# CORRELATION METHOD OF CONTROL OF AIRTIGHTNESS OF PIPE LINES

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**ABSTRACT**: The methods existing for control of airtightness are based on the laws of hydrodynamics and hydrostatics, as the gas or liquid consumption is most important characteristics of the process. Main defects at the places of the welds of the pipelines and of the pipes themselves, as cuts, knots, etc., is the reason for the leakage of working substance from the pipeline. The article considers a vibro acoustic control method and treatment to the signal by correlation method.

**КОРЕЛАЦИОНЕН МЕТОД ЗА КОНТРОЛ НА ХЕРМЕТИЧНОСТ НА ТРЪБОПРОВОДИ ПОД НАЛЯГАНЕ**

**РЕЗЮМЕ**: Съществуващите методи за контрол на херметичност се основават на законите на хидродинамиката и хидростатиката, като най.важната характеристика на процеса е разходът на газ или течност. Основни дефекти в местата на заварките на тръбопроводите а също и в самите тръби, като прорези, шупли и др. са причина за изтичане на работно вещество от тръбопровода. В настоящата статия се разглежда възможността за приложение на вибро-акустични методи за контрол, с последваща статистическа обработка на вибро-акустичния сигнал.

## INTRODUCTION

The methods existing for control of airtightness are based on the laws of hydrodynamics and hydrostatics, as the gas or liquid consumption is most important characteristics of the process. Main defects at the places of the welds of the pipe lines and of the pipes themselves, as cuts, knots, etc., is the reason for the leakage of working substance from the pipeline.
Most oftenly, the control is executed at two stages, namely: firstly, control is being executed according to a method of lower level of sensitivity and, after eliminating the defect welds, there is a test is being performed with a method of higher level of sensitivity. The methods of control usually include the use of the so-called experimental or test substances (others than the working fluid), as their type is specified in the technical requirements for control of the article

## NATURE OF THE METHOD

The correlation method in its essence is a method for statistical processing of vibro-acoustic signal. It finds application in the apparatuses for airtightness testing and localization of the place of leakage in underground pressurized pipe lines.
The correlation method of finding and localization of leakages, described by Smirnoff V. A. (2005), is based on the measurement of a vibro-acoustic signal generated by a leaking pressurized fluid, with the help of two piezo-electric transducers situated just next to the pipeline from both sides of the section under control. A and B (Fig. 1) vibro-acoustic signals measured in both channels are being increased by preintensifiers and passed to a two-channel analogous digital analyzer where the same undergo synchronous processing with the help of the fast Furie transformation for obtaining a number of temporary functions, including a mutual-correlation function. The processing of the signals is made on a program basis by using suitable software, as the graphics of the various types of temporary and spectrum functions (Fig. 3 and Fig. 4) are visualized on the analyzer (computer) screen. The maximum of the mutual-correlation function determines the difference in time (retaining) for the distribution of the signals from the leakage to each one of the two gauges.
It is possible, when we know the speed of signal distribution along the pipe and the distance between the gauges, to be able to exactly determine the place of the leakage by using the following formula 1:

$$l_{1,2}=1/2\ (l \pm v^{*}t), \qquad (1)$$

where: l – the distance between the gauges, m;
v – the speed of signal distribution in the pipe, m/s;
t – retaining by time determined by the maximum of the mutual correlation function, s;
$l_{1,2}$ –distance from the leakage to gauges 1 and 2, m.

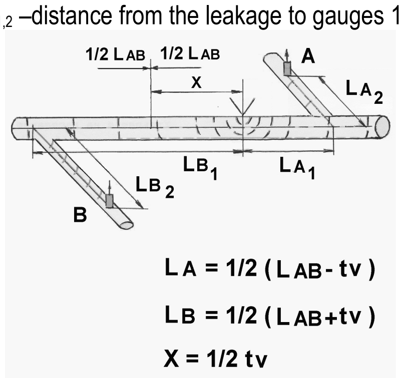


**Fig. 1. Correlation and acoustic method for determining the place of the leakage in pipelines**

$L_{AB}$, $L_A$, $L_B$ – respective distances in the measuring scheme;
t – delay time of the signal from point A compared to the signal from point B;
v – speed of the signal distribution along the pipe.

