Accident Prevention and Diagnostics of Underground Pipeline Systems

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Abstract. Up to forty thousand accidents occur annually with underground pipelines due to corrosion. The comparison of the methods for assessing the quality of anti-corrosion coating is provided. It is proposed to use the device to be tied-in to existing pipeline which has a higher functionality in comparison with other types of the devices due to the possibility of tie-in to the pipelines with different diameters. The existing technologies and applied materials allow us to organize industrial production of the proposed device.

1. Introduction
By the beginning of 2010, the share of oil pipelines with more than 20 years old was 73 % and more than 30 years – 40.6 %. The main reason for failure of oil and gas structures in the corrosion factor. In Russia 40-50% of machines and equipment working in aggressive environments and 30% in slightly aggressive, and only about 10% do not require an active corrosion protection. On the infield pipelines of oil, water and gas 95 percent of the failures falls on in-line inspection and external corrosion [1-3].

The analysis of statistical data showed that the intensity of accidents on trunk pipelines has a pronounced regional character, i.e. not only the overall performance of scientific and technological progress in the industry, and a number of local factors, features of construction and operation of a specific area, well-developed industrial and transport infrastructure, total economic activity in the region. The main danger emergency depressurization of gas pipelines are:

1. Sections of the pipeline after the compressor station (5 km) — due to non-stationary dynamic loads;
2. The gas pipeline sections on the connection nodes;
3. Areas near settlements and areas with high levels of anthropogenic activity (construction areas, intersections with roads and railways).

The manifestation of accidents on gas pipelines, representing the linear structures has a pronounced territorial character. Regional manifestation of accidents is due to the difference in various regions of the geotechnical characteristics of slopes, condition of the road network, the overall level of industrial and agricultural development. The analysis showed that the corrosion rate North of the 60th parallel in natural soil conditions due to the relatively low temperatures of 15-20 times higher than, for example, in parts of Central Asia. Due to the influence of climatic factors in conjunction with regional characteristics corrosiveness of soils, the failure rate in the Northern zone in 1.4 times, and in the South is 16 times higher than the value for the middle band.
2. Experimental research
Currently, there is a need to quantify the physical condition of underground pipelines with the aim of preventing accidents and planning of the capital costs of the repair methods is outdated and requires revision [4]. For example [5], guidelines for corrosion testing include: a) a quality assessment of insulation coating of the pipeline at selected points of the network; b) prediction of the corrosion process, etc.

The measurements needed to estimate corrosion process, it is recommended that pipelines directly in the pits. In the study with a step of 200 m (step 200 more meters will not give reliable information for complex pipe network) for the analysis of corrosion condition, e.g., 3,000 km gas pipeline network of the city will need 15,000 pits.

In addition to direct costs, identified the following negative processes:
1. Excavator at the opening of the pipeline with a bucket hits him and breaks the integrity of the insulating material cracks, which are characteristic not only at research, but on either side of this point, and maybe beyond the pit.
2. New insulation exposed area will lead to the fact that the pipe in the pit will occur galvanic heterogeneity. This will result in a pipe network of hundreds of new foci of corrosion.
3. Recommended for measuring the specific electrical insulation resistance the technique of "wet towels", that is superimposed on the insulated tubing of a band electrode with the polarization of the pipeline from an external current source does not always give correct results.
4. Measurement of resistivity of soil (ρ) taken from the pit, using the standard four-electrode laboratory setup is not always accurate. The results of laboratory measurements of ρ may vary from the results field on the right, always downward.

3. The technique of diagnosing corrosion condition of pipelines
In recent years, the authors developed a design and field methods of diagnosing corrosion condition of pipelines [6-8].

It is found that when field measurements of electrical resistivity of the soil ρ step four-electrode measurement setup should not be less than two depths of pipe laying [9,10]. The error of measurement of the specific electrical insulation resistance R is connected with the determination of the true values of the stationary potential of the pipeline [11-15].

In the study of piping systems need to quickly remove petroleum product from a pipe. This paper proposes to use the device for penetration into the existing pipeline. It allows qualitative insight into the pipelines of various diameters and to carry out penetration at a given angle.

The apparatus comprises a centering mechanism made in the form of the hull with the clamps, at least one row and two pins in a row, with the possibility of interaction with internal surfaces of pipe, valve and a sealed housing (Figure 1). Moreover, the shaft of the cutting element causes the rotation of the driving mechanism of rotary type and connected with the housing. The body centering mechanism connected with the hermetic housing of the drive mechanism of the reciprocating type so that in the folded condition of the drive mechanism for reciprocating the last point of the moving parts from the pipeline could be in a sealed enclosure.

The operation of the device is as follows. To the current pipeline (Figure 1) attach the outlet, closed shut-off element, a sealed housing, and in this case in a sealed enclosure are: a moving part comprising a shaft mounted with a cutting element, the drive mechanism of rotary type, the centering mechanism, etc.). The drive mechanisms of the reciprocating type have in this case the minimum size, for example, by the addition of a hydraulic cylinder. The drive mechanisms of the rotary type constructed in such a way that the extreme point of the locking mechanism cut from a pipe of area moving parts located inside a hermetic enclosure. Once all the elements are tightly connected (pipe, tube, shut-off element, a sealed housing), the locking element is open, the drive mechanism of the reciprocating (for example, because of sliding of the hydraulic cylinder) moves the part out of a sealed enclosure, pass through the open shut-off element, placed inside the pipe. Moreover, due to the centering mechanism is centered in the nozzle, and through the drive mechanism, the reciprocating and rotational type, the feed and
rotation of the cutting element 6, after the formation of the hole, the cutting portion of the tubing remains on the locking mechanism cut from a pipe section.

**Figure 1.** General view of the device for the tapping of branch to the existing pipe: 1 – pipe; 2 – branch pipe; 3 - the shut-off element (gate valve, ball valve etc); 4 - sealed housing; 5 – shaft; 6 - cutting elements; 7 - driving gear, reciprocating (cylinder, etc.); 8 - drive units of rotational type (electric motor, hydraulic motor, etc.), 9 - centering mechanism; 10 – housing; 11 – locks; 12 – stop; 13 - extreme point of the cutting element, 14 - extreme point of the locking mechanism cut from a pipe section; 15 - moving parts; 16 - supporting surface; 17 – the rollers

By means of the drive mechanism of the reciprocating part is moved to the sealed housing so that the extreme point of the locking mechanism cut from a pipe section (or an extreme point of the cutting element, if there is no locking mechanism cut from pipe section) moving parts located inside a hermetic enclosure. Further, the locking element is closed, an airtight chamber is detached and the locking element can be connected to the pipeline.

The main advantage of the proposed device is the diagnostic accuracy, quick identification of problem areas and Troubleshooting without opening utilities. Using this equipment is guaranteed to find exact locations of faults for further repair work.

4. Conclusion
The proposed device for tapping into the existing pipeline will extend the functionality of this type of device, due to the possibility of tie-in pipelines of different diameter. Existing technologies engineering and applied materials allow to organize industrial production of the proposed device.

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