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The Project of Creating an Expert Company for the Diagnosis of Gas, and Also Oil and Gas Pipelines Using Mps

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Abstract

Various technological defects arise in manufacturing products and welded structures. Mechanical, chemical and thermal influences on structural materials during processing and welding procedures cause changes in ultimate strength, brittle fracture resistance, corrosion resistance, etc. The main operational causes of failures and damage are: defects; violation of operating conditions; corrosion; wear; the presence of overloads and unforeseen loads; improper maintenance, etc. The danger of the influence of defects on performance depends on their kinds, type and number. The classification of possible defects in the product allows us to choose the right method and means of control. However, it should be noted that the norms of rejection based on the results of non-destructive testing adopted in the guidance documentation do not guarantee that the presence of defects in an object with dimensions exceeding the permissible ones leads to a critical decrease in performance during operation. This is due to the fact that the applied X-ray inspection technologies do not allow us to reliably establish the type of defect and determine its characteristics, without which it is impossible to achieve an acceptable reliability of strength calculations. In this regard, this paper discusses the relevance of creating an expertise company for inspection of gas, and oil and gas pipelines using MPS (magnetic prospecting survey). The company will allow the owner of a pipeline monitoring with the use of the MPS method to obtain such data as: presence or absence of unauthorized tie-ins; location of pipeline defects. The main conclusions are made on the technical and economic analysis of the planned production, with the preparation of marketing, production and calendar plans; the risks of the project are analyzed.

Keywords: Magnetic Prospecting Survey, In-Line Inspection, Stress Corrosion Cracking, Pitting, Defects, Project.

I. INTRODUCTION

The idea for the creation of an "expert company for the diagnosis of gas, oil and pipelines using MPS" was generated under several factors.

One of the main and principal factors is the absence of companies providing services with the use of this inspection method in the Republic of Tatarstan. Working in this industry and having faced with various methods of finding and eliminating defective sections of trunk pipelines, we have generated the idea of another search method such as the magnetic prospecting survey (MPS). The method is based on measuring the magnetic field of the pipe. In the place where there is or is developing a defect (corrosion spots, pits, a defect in the weld seam, seizure of the pipe body, dents), a kind of "splash" will be observed. According to the form and level of this disturbance, the classification of the defect and the determination of its criticality are possible with a high degree of probability.

These works are carried out from the earth surface and do not require any complex preparation of the customer's facility. It is only required to determine the axis of occurrence and indicate the places of intersections with other communications.

After preparation of the object, a specialist conducts a "scan" of the pipeline (walk-around with the device along the route) and marks the places where defects were found. Further, it is in these places that pit works are carried out in order to conduct non-destructive testing.

By inspecting pipelines according to the above scheme, it is possible to significantly improve the quality and reliability of inspection work, namely:

- Pitting is carried out only in places where defects are found;
- The volume of pitting is reduced, and this is important for relatively new pipelines, since the insulating coating is damaged to a lesser extent and the risk of pipe damage by earthmoving equipment is reduced;
- The reliability of the information obtained during inspection increases.

Below there are the main characteristics of the equipment and the parameters of the detected defects.

1. Types of detected defects:

• Corrosion pits, stains;

• Defects of welded seams;

• Cracks;

• Dents;

• Scores;

• Transitions of diameters, changes in pipe wall thickness.

2. The minimum length of detected defects:

• From 2 mm (cracks, defects in welded seams, blisters).

3. Depth of detected defects:

• At least 10% of the pipe wall thickness.

4. Deviation from the pipeline axis during inspection:

• No more than 1.5 m (depending on the working pressure).

5. Operating temperature range:

• Up to minus 5 ° C.

6. Diameters of inspected pipelines:

• 56 ÷ 530 mm.

II. METHODS

Currently, in most cases a "traditional" search method is carried out, such as in-line inspection (INI). The magnetic method of in-line inspection is based on the registration of stray magnetic fields generated when the pipe wall is magnetized.

With the similarity of methods, MPS does not require chambers for launching and receiving the inspection pig, as well as removing the medium that is in the pipeline during the launch and reception of the projectile. To carry out the INI, it is necessary to deliver and install the projectile, and then place a rather heavy and cumbersome structure in the chamber, which is impossible without equipment and technical personnel. When carrying out MPS, only one or two * (* depending on the amount of control, terrain, climatic conditions) people, determination of the laying axis and indication of intersections with other communications are required.

The equipment necessary for carrying out MPS is fixed on the back with a backpack. It is also possible to perform study on the water by fixing the equipment properly on the boat.

If necessary, it is possible to install equipment on a drone, which will significantly speed up the shooting process, but will affect its cost.

