NEW TECHNOLOGIES
OF "SPETSNEFTEGAZ" MAGNETIC IN-LINE INSPECTION

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For the period from 1991 to 1995, "Spetsneftegaz" scientists have developed original, the first in Russia, magnetic in-line inspection technology and created high resolution magnetic ILI tools. Since 1995, "Spetsneftegaz" has been continuously performing in-line inspections of "Gazprom" trunk gas pipelines, using its own equipment and technologies, constantly upgrading quality of work. Since that time, more than 100,000 km trunk gas pipelines of various diameters have been inspected worldwide, using high resolution MFL & TFI technology.

All "Spetsneftegaz" intelligent pigs work on the basis of magnetic flux leakage registration, detecting metal loss defects by MFL technology, stress corrosion cracks and single longitudinal cracks by TFI technology.

To perform in-line inspections, "Spetsneftegaz" disposes of wide spectrum of high resolution MFL & TFI tools for on-land and offshore pipelines from 16" to 56" in diameter with pipe wall thickness from 5 mm to 30 mm. The ILI tools can pass 2.5D bends and inner pipe diameter narrowing up to 0.85 D.

The sequence of runs of ILI tools to inspect one pipeline section, is as follows:

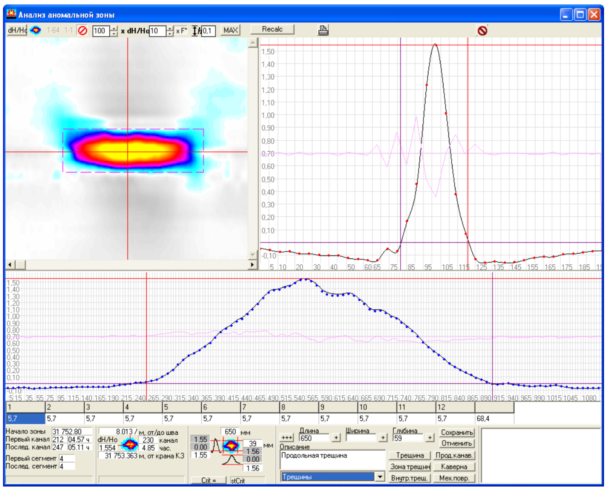
- Runs of cleaning pigs
- Run of electronic caliper logging tools
- Run of TFI tool.

For ILI tools to be able to work in conditions of high velocities of transported pipeline product, bypasses with electronic control have been developed. Usage of built-in bypasses enabled to reach the speed of 2 m/s for ILI tool run, which is optimum for good data record, in product flow up to 12 m/s. Influence of eddy currents is insignificant here. So accuracy and reliability of metrological data are provided.

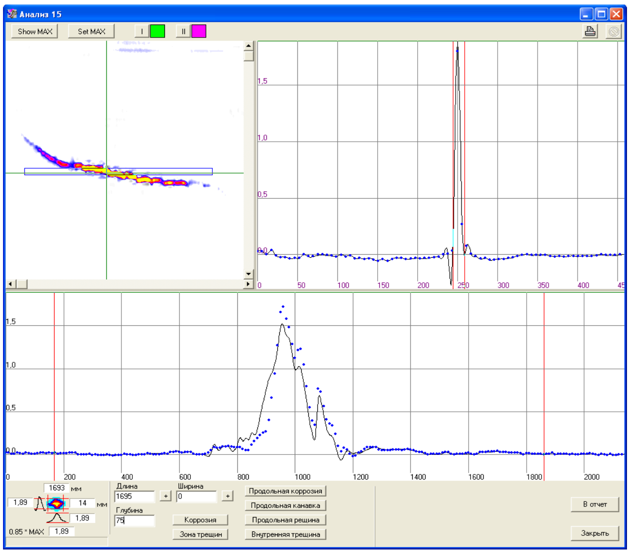
Runs of MFL & TFI tools enable to obtain information on practically all types of defects that can exist in a pipeline, including complicated cases of defects detection as follows:

- Pipe manufacturing defects (faulty fusions of longitudinal weld seams with cracks in the zones, where weld seam body joins the pipe).
- Zones of minor stress corrosion cracks.
- However, MFL technology is not able to detect such a crack, which is shown on the pipe layout recorded by MFL tool.

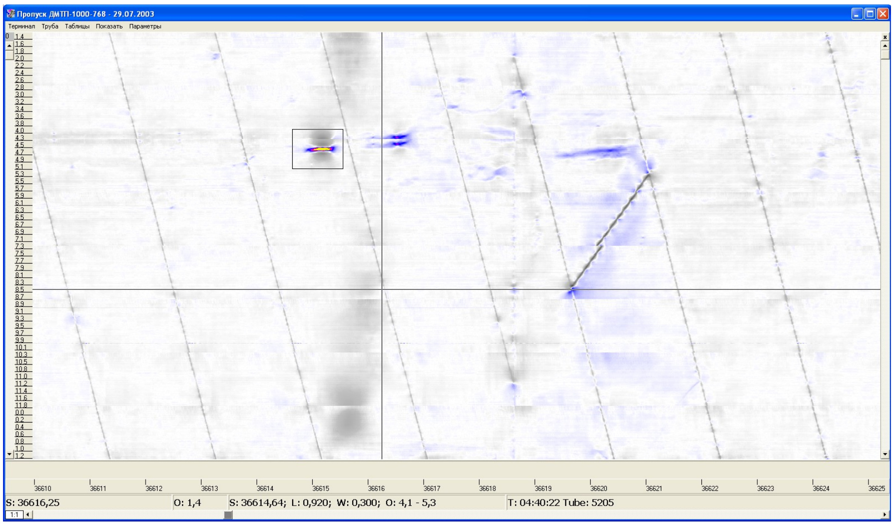
Overlapping of MFL & TFI inspection plots enables to obtain three dimensional sizes of any pipe defect.



Now the problem of discrimination in identification of mid-wall laminations and SCC cracks is solved. Statistically, nearly 95% of such mid-wall laminations are opened in the inner pipe wall, only insignificant number of such cracks being opened in the outer pipe wall. The longitudinal crack is clearly seen on the colored TFI inspection plot.



TFI tools are very useful for locating & sizing zones of small longitudinal cracks. A zone of very severe longitudinal cracks, being 60% p.w.t., was precisely located and assessed, using TFI technology. This zone was detected in a Russian trunk gas pipeline.



Here is TFI inspection plot that shows a pipe layout. Nearly all defects here are of metallurgic origin. Defects of longitudinal weld seam and girth weld defects are well detectable, using joint MFL + TFI technology.

However, there are stress corrosion cracks with extremely minor opening about 5 – 10 microns, which are difficultly identifiable. ”Spetsneftegaz” specialists detected such cracks in Argentina trunk gas pipelines. The sample of such crack zone is shown on the photo.

This figure shows the image obtained by TFI tool. The problem of identifying such crack colonies is that they are recorded not only by TFI tools, which are destined for their detection, but also by MFL tools.

The task of our scientists was to segregate the signals initiated by cracks on the background of other signals, for example, to distinguish such cracks from general corrosion defects or mid wall laminations.

To solve this problem, research work in several trends was accomplished:

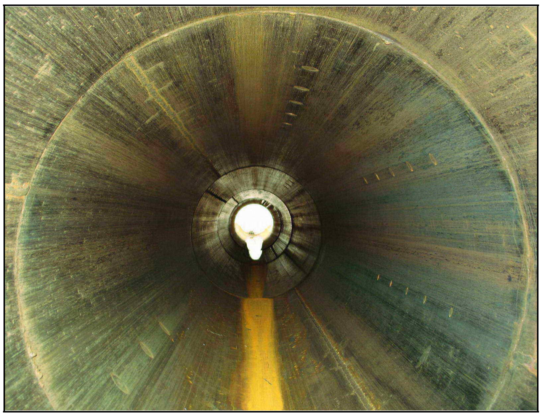
1. Discrimination of inner and outer defects.
2. Measuring signal initiated by defect in different fields of the same direction and under various angles.
3. Measuring stressed state of pipe body in the zone of stress-corrosion cracks.
4. Development of other methods and their combinations (eddy current method, EMAT method) applicable for in-line inspection tools.

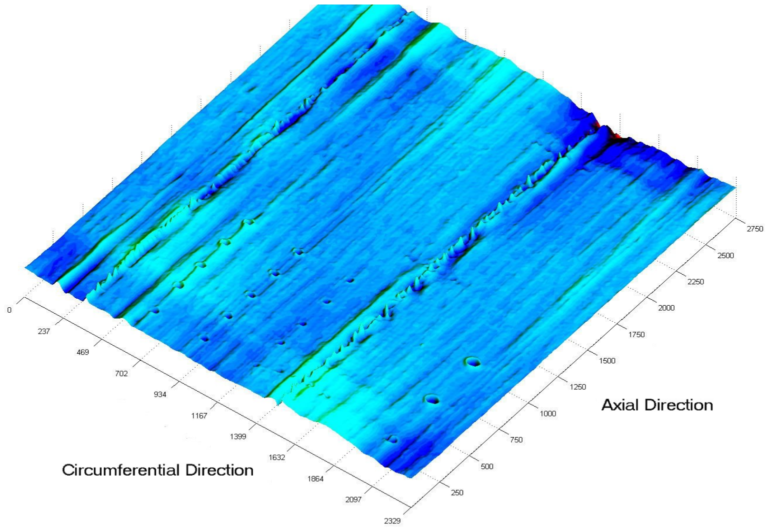
“Spetsneftegaz” scientists simultaneously conduct research in these four trends.

As far as the first trend is concerned, our specialists created the “inner vision” ILI tool, which is called intrascope or MFL+ type. This tool “clearly sees”, like camera, only inner pipe wall defects on the basis of magnetic method. Its resolution ability is not worse than UT tool. This tool 30” diameter and a special pipe test stand is shown on the photo.

Artificial defects of various depth are made in the pipe pull test stand. Now look at the image of test stand pipe layout obtained by the MFL+ tool. As we know, ordinary MFL tool has the same resolution capability for outer and inner defects. However, photographic resolution ability of inner pipe wall defects is obtained only by MFL+ tool.

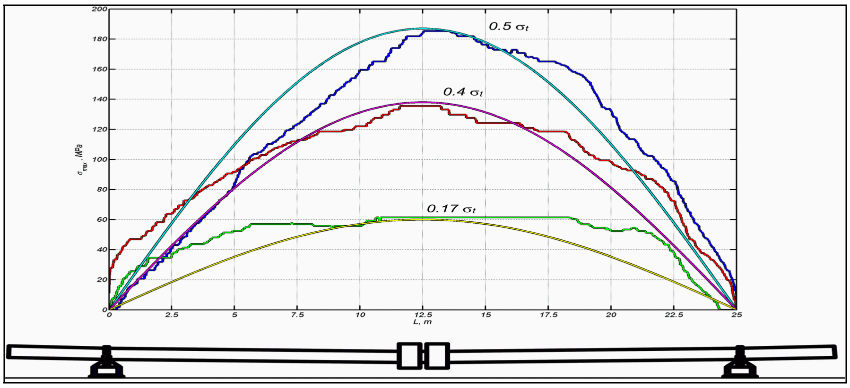
Here is example of another test stand pipe layout with the engraved word “MFL+” and pipe diameter 1020 mm. The depth of the letters figures is 30 mm. It is obvious that the tool has copied very clearly all the engravings, magnetic flux leakage and quality of weld seams inside a pipe (Slide 25).





Research work of second trend, i.e. measuring signals initiated by defects in different fields is practically completed. There were opinions of scientists from other countries that it is impossible to detect small stress corrosion cracks with minor opening, using only magnetic method. Our specialists also made conclusion that zones of minor SCC cracks are detected by MFL tool only because local stress state of pipe metal body arises above such zone, which is detected by MFL tool.

At present, “Spetsneftegaz” specialists work at creation of in-line inspection tool, which is capable to measure local stressed state of a pipeline. The first test sample of such tool has been already made.



This figure shows the result of experiment, using such tool. Pipe test stand 30” in diameter was used for first pull test run of this tool (Slide 26). Due to the fact that central supports under the test stand are absent, calculated loading on the pipe plus weight of the tool is characterized by lower curve on the graph. Two other parabolas are results of loading of the pipe with anchors 0,4 σ_T and 0,5 σ_T. As we see, the new tool reacted on changing of stressed state of the pipe.

As it was already mentioned, work is continued at application of magnetic ILI methods jointly with other methods, to reach the goal to identify reliably defected zones of pipelines.

To summarize the above mentioned information, “Spetsneftegaz” is ready for joint research activities with other companies and scientific research institutes, working continuously at development of new technologies and upgrading available ILI tools. Our scientists are ready to perform research work in problematic sphere of pipeline integrity and to submit results.