1.7.21. LOCALIZATION OF AE SIGNALS IN PIPES WITH ONE-SIDED ACCESS

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While conducting acoustic-emission (AE) diagnostics of operating pipelines great importance is attributed to the accuracy in localizing revealed faults with the most critical goal being the precise definition of continuous faults coordinates in hard-to-reach sections of pipelines with limited access. This paper proposes the technique based on the analysis of autocorrelation functions for localization of continuous AE in pipelines with one-sided access. The proposed technique consists in spatial filtering of AE signal in the pipeline.

It is known that within the frequency range 20 – 40 KHz (AE spectrum maximum) the pipeline is a stratified-nonhomogeneous waveguide. The waveguide is formed by the pipeline wall, pumpable product, and the ground. In the specified frequency range several normal waves (modes) can be exited in the waveguide. Thus, the acoustic path of signal propagation is nonhomogeneous and can be represented by a set of several homogeneous acoustic paths. At each point of the pipeline normal waves interact with each other and thus form a complex interference pattern that predetermines the signal spatial spectrum. If AE spectrum is limited in terms of frequency by white noise (signal autocorrelation function is in this case has a single maximum), then the presence of several acoustic paths leads to the enveloping curve of autocorrelation function having a number of maximum values with the coordinates equal to:

$$\tau_{ij} = \frac{L}{c_i} - \frac{L}{c_j}, \tag{1}$$

where L – the distance from a signal source to a signal receiver; c_i – the velocity of i-normal wave; τ_i – the delay time of i-wave in relation to j.

When the velocities of normal waves are known, the distance to AE source can be determined by measuring the delay time. The implementation of the technique will bring about some difficulties related to the absence of a priori information about the released interference component since the excitation efficiency and the propagation rate of certain modes depend on numerous factors that cannot be considered beforehand. In order to overcome this, another measuring channel is introduced. Receiving transducer of the second measuring channel is located at the distance d from the first one. Given this the distance to the source is calculated by a simple equation:

$$L = \frac{d}{\tau_{ij}^{(2)} - \tau_{ij}^{(1)}} \tau_{ij}^{(1)} = \frac{d}{\Delta\tau_{ij}} \tau_{ij}^{(1)}.$$

The experimental verification of the proposed technique performance efficiency was carried out on the assembly that looked like a steel pipe section with dead ends. The leakage from a through hole was used as an AE source. The experiments involved the detection of leakages for various signal/noise ratios followed by spatial filtrating of AE signal along each channel. By varying the duration of analyzed realization of AE signal we managed to distinguish two interference components of the signal and determine the distance to the source.