III. RESULTS AND DISCUSSION

Pipelines built before 2000 have technological features such as large pipe bends where an inspection pig moving inside the pipe can simply get stuck. This will entail repair work on this site, with its subsequent release from the working medium. As a rule, such areas are located in mountainous and hilly areas, where the main laying is due to the relief of the terrain. In this regard, all repair work in such an area will be very expensive and technologically difficult. Another feature is the "technological straight cut", where one pipe is welded into another, after which one of the pipes "sticks out" inside the other, creating an obstacle to the movement of the inspection pig inside the pipe. Finding and examining the presence of such inserts is very difficult. Compared to INI, the magnetic prospecting survey method does not require equipment to be placed inside the pipe and is non-contact, which allows it to solve a number of problems that arise in case of using the INI method.

The second important factor is the treatment of a customer. The equipment necessary for inspection is placed in a case, which allows us to take it to a demonstration for the customer. Thus, it allows the customer to take a look at this method and understand whether it will suit him. When conducting a demonstration, a specialist can assess the volume and specifics of the work to be done, which excludes repeated visits to the site, thereby reducing costs. Organizations providing INI services use for their operation the equipment from different manufacturers, which implies different software for decryption. In order for the customer to make a decision in favour of one or another organization for inspection, he must rely on the reference information of the organization conducting INI, which may significantly differ. Therefore, the demonstration of equipment before the customer is an important aspect for the conclusion of agreements.

The third factor is the absence of any stress caused on the pipeline. At the same time, in order to carry out INI, it is necessary to lower the pressure with subsequent pressurizing. This negatively affects the performance of the pipeline due to pressure surges.

Suppose that measurements are carried out on an oil pipeline at one of the fields, with an incremental magnetometer MM-60, the measurement step is 0.25 m. After the measurements are processed in the field using a laptop computer, the pitting is carried out at points 1 and 2:

- If a section of the pipeline without visible defects is found at the point, then pitting is performed at this section. If visual and measuring control showed the presence of corrosion with a nominal diameter of 3-5 mm, which does not meet the requirements of VSN 012-88, then it must be eliminated;
- If a crack is found at the point (there was a leakage of the pumped liquid), then this defect must also be eliminated.

The proposed method for detecting defects is non-contact, non-destructive, does not require excavation during measurement, reduces labour costs for performing measurements (the work is performed by two people), has the prospects for a high level of automation, allows documenting measurement results, building a database on the basis of which one can build a system of pipeline wall continuity, and quality control of installation work. The method is applicable for the entire range of pipelines made of ferromagnetic materials and using ferromagnetic materials (for example, metal-plastic pipes).

This method of monitoring and detecting defects on pipelines made of ferromagnetic materials makes it possible to carry out measurements in the above-ground, underground, above-water and underwater versions of pipelines, if appropriate equipment is available.
For a start-up, the company needs to purchase special equipment and patented software for data processing by a unique method under the Patent "Method for monitoring and detecting defects in pipelines made of ferromagnetic materials." [1]
The technical task of the proposed equipment is to increase the efficiency of identifying defects, their ranking according to the degree of danger and determining the state of the pipeline body in a non-contact way, reducing labour intensity (there is no need to use additional equipment and there is no need to access the pipe body).
The technical problem is solved in the following sequence: 1) measuring the absolute value of the magnetic induction modulus measured in T (Tesla), and / or the gradient of the magnetic induction modulus magnitude measured in T, 2) plotting a graph for the dependence of the magnetic induction modulus magnitude and / or gradient of the magnetic induction modulus magnitude versus distance, 3) finding the average values of the magnetic induction and / or the gradient of the magnetic induction modulus magnitude for the selected area, 4) determining the magnitude of the standard deviations and highlighting the area where the magnetic field modulus magnitudes and / or the gradient of the magnetic induction modulus magnitudes are equal to or exceed twice the standard deviation value. After that, the sites corresponding to the areas highlighted on the graph are determined on the ground, and the pipeline is monitored by non-destructive methods in these places.
It is preferable if in the method, the average values of the magnetic induction modulus magnitudes and / or the gradient of the magnetic induction modulus are determined for pipeline sections with the same distance between the sensor and the pipeline axis (in the case of underground or underwater versions, the laying depth, i.e. the pipeline is laid approximately at the same depth). The spread of the pipeline axis position in relation to a "constant" can be ± 0.5 m.
When making measurements, the sensor sensitivity must be taken into account. The measured distance is the distance from the sensor to the pipeline axis.
The magnetic induction modulus magnitude and / or the gradient of the magnetic induction modulus are measured with a discreteness of 0.25 - 0.5 m and with fewer intervals also, if necessary.
The main factors leading to a decrease in the reliability of pipelines are:
1) Corrosion damage to the outer surfaces of pipelines due to insulation failure;
2) Erosion damage to the internal surfaces of pipelines due to intergranular corrosion and hydrodynamic shocks of the transported product leading to the loss of metal in the pipe wall;
3) Defects in welding.
These are potential factors leading to cracking and rupture of the metal.
It is known that a defect of a pipe is a stress concentrator. Stresses of this kind in a ferromagnetic material lead to additional magnetization in the region of the defect.
The method is implemented as follows.
The magnetic induction and / or the magnetic induction gradient are measured on the ground along the pipeline with a discreteness (step) of 0.25 -0.5 m (and with fewer intervals also, if necessary). To carry out measurements, devices can be used that register the magnetic induction modulus and / or the gradient of the magnetic induction modulus of the magnetic field. For example: quantum-mechanical, proton-precession (including those based on the Overhauser effect), magnetoresistive magnetometers, and magnetometers based on the Zeeman effect.
In the course of measurements along the pipeline, a graph of the dependence of the magnetic induction modulus magnitude and / or the gradient of the magnetic induction modulus on the distance are obtained and the average values of the magnetic induction modulus magnitude and / or the gradient of the magnetic induction modulus for the selected section with the same distance between the sensor and the axis of the pipeline are found.
Then the values of the root-mean-square deviations are determined and the regions are distinguished where the values of the magnetic field modulus and / or the gradient of the magnetic induction modulus are equal to or exceed twice the value of the standard deviations.
Overrunning of the measured value beyond the "mean value plus / minus two standard deviations" is evidence of the transition of a technical system (in our case, the pipeline) into an emergency state.
The areas highlighted on the graph are determined on the ground, and non-destructive testing of the pipeline is carried out in these areas. Typically, these areas contain either defects or areas that pose a potential threat of defects.

