1.6.9. ESTIMATION OF SOME ERRORS OF CORRELATION LEAKDETECTOR AND WAYS OF THEIR REDUCTION

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Nowadays acoustic leak detectors with correlation processing of signals have widespread application in testing pipelines for leak-tightness. The operating principle of these devices is based on passive location of acoustic noise (acoustic emission) that arises when the liquid flows through discontinuity flaw at the surplus pressure in the pipe. The leakage location is defined by two transducers installed at the pipeline wall on both sides of the proposed leakage point. The signal propagation time to each of the transducers is different and depends on the fault location. The difference in noise signal arrival time (delay period) can be determined by the maximum of the cross-correlation function that characterizes probabilistic relation of the process values divided by time interval.

In practice the correlation function with the only maximum is extremely rare in occurrence, for instance, at recording the signals propagating by air in the absence of reflecting surfaces. In most practical cases the correlation function contains numerous correlation maxima that can overlap; the magnitudes of some maxima can alter in time and depend on the point of the sensor installation on the pipe. Thus, the correlation maximum appears diffused. This results in the error of delay period measurement, which impairs the accuracy of localization and sometimes even leads to gross miscounts.

The analysis of signal propagation in pipes with liquids shows that major causes of the diffused correlation maximum are the presence of external noise, the formation of stationary wave in the pipe, the sound velocity dispersion in the pipeline, and the excitation of several modes of vibration in the pipe. The correlation leak detector TAK-2005 developed by the authors represents the implementation of the acoustic signals filtration technique that allows minimizing this component of error. The core of the proposed technique consists in distinguishing a narrow spectral band within signal spectra where the coherence function is maximum and relatively level while the phase of cross-spectral density is a sawtooth function with several sections properly approximated by linear dependence. In other words, unlike most contemporary leak detectors with the filter pass band being determined only by the coherence function maximum value, our analysis also involves the phase of cross spectrum. This allows minimizing the impact of multi-mode pattern of propagation and the presence of sound velocity dispersion in the pipe. This is achieved by the following way. As is known, in case of a single path without dispersion the phase of cross spectrum has the appearance of linear sawtooth function. Hence, while isolating the sections with linear phase we select for analysis the waveband where the leak signal propagates predominantly through a single path.

The verification of the proposed technique was carried out both at the experimental assembly and in operating pipelines. The tests confirmed the effectiveness of the applied technique. Nevertheless some drawbacks were encountered one of which is the equivocation of sound velocity in the pipeline. This is stipulated by the fact that a priori it is unknown which mode is most effectively exited and propagated in the pipeline. Thus, sound velocity should be pre-measured when the test is carried out.