AUTOMATED CONTROL OF PARENT METAL OF PIPE WALLS AT TRUNK PIPELINES
WITH THE NONCONTACT ULTRASONIC SCANNER-FLAW DETECTOR A2075 «SoNet»

V. Suvorov, Acoustic Control Systems, Ltd., Moscow

Introduction
The Gazprom gas transport system includes more than 160 thousands kilometers of pipelines. The most part of it was built in the seventies-eighties of the last century. Aging of basic assets at the linear part of trunk pipelines is about 60%. [1] Average actual lifetime of pipelines is about 30 years. Long service life of trunk pipelines results in increasing number of flaws detected at regular diagnostic tests. One of the ways to prolong lifetime of a pipeline is a general overhaul.

According to Gazprom requirements the re-isolation and overhaul technology includes obligatory diagnostics of pipes with non-destructive control methods. The aim of the work is to evaluate on-the-fly technical condition of tested objects with visual and physical methods, to specify and record detected flaws, to issue a report on possibility of using pipes again with current exploiting regimes and suggesting methods of repair if needed.

Repair works base on the information about place, type and size of flaws received during diagnostics. Among all other flaws the most dangerous are cracks on the outer pipe wall of stress-corrosion origin.

To automate search of stress-corrosion cracks and other surface flaws of parent metal of pipe wall and lengthwise weld joints, in 2008 Acoustic Control Systems, Ltd. created the external ultrasonic scanner-flaw detector A2075 SoNet.

Description
Picture 1 shows the appearance of the device actual model and basic characteristics are given in Table 1.

Pic.1 Scanner-flaw detector A2075 SoNet

The scanner - flaw detector construction consists of a scanning system which is set on a pipe during testing, and an operating console - Panasonic industrial laptop. The system and the laptop are connected through WiFi so the operator doesn’t have to be in the trench.

The system can be transported in a car and set on a pipe by two persons.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe diameter, mm</td>
<td>720…1420</td>
</tr>
<tr>
<td>Pipe thickness, mm</td>
<td>6…25</td>
</tr>
<tr>
<td>Operation temperature, °C</td>
<td>-40…+50</td>
</tr>
<tr>
<td>Control efficiency, at least, m/min</td>
<td>6</td>
</tr>
<tr>
<td>Time of continuous operation from battery under normal climat conditions, hours, at least, hours</td>
<td>8</td>
</tr>
<tr>
<td>PC dimensions, mm</td>
<td>185x145x55</td>
</tr>
<tr>
<td>Scanning device dimensions, mm</td>
<td>655x407x220</td>
</tr>
<tr>
<td>Receiver-transmitter unit dimensions, mm</td>
<td>555x360x210</td>
</tr>
<tr>
<td>Assembled inspecting system dimensions, mm</td>
<td>655x407x450</td>
</tr>
<tr>
<td>PC weight, maximum, kg</td>
<td>1,4</td>
</tr>
<tr>
<td>Scanning device weight, maximum, kg</td>
<td>28</td>
</tr>
<tr>
<td>Receiver-transmitter unit weight, kg</td>
<td>12</td>
</tr>
</tbody>
</table>

Excitation (sending) and receiving of ultrasonic waves are performed by EMA technology avoiding use of a couplant. The scanning system is set on the top generatrix of the pipe and moves along it while testing. The pipe body is echoed circumferentially with 5 mm step. All signals are registered to form a scan image of the pipe.

The scanning system is fixed by transmitting to the leading wheels the force of the electromagnetic-acoustic transducer featuring a powerful permanent magnet. The force required to remove the transducer from the pipe is about 200 kg, so the scanner is pressed to the pipe with the force sufficient to hold it reliably not only on the top generatrix, but also on 3 or nine o’clock.
Scanning is performed at a section from one welding joint to the next one, and for every section a separate scan image is generated. Results are sent to the operator’s console and represented in real-time mode.

Working with the scanner - flaw detector,

According to [2], the sensitivity threshold of the external scanner-flaw detector is calibrated with standard industrial calibrating samples with examples of flaws or with a reference samples. As it is too expensive to make and to transport a sample of a pipe 1420 mm in diameter, the A2075 SoNet is calibrated with a reference sample. The sample 120x600 mm is made of aluminium alloy and included in the delivery kit. It is shown on the Picture 3.

To test the sensitivity the calibrating sample is set on the electromagnetic acoustic transducer. The coordinate X of the signal maximum from the butt-end is to be 600±100 mm, amplitude of the signal is to be 0±2 dB. Calibrated this way, the scanner-flaw detector provides reliable search of reflectors, restricted by [2] - cuts 40 mm in length and 0,7 mm in depth and a group of drillings from 10% of pipe wall thickness in depth. In real work conditions the scanner-flaw detector can detect aggregations of cracks from 0,5 mm in depth and pitting corrosion from 1 mm in depth.

The red line in the middle of the scan image (1) is an image of the transducer’s dead zone, which is about 200 mm. The dead zone divides the scan image into two parts. When the scanner is moving along the top generatrix, the flaws found from 6 o’clock to 12 are shown in the upper part of the scan image, and the lower part shows flaws from 0 to 6 o’clock.
Red lines 2 are the images of lengthwise welds, zones 3 and 4 are images of stress-corrosion flaws. The flaw type is meant to be identified by precise manual tool control, but an expert operator can identify them by images with reasonable certainty. For example, images of stress-corrosion flaws can be described as a gathering of zones with jagged edges extended along the pipe axis. Such picture is explained by the reflecting ability of the flaw.

As an example of visualization of different type of flaws, the Picture 5 shows stratifications.

As it can be seen, flaws of this kind are displayed as a group of zones with even edges, and relative positions of the zones are random. The type of the flaw was confirmed by a manual ultrasound test, and two templates were cut out. Picture 6 presents results.
With a special software results of testing with the scanner-flaw detector are formed as a report with coordinates and dimensions of abnormal zones. The report also contains information about types and depths of flaws, received in the process of confirmative manual control. An example of such report is shown at Picture 7.

![Picture 7 Example of a test results report.](image)

This document contains all necessary information and is used to create a full reporting statement on results of automated control.

**Trial results**

Potentialities of the equipment were confirmed with a range of trials performed at many gas enterprises at single samples of pipes with real flaws as well as at pipelines during repair re-isolating works.

- VNIIGAZ Ltd, Moscow
- SJSC "Orgenergogaz", Vidnoe
- Gazprom Transgaz Moscow Ltd, Emergency Recovery base, Stolbovo
- Gazprom Transgaz Ekaterinburg Ltd, KZIT Ltd
- Gazprom Transgaz Ekaterinburg Ltd, Burdygino compressor station
- Gazprom Transgaz Chaikovskiy Ltd
- Gazprom Transgaz Ukhta Ltd, section Ukhta-Torzhok - compressor station-3 Myshkinskaya - compressor station Torzhokskaya
- Gazprom Transgaz Ukhta Ltd, Sheksna
- Gazprom Transgaz Samara Ltd, Tolyatti Line Pipe Operation Department
- Gazprom Transgaz Volgograd Ltd, Bubnovskoe Line Pipe Operation Department
- Gazprom Transgaz Surgut Ltd, compressor station-3 Aganskaya
Results of trials confirmed stable work of the system at wide range of adverse climat conditions, interference immunity and possibility to perform control at the distance up to 10 meters from the pipe cleaning machine, reliability and sufficient safety margin of mechanical and electronic parts.

Basing on the results of qualifying trials the scanner-flaw detector A2075 SoNet was listed at the registry of equipment permitted to be applied at objects of Gazprom Ltd.

Conclusion

Five year experience of operational exploiting of the scanner confirms the efficiency of science and technical decisions suggested to solve the problem of locating stress-corrosion and other flaws in the pipe body. More than 2000 km of pipelines of various diameters have been tested with the scanner - flaw detector for all these years.

The scanner-flaw detector have been working at various weather conditions, from -40 to +50 °C. Thanks to the EMA technology there’s no more need to use a couplant to increase repeatability of control results and decrease labour-intensiveness. Modular design of the receiving-transmitting unit makes the maintainance of the device easier and lowers the cost.

Literature

1. A. Samokrutov, M. Mitrokhin, I. Veliulin, A. Kasyanov “Automatization of Pipe Testing During General Overhauls of Linear Part of Trunk Pipelines”, VI International conference “Gaz and Oil Pipelines Maintainance and Repair”, 2012
2. R Gazprom 2-2.3-596-2011 “Organizing and performing technical diagnostics of linear part of trunk pipelines with external scanner-flaw detectors during general overhauls. General requirements”.