IV. SUMMARY

The purpose of the work was to develop a project plan for the creation of an expert company for the diagnosis of gas, oil, and other pipelines using MPS (in terms of time, work, organizational structure and cost), as well as to show the economic efficiency of the project. To achieve this goal, the following tasks were solved:
1) Types of defects in gas pipes are considered;
2) A marketing plan has been developed [6]:
- Key competitors were identified and the competitiveness of the company was assessed using the SWOT analysis method; the weak and strong sides of the project were identified. Based on the analysis of a number of competitors operating in the market, we can conclude that all these companies use fairly similar methods of searching for defects and their classification. This gives an undeniable advantage over competitors. The presence of a unique (proven) method allows not only to create competition for such large companies, but also to push them out of this niche. Competitive advantage is given not only by the equipment available in the state, but also by the unique software, with the help of which the ranking and classification of the found defects is carried out; [2-5]

- A marketing strategy has been developed and 100,000 roubles will be spent on advertising;

3) The production schedule has been developed [6]:

- The technological equipment and office space have been selected; the main costs for the purchase of equipment, licensed software, as well as the cost of electricity have been calculated. When carrying out scheduling, the life cycle of the project was assessed; its participants and their responsibilities at each stage, as well as the staffing table and the salary fund of employees with mandatory deductions were determined. A tree of goals, a matrix of responsibility, a network model, and a precedence diagram have been built. Using the critical path method (137 days) and the PERT method (123 days), a network schedule of the project was built; as a result, a Gantt chart was built as a visual and convenient project management tool;

4) The economic efficiency of the project was assessed [7]:

- Net discounted income with a discounting ratio of 7.25% for the seventh year will amount to 146,570,361.4 roubles; payback period would be a third quarter; discounted profit for one rouble of invested funds would be 49.06 roubles (profitability index);

- The internal rate of return: it is necessary to calculate the internal rate of return (IRR) in order to determine the net present value (NPV), which has a negative value, and in our case it is positive even at $r = 200\%$. Consequently, the project is financially sound, and the calculations indicate its fairly high efficiency;

5) The break-even analysis of the project was carried out and the main risks of the project were analysed [7]:

- Productivity per day can be from 1 to 3 km (depending on the terrain relief and weather conditions). Accordingly, productivity per month would be ≈ 22 - 66 km. The average cost of pipeline inspection services for the region will amount to 100,000 roubles per kilometre. Thus, the break-even point was 54.48 km per year, with an annual production of 327 km in the first year and 600 km from the second year. The most dangerous risk will be the risk of higher inflation. At the same time, the adjusted net present value has the largest difference with the initial value. The second place in terms of danger is occupied by the risk of a decrease in revenue, upon which there is a significant decrease in the values of net present value. The risks of increasing the cost of equipment are insignificant. The difference between the values of the initial and adjusted discounted income is minimal here.

V. CONCLUSIONS

Having faced with various methods of finding and eliminating defective sections of trunk pipelines and with the absence of companies in the Republic of Tatarstan that provide services for inspection of gas, oil and other pipelines, the idea arose of a different search method, such as the method of magnetic prospecting survey (MPS). The method is based on measuring the magnetic field of the pipe, which makes it possible to find bottlenecks where a defect exists or develops (corrosion spots, pits, weld defects, seizures of the pipe body, or dents). Such work is carried out from the earth surface and does not require any complex preparation of the customer's facility. It is only required to determine the laying axis and to indicate the places of intersections with other communications.

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