen, 002).

This paper presents new results obtained to identify, through the se of pattern classifiers developed by neuronal networks, the ropagation of discontinuities in pressurized tubes monitored by coustic emission. The main objective is to provide continuity to reviously completed and published research (Silva et al., 2006), by hecking the accuracy of the classifiers through the use of new sig-als (new tests were made on specimens similar to the previous nes), and testing the relevance of new parameters obtained during he tests carried out on the specimens. The objectives developed in his paper can be described as follows:

- development of the pattern classifiers by artificial neural net-orks — optimizing the number of neurons in the intermediate yer, confirming the best index attained with samples of the set of sts (Duda et al., 2001; Haykin, 2001)
- calculation of the accuracy of the classifiers by random selection test training sets, as well as the false positive and false negative dices
- evaluation of the relevance of the new parameters (not evaluated previously [Vallen, 2002]) of the signals in the discrimination of the no propagation (NP) and propagation (P) classes of the discontinuity
- test of the classifiers only with the parameters shown as the most relevant for the discrimination of the NP and P classes
- construction of a receiver operating characteristic curve to estimate the reliability of the detection of the propagation of discontinuities in the acoustic emission signals.

*Departamento de Ciencia de la Computación, Pontificia Universidad Católica de Chile, Av. Vicuna Mackenna 4860(143), Santiago, Chile; e-mail <romeu@romeu.eng.br>.

†Departamento de Ciencia de la Computación, Pontificia Universidad Católica de Chile, Av. Vicuna Mackenna 4860(143), Santiago, Chile; e-mail <dmery@ing.puc.cl>.

‡Technology of Materials, Equipment and Corrosion, Petrobras Research Center (CENPES), Brazil; e-mail <sdama@petrobras.com.br>.

MATERIALS, TESTS AND METHODS

Materials

The specimens used were built from tube sections made of API XL 60 steel 0.5 m in diameter and 14.5 mm thick. These sections were welded at their ends to form a closed volume that could be pressurized. On these specimens, four external elliptic cracks 7.25 mm deep with an aspect ratio $2c/a$ equal to 10 or 20 were machined, two of them close to the weld seam and two on the base metal. Figure 1 shows a schematic design of the positions of the cracks on the specimens.

Hydrostatic Test

The specimens were subjected to a hydrostatic test up to the pressures that would cause stable or unstable discontinuity propagation.

Acquisition of the Acoustic Emission Signals

Acquisition of the acoustic emission signals was made with the three sensors positioned as in Figure 1 for the first test (first set of signals), and with eight channels in two other tests (signal sets two and three).

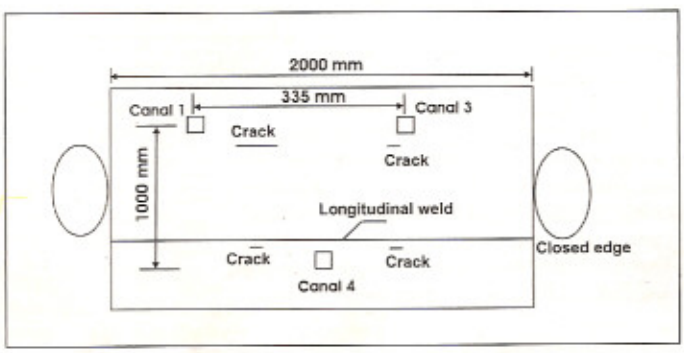

Figure 1 — Schematic of the specimens with the locations of the machined cracks and the positions of some of the channels.