TEN YEARS OF EXPERIENCE OF STRESS-CORROSION AND OTHER PIPELINES' SURFACE FLAWS TESTING BY MEANS OF EDDY CURRENT TECHNIQUE

V.F.Muzhitsky[1], V.A.Karabchevsky[1], S.V.Karpov[2]:
[1] JSC "SPECTRUM-RII"; Moscow: Russia; [2] OOO "VNIIGAZ", Moscow, Russia

Abstract: From 1993 till nowadays our specialists develop, produce and provide Russian gas industry with NDT equipment for main pipeline testing. From 1996 our multi channel eddy current flaw detector is used for measuring of stress-corrosion cracks to provide a recommendation on pipeline safety. Now 16 channel version of it with magnetic carriage of probe is prepared to release.
Significant contribution into main pipeline inspection and detection of stress-corrosion flaws was provided by our other eddy current flaw detectors: the first one - with indication of crack danger, another one - with indication of crack danger and with infinite reliability of flaw detector probe.
From 1996 more than 10 thousand kilometers of pipeline have been inspected, and with that data an algorithm of pipe condition evaluation has been developed for pipelines with flaws in case of troubles with its repair.
In contrast to magnetic methods, that equipment doesn't make mistakes because of magnetic or metal structure influencing on tests. It successfully detects flaws through coating of pipelines. With significantly increasing of volume of repairing that technique will finally fight entire gas industry.
Stresses and deformations are playing main role in stress-corrosion formation. So the additional apply of our magnetic structure scope for pipeline inspection within pipe testing up to destruction allows us to investigate the metal stress state simultaneously with sizing of stress-corrosion cracks.

Introduction: From 1993 to nowadays our specialists develop, produce and provide Russian gas industry with NDT equipment for gas mains testing.
Significant contribution into gas main examination and into detection of stress-corrosion defects was provided by our eddy current flaw detectors: the first one - with displaying evaluation of defect danger, another one - with displaying evaluation of defect depth and with practically infinite reliability of detector probe. In addition these devices successfully detect defects through coating of pipelines.
From 1996 our multi channel eddy current flaw detector is used for measuring 0f stress-corrosion defects to provide recommendations for pipeline safety. From 1996 more than 1 thousand kilometers of pipeline have been inspected, and for these data an algorithm of pipe condition evaluation has been developed for pipelines with defects for case of troubles with possibility of its repair. Results of outside surface inspection of gas main carried out by that flaw detector include many digital data being picked up at the same time and permanently. Opportunities of this flaw detector allow transforming big volume of digital data into graphics and drawings for presentation. At the same time, for long line part of pipeline, it can be computed as result how much square of surface of pipeline is occupied by defects of different depth. Permanency and simultaneousness of measuring much data allow us reliable comparing of these data, but these allow us to register the defect reliably and to determine its depth. Now version of it with 16 channels, with magnetic carriage of detector is prepared to be released.
For monitoring of stress corrosion defects on gas mains, our company developed and applied instruments with detectors fixed upon pipe defect for time longer, than two years, for example, up to time, when it would be possible to remove defect of pipe.
Sensitivity of eddy current flaw detectors is so high that in a process of real inspection it lets to detect defects with a depth up from 0,5 mm. In contrast to magnetic methods, eddy current equipment don't make mistakes because of magnetic fields or metal structure influencing on tests, so results of defect testing appear reliable.

For case of access to outside surface of pipeline been dug out, technique and rules on carrying out an inspection of gas mains to detect a presence or absence of stress corrosion defects were developed at VNIIGAZ institute. Also there were developed as methods of evaluation and certifications of defects, which had been detected on outside surface of pipeline by eddy current flaw detectors, so methods of evaluation of its danger for the operating pipeline.

At present because of increasing up of a volume of gas mains inspections, flaw detectors and methods are more demanded not to test a depth of one or two defects, but to guarantee an absence of dangerous defects on surface of tested long line parts of gas mains. With significantly increasing of volume of repairs, our technique will widely spread in gas industry.

Results: From 1993 to 2003 our specialists took part in gas mains inspections at "GAZPROM" company in view to detect stress corrosion defects.

As all equipment was delivered for those inspections, so our specialists were using it with all rules of operation. Geographically from the north to the south of Russia along gas mains it was carried out at seven regions of gas transport system.

Due to task appearance, firstly, parts of destroyed pipes, every piece of metal, which we were able to get, were inspected by our eddy current flaw detectors. Additional tests of metal of gas mains show that using of eddy current flaw detectors are very reliable method for detection of stress corrosion defects of gas mains. Next, after carrying out hydrostatic tests when many of deep defects were found out, eddy current flaw detectors were used to inspect closest pipes in the same area to remove pipes with defects out of gas main. There were inspected approximately 90 pipes with defects on six gas mains. Everywhere there were detected and described by their positions and depths all types of defects, and this let us investigation of process of defect appearance in gas pipeline. It gave scientists some data to suggest some different variants of development of defect and of influencing it of such outside factors, as isolation, water, soil and others.

