THE USE OF GIS TECHNOLOGIES TO CALCULATE THE AREA OCCUPIED BY GAS PIPELINES

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Abstract

The article considers the possibilities of using geo-information technologies for managing gas supply facilities. Specific GIS solutions are proposed for the creation of a unified system that integrates executive, technical and management documentation with a digital model of the gas pipeline network. