

Anticorrosive Monitoring and Complex Diagnostics of Corrosion-Technical Condition of Main Oil Pipelines in Russia

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Safety operation of main pipelines is primarily provided by anticorrosive monitoring. Anticorrosive monitoring of oil pipeline transportation objects is based on results of complex corrosion inspections, analysis of basic data including design data, definition of a corrosion residual rate and diagnostic of general equipment's technical condition. All the abovementioned arrangements are regulated by normative documents.

For diagnostics of corrosion-technical condition of oil pipeline transportation objects one presently uses different methods such as in-line inspection using devices with ultrasonic, magnetic or another detector, acoustic-emission diagnostics, electrometric survey, general external corrosion diagnostics and cameral processing of obtained data. Results of a complex of diagnostics give a possibility:

- to arrange a pipeline's sectors according to a degree of corrosion danger;
- to check up true condition of pipeline's metal;
- to estimate technical condition and working ability of a system of anticorrosive protection.

However such a control of corrosion technical condition of a main pipeline creates the appearance of estimation of a true degree of protection of an object if values of protective potential with resistive component are taken into consideration only. So in addition to corrosive technical diagnostics one must define a true residual corrosion rate taking into account protective action of electrochemical protection and true protection of a pipeline one must at times.

Realized anticorrosive monitoring enables to take a reasonable decision about further operation of objects according to objects' residual life, variation of operation parameters, repair and dismantlement of objects.

Keywords : corrosion, monitoring, diagnostic, pipelines

1. Introduction

Main pipeline transportation is presently one of the most capital intensive industry sectors. Operation conditions and operation lifetime of main pipelines are mostly affected by corrosion and biological corrosion aggressiveness of an environment, corrosion power of transmitted products, presence of mechanical strains, condition of anticorrosive protection (quality of insulating coating and efficiency of electrochemical protection). A negative combination of the abovementioned factors could shorten the main pipeline lifetime and results in necessity of early repair of the objects.

2. Results and discussion

Safety operation of main oil pipelines must be provided

by anticorrosive monitoring and complex diagnostics of their corrosion-technical condition. This must be described in the relevant industry regulative documents. Based upon the requirements of the Russian State standard GOST R 51164-98 and according to the requirements of the Federal Law of the Russian Federation "Technical Regulation" a number of industry normative and technical documents have been developed. They specify technical conditions and the order of performance of requirements of the federal documents.

There are several such documents regulating anti-corrosive protection of main oil pipelines:

- 1) Design rules of electrochemical protection of main pipelines and equipment of oil pumping stations, Moscow, VNIIST, 2006. It contains requirements of electrochemical protection for design, reconstruction and repair of main oil pipelines, process and branch pipelines of oil pump stations, oil tanks, sea terminals.

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2) Instruction of diagnostics of corrosion condition of process and branch pipelines of oil pump stations, oil tank farms, sea terminals and railroad overpass, Moscow, VNIIST 2006. It sets requirements of procedure and amount of work for complex corrosion diagnostics.

3) Regulations of diagnostics of corrosion condition of main oil pipelines and condition of corrosion protection equipment, Moscow, VNIIST, 2006. It sets requirements of procedure and amount of work for complex corrosion diagnostics.

4) Technique to evaluate corrosion rate of buried oil pipelines' walls, Moscow, VNIIST, 2006. It determines residual corrosion rate of main oil pipeline's walls.

Presently for estimation of corrosion condition of oil pipeline transportation facilities one uses cameral works which follows different diagnostics: in-line inspection by different pigs, acoustic-emission diagnostics, complex cor-

rosion diagnostics (Fig. 1).

Fig. 1 shows that complex diagnostics of corrosion-technical condition of the main oil pipeline is a synthesis and an analysis of different information. Using all the factors one can divide a pipeline sector depending on the category of corrosion danger. A performed in-line inspection uncovers defects of pipeline metal, weld joints and repair operations. Obtained data are processed and all discovered defects are classified based on their origin: corrosion or mechanical, on their potential danger types, which might require reduction of operation pressure of a main oil pipeline. After a repeated in-line inspection direct determination of a defect's corrosion rate is possible. Another aim of in-line inspection is to detect defects with a depth more than 10 % and 15 % of a pipeline wall thickness. Presence of such defects sets specific requirements for anticorrosion protection equipment of a pipeline sector.

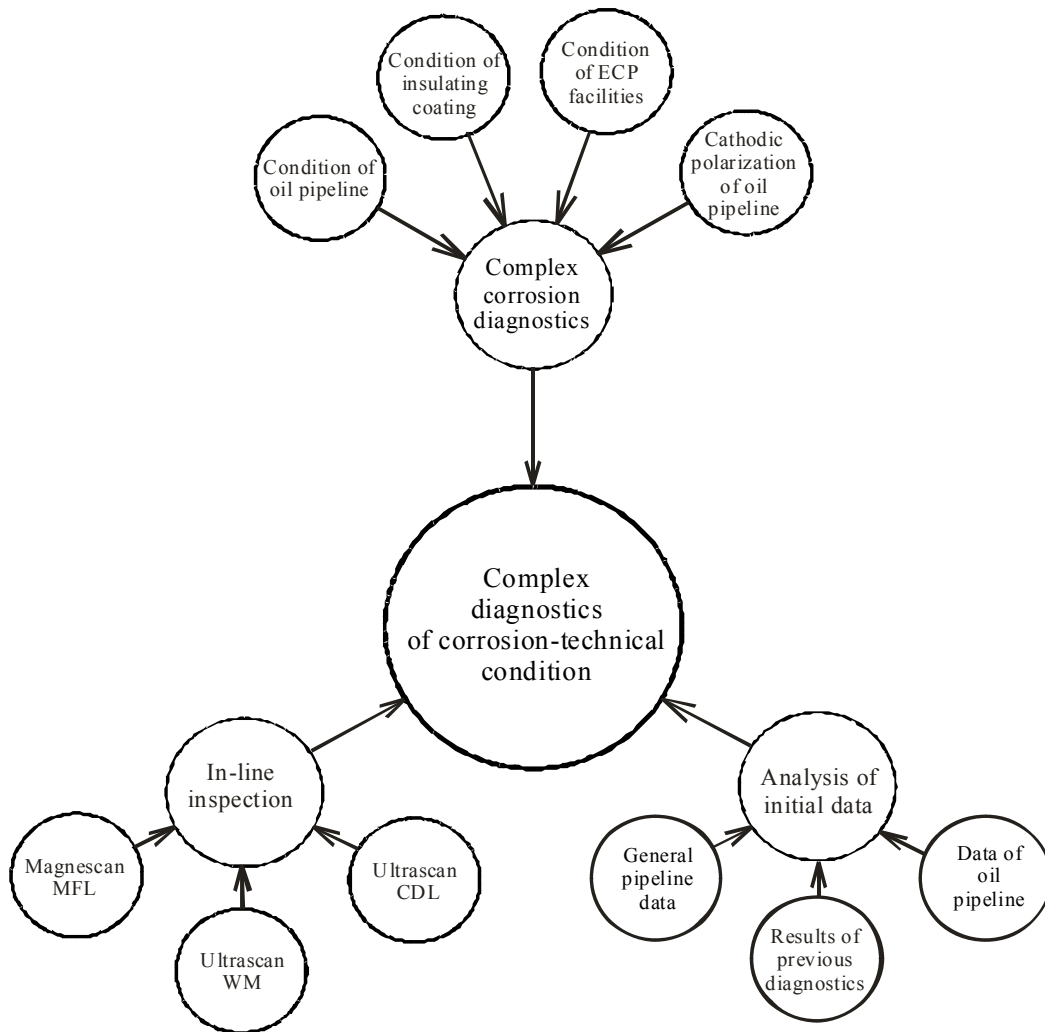


Fig. 1. Procedure of complex diagnostics of corrosion-technical condition of main oil pipelines in Russia.