Next eddy current flaw detectors were used to inspect pipeline defects detected by in pipe magnetic intelligent tools. It was necessary to do it because of low sensitivity of intelligent tool and because of narrowness of area been shown by intelligent tool around defects. There were detected very many small defects around the deep ones. All deep defects were tested by eddy current flaw detector VD-89NM. There were picked up and saved depths profiles of defects, they were used to compute work safety time for pipe with defect to avoid immediate stop of gas main to make repair. In wet places there it was convenient to move mechanisms along frozen ground in winter along gas main but it was impossible to stop gas main for repair and leave people in their homes without heat and electricity. The pipe with deep defect worked one month more and had been removed immediately when it became possible. The methods of computing that work safety time was developed by specialists of VNIIGAZ institute.

In region of river Volga there were carried out as first searches possible presence of stress corrosion defects on gas mains, so and inspections of gas mains in short and long pit-holes under indirect data, such as the indications of an electrometric, analysis of grounds, vegetation etc.

Simultaneously in other pit-holes there were carried out an inspections of sites closest to them on which emergencies had happen. The flaw detectors VD-12NFM for the first time were applied for scheduled examination of lengthy sites(segments) of the operational gas main applicable to landscape features of a line(route): to slopes and low places of landscape.

In Bashkiria mass examination of pipes in pit-holes on low surface of landscape have proceeded, for what it was required to inspect more than kilometer of length of a pipe to reveal and to describe some hundreds stress corrosion defects.

In northern locales the examination of helical pipes with defects was made, and also examination in extended pit-holes on gas main, where it was required to supply with means of examination a site on which one was simultaneously made pit-holes of pipes in miscellaneous places by several excavators. Here perfectly have exhibited itself search eddy current flaw detectors VD-12NFM with sensors reliably protected from wasting by special tips.

Also in a north the examination of joints of pipes with factory isolation(insulation), and also check of outcomes of the results of the intelligent tool run was made. As had appeared joints of pipes with factory insulation are a vulnerable point gas main, for joints and under separations of factory polythene insulation the great many of stress corrosion defects was revealed. The check of defects after the intelligent tool run has shown that after its passing there can be undetected steep stress corrosion defects, and the inaccuracy of an estimation of depth of cracks by these tools is higher, than it was expected.

In Bashkiria and in Moscow the hydro tests on a bench with pipes with substantial stress corrosion defects were conducted, apart from an estimation of strength of pipes these tests " down to destruction " have shown, that the inaccuracy of an estimation of depth of stress corrosion defects eddy current flaw detectors makes no more than 5... 10 %.

Discussion: Experience shows necessity of complex approach to decision of all problems.

For elapsed period our company has supplied with search flaw detectors a number of technical-engineer centers of firms of the company "Gazprom". So computer-controlled eddy current flaw detectors VD-89NM were acquired by firms behind Ural, on Ural and in Moscow. With 1998 were annually illuminated on business venues and conferences, including "Diagnostic" of the company "Gazprom".

To advantages of search VD-12NFP it is necessary to attribute high reliability, simplicity of set-up and operation. VD-89NM has threshold sensitivity, the flaw detector in all range of change of parameters is gentle dependent from range of change of an operating clearance - makes a separate estimation of depth of a defect and gap, working practically on amplitude-phase method.

At maintenance of activities of the company "Gazprom" on examination gas main for presence of stress corrosion damages with looking up of inter quartile defective sites(segments) under the indirect factors our specialists inspected annually up to 2 km of pipes in extended pit-holes, annually finding out 3... 5 stresses corrosion defects in emergency condition (depth are more, than 5 mm and some meters in length).

Stresses and deformations are playing main role in stress-corrosion formation. So additional use of our magnetic structure tester for pipeline inspection within pipe testing up to destruction allows us to investigate the level of stress of metal simultaneously with measuring of stress-corrosion defects.

The use of a coercimeter KRM-C-2K at hydro tests of stress - corrosion defects " down to destruction " allows high resolution to keep track of by change of pressure and deformations of metal of a pipe in zones of defects. The outcomes of sharing eddy current of flaw detectors for an estimation of parameters of stress - corrosion cracks with other monitoring facilities are as demonstrates experience in good conformity. So the increment of estimations of depths of cracks is revealed at creation in a pipe of a gas main at hydro tests of pressure above than yield strength. Thus the distribution of increments of pressure on a defective site(segment) will quite be agreed a picture of arrangement and depths of cracks.

At examination of the gas pipeline on presence of stress - corrosion cracks in a complex with eddy current flaw detectors are applied a digital thickness meter of pipe walls, for example, the electromagnetically - acoustic digital thickness gauge EMAT-100 - since for definition of hazard of emergency of a defect is necessary precise value of thickness of a pipe in a place of a defect, magnetic digital thickness gauge of coatings - for a case, if the looking up of defects conducts not removing insulation of a pipe, magnetic particle means of a non-destructive testing for endorsement of a genesis of a defect under the form of cracks, magnetic digital thickness gauge for measurement of thickness of oxide surface slicks of metal, coercimeter for an estimation of a stress distribution and some others.

Conclusions: We will firmly look for opportunity of different financing of our projects for gas industry. We have real advantage against outboard companies in simplicity of communications with our consumer. This advantage makes useful all our efforts in advertising and science. It is clear that we slowly transform market demands to our products.