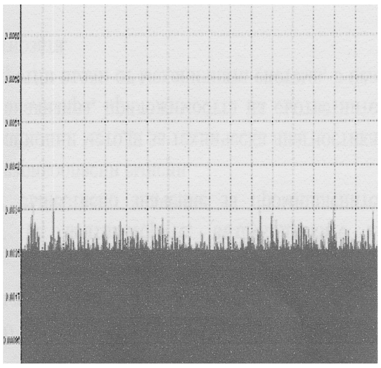

**Fig. 2. Mutual correlation function when there is no leakage.**

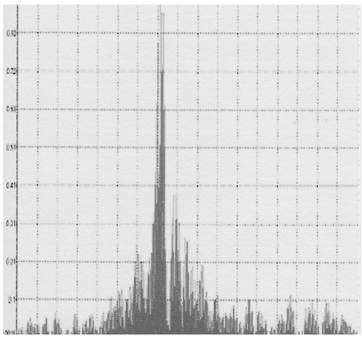

**Fig. 3. Mutual correlation function when there is a leakage**

The exactness of determining the place of the leakage depends on the exactness of the time of delay, the distance set between the gauges and the speed of signal distribution from the leakage along the pipeline. The last parameter itself depends on the material and the construction of the pipeline, the temperature, the pressure, the type of fluid transported, the soil structure, etc. Table 1 presents tentative data for the speed of sound distribution along the pipes.

Table 1. Speed of sound distribution along the pipes

| Diameter of the pipeline, mm | Grey cast iron, m/s | High compressive cast iron, m/s | Steel, m/s | Asbestos-cement, m/s | PVH, m/s |
|---|---|---|---|---|---|
| 60 | 1386 | 1346 | 1298 | 1168 | 468 |
| 80 | 1328 | 1322 | 1279 | 1110 | 460 |
| 100 | 1287 | 1302 | 1268 | 1107 | 376 |
| 150 | 1247 | 1255 | 1234 | 1098 | 370 |
| 200 | 1219 | 1212 | 1225 | 1057 | 294 |
| 250 | 1196 | 1134 | 1208 | 1049 | 268 |
| 300 | 1176 | 1160 | 1199 | 987 | - |
| 350 | 1162 | 1143 | 1192 | 976 | - |
| 400 | 1149 | 1126 | 1153 | 953 | - |

Lead - 1100 m/s, Polyethylene - 230-300 m/s.

The signal of the leakage is distributed along the pipe length in two directions from the point of measurement A and B. The time of the signal distribution to these two points will vary depending on their remoteness from the leakage. As a result of this, the signals registered at point A and point B will be removed one toward another at a distance equal to the difference in the time for reaching the signal from the leakage to these two points. After calculating and visualizing the mutual correlation function of these two signals, it is then clear on the graphics obtained a maximum specified that corresponds to the delay of time.

In order to obtain the exact localization of the place of the leakage, it is necessary that the following are precisely selected and determined, namely: the frequency range for measuring and analysis, the level of result averaging, the duration of measuring and the possibility allowing for visualization of the function.

Based on the so described correlation acoustic method, T2001 apparatuses have been developed in Russian specially intended for control of the airtightness of underground pressurized pipelines. The advantages of the apparatuses in question compared to the standard sound-level measuring devices are as follows: higher level of sensitivity upon determining small leakages; high level of precision upon llocalization leakages, and, last but not least, possibility for application for pipelines located at a deep level of depth.

## CONCLUSIONS

The correlation and acoustic technology for airtightness control of underground pipelines is a high sensitive and reliable method. The reliability of results is not influenced by the depth of placing of the pipeline. As for the apparatuses used, the correlation acoustic method is thriftier compared to the other highly sensitive methods known in the practice for airtightness testing. The high level of sensitivity of this method and the exact determination of the place of leakage decrease to a significant extent the excavations works accompanying the removal of the leakages registered.

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