However, classification of corrosion danger of main oil pipeline sectors depends on a number of factors, besides presence of pipeline wall defects. There are three categories of existing corrosion danger for main oil pipelines (Fig. 2).

Sectors of top corrosion danger include:

- sectors where corrosion failures have taken place;
- sectors where corrosion defects with a depth more than 15 % of a pipeline wall thickness have been detected;
- sectors where an observed corrosion rate is more than 0.5 mm/year;
- sectors laid in soils with specific electrical resistance less than 20 Ohm m;
- sectors situated in areas of influence of direct stray currents on main pipeline;

Sectors of main oil pipelines are related to high corrosion danger sectors if some of the following factors are observed:

- corrosion defects with a depth more than 10 % of a pipeline wall thickness have been detected;
- corrosion rate in the range from 0.3 mm/year up to 0.5 mm/year has been observed;
- soils with specific electrical resistance in the range 20-50 Ohm m;
- danger corrosion influence of alternate current;
- crossing of a main oil pipeline and an overhead high-voltage power line with a voltage 220 kV and more;
- transitions of a main oil pipeline under railroads and automobile roads;
- underwater transitions of main pipelines;
- main pipeline sectors situated closer than 1000 m from industry and household outflows, garbage dumps;
- danger of microbiological corrosion;
- temperature of transported product in excess of 30°C;
- crossing of a main oil pipeline and another pipeline;
- chernozem soil type;
- swamps;
- irrigated areas.

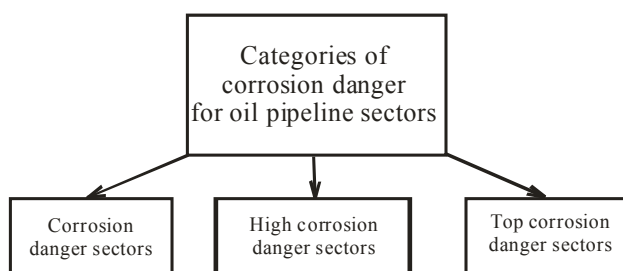


Fig. 2. Classification of corrosion danger categories for oil main pipelines sectors.

• Finally sectors of corrosion danger include:

- sectors where protection zone of a cathodic protection unit is less than 3 km;
- sectors where polarization potential of a main oil pipeline is not within the allowable range.

Complex corrosion diagnostics should be performed to classify pipeline sectors in dependence on their corrosion danger categories. Complex corrosion diagnostics consists of the following procedures:

- electrometric and visual diagnostics of insulating coating of a main pipeline: determination of electrical resistance, search of sites of defects of coating integrity, observation of metal adhesion etc;
- technical diagnostics of electrochemical protection equipment including calculation of their power reserve with account of further deterioration of insulating coating and anodic ground electrodes;
- observation of general corrosion situation at a pipeline routing: soil corrosion power, danger of microbiological corrosion, influence of direct stray currents, induction influence of overhead high-voltage power lines;
- measurement of cathodic potential of a pipeline along a pipeline length;
- analysis of presence of pipeline wall defects, superposition of pipeline wall defects, polarization potential values, coating defects.

As a result of complex corrosion diagnostics one defines an objective factor of corrosion situation of a pipeline route and effectiveness of corrosion protection. This factor must concern corrosion mechanisms, environmental conditions of a pipeline's operation. It is called a degree of protection. A degree of protection of a pipeline for a concerned time interval (n years) can be calculated proceeding from annual values which can be revealed using the polarization curve of a pipeline steel plotted in laboratory, the Pourbe diagram, values of polarization potential obtained by field measurements (a factor of a degree of protection) and a duration of disturbances of a maintained level of protective polarization potential (a factor of time protection).

Complex corrosion diagnostics is a part of corrosion monitoring of operated main oil pipelines (Fig. 3). Corrosion monitoring is mainly intended for the following:

- improvement of reliability to estimate effectiveness of corrosion protection of a main oil pipeline depending on the factor of a degree of protection, the factor of time protection and irregularity of distribution of polarization potential along a main oil pipeline;
- definition and refinement of corrosion danger categories of pipeline sectors;
- development of arrangements for elimination of ori-

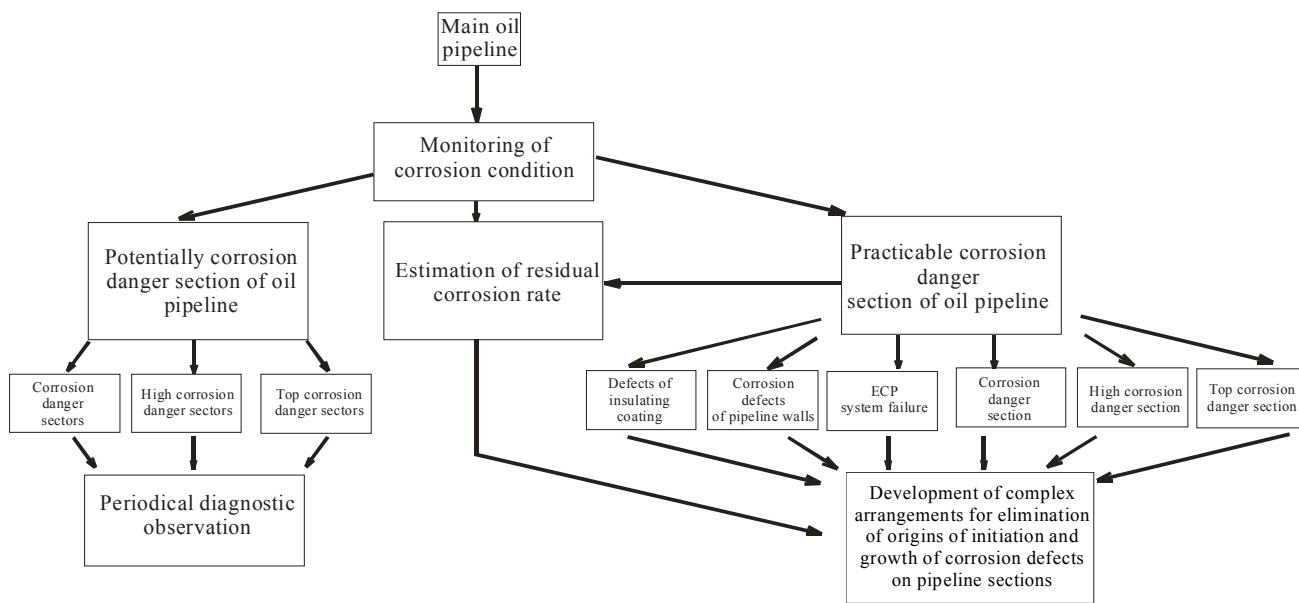


Fig. 3. Scheme of corrosion condition monitoring of main oil pipelines.

gins of initiation and growth of corrosion defects on pipeline sectors.

Arrangements for elimination of origins of initiation and corrosion defects on pipeline sectors consist of:

- update and adjustment of existing electrochemical protection equipment, design of additional electrochemical protection equipment;
- recommendation of repair of insulating coating;
- establishment of time of the next corrosion diagnostics.

3. Conclusion

Monitoring of anticorrosion protection and diagnostics of corrosion condition of main oil pipeline ensures its safety operation. Monitoring results in classification of corrosion danger of pipeline sectors based on their corrosion condition and effectiveness of electrochemical corrosion protection. Such a general estimation of corrosion condition of main oil pipeline shows objective picture of corrosion condition and gives an opportunity to take a reasonable decision about further operation of the object, variation of its operating parameters, its repairing or disassembling.