Z-99 Possibility of heating system pipeline corrosion investigation with electrometrical methods

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Coated steel underground pipelines are widely used in the municipal heat supply. The soils, where the pipelines are placed, are usually highly corrosive for pipe's metal. In the places of crippling of external coating the corrosion processes begin, and this can provoke a pipe breakage. To ensure the pipeline survivability it is necessary to carry out the control of pipeline conditions. The electrometric methods are widely used in world-wide practical work.

Authors have studied the corrosion processes of the municipal heating system pipelines in Saint-Petersburg (Russia) using a variety of geophysical methods. Hundred kilometers of pipelines were explored last year.

The investigation object comprises a pipeline composed of two parallel tubes, which are placed 1-2 meters deep. The fact that the Russian Federation and CIS countries still use the direct heat supply system makes impossible any addition of anticorrosion components to circulating water. Pipelines operate under high pressure (up to 5 atm) and high temperature (designed temperature is 150°C). Tube's isolation is meant for heat loss minimization, and ordinary has poor hydro-isolation. Some pipeline construction elements (sliding and fixed bearings, pressure compensators, head enclosures) are often non-isolated, and tube's metal contacts with soil. Hard usage condition, ingress of technical contamination cause, stray currents etc. cause high accidental rate.

Realization of geophysical diagnostics, including electrometry, is hampered in a city by underground communication systems, power lines, isolating ground cover (asphalt), limitation of the working area with buildings. These restrictions forms the investigation conditions.

Diagnostic operation system worked out during last few years includes air thermal imaging, investigation of electromagnetic fields and spontaneous polarization, measurements of electrode potentials of metal tubes.

High resolution air thermal imaging (ATI) allows to inspect efficiently large squares of heat systems, typical for cities. It gives objective information about heat loss on the pipeline, which reflects thermo-isolation conditions. ATI effectively detects reach-through holes (the places of heat escape) and sizeable defect areas of isolator and attendant drainage system. The experience shows, that the areas with less that 10% defects are not detectable (especially at the bottom of pipeline). However, right at these places such corrosion processes as blowholes are most intensive. Therefore the utilization of land electrometrical methods of field geophysics is preferable to detect small defects of insulation coating.

Wide investigation was carried out to select the geophysical methods, suitable to resolve the problem. At present time in order to detect and localize isolation defects authors successfully use the method of charge measurement together with the measurements of magnetic and electrical components of electromagnetic field.

In case of undisturbed isolation, electromagnetic field, produced by the current in a tube, must be constant (neglecting small capacitive loss). The decrease of magnetic induction corresponds with the decrease of electrical current in the tube, which appears near tube branching or isolation defects.

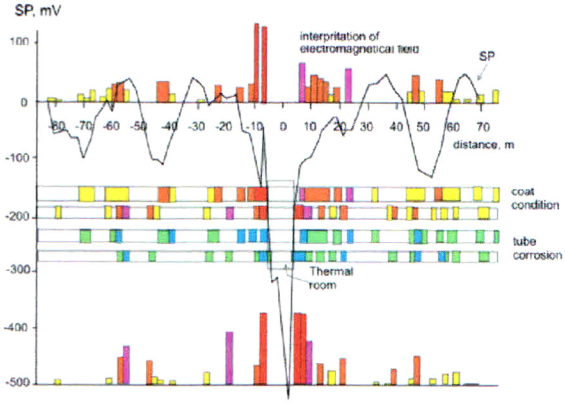
Heterogeneity of electrical component correspond to the electrical current trickling as a result of isolation defect or isolation missing. Peak value and width of the heterogeneity carries the information of a defect size. Simultaneous analysis of longitudinal and transverse axes of electrical component reveals the presence of metal objects near pipeline.

However, the electrical contact between a tube and the soil, as well as the presence of zones of isolation defects are not the direct indicators of corrosion focus places. The spontaneous polarization of electrochemical fields is the direct attribute of corrosion process. Authors use SP method to investigate electrical fields, caused by underground electrical currents caused by natural electromotive forces of electrochemical origin.

Due to the fact that a tube has higher conductivity than the soil, the measured potential fields are considered to be steady-state. Using this assumption, natural variations of spontaneous polarization (weather condition, hydrodynamic peculiarities, etc) can be excepted.

The places of underground pipeline coat destruction can be specified by complex of geophysical investigations. Also, it is possible to detect the intensity of destruction processes in real time.

All investigation methods, described above, correspond to the present time pipeline condition. To predict the corrosion development it is necessary to use together different investigation methods, to organize object monitoring, to create investigations results data base, to carry out statistical analysis.



The results of geophysical investigation of Heating System Pipelines in Saint-Petersburg are shown on the image. The interpretation of electromagnetical fields corresponds to the tube

coat condition. Red color shows the places where the tube is exposed. The coat is absolutely destroyed near head enclosures. Defected coat is colored from yellow to rose.

The SP curve demonstrate the corrosion processes distribution. More intensive corrosion areas are colored in blue.

At the present time we try to elaborate quantitative assessment of corrosion processes based on natural electrical fields measurements. We suppose to use the model of oxygen depolarization. This model agrees with corrosion process in fresh conditions, where the more important oxidizing agent is oxygen. In this case it is possible to calculate the equilibrium potential of reaction basing on the maximum oxidization current. Such model will be more complex for conditions which cannot to assumed to be fresh.

We will be glad to exchange the experience with you in case of positive results.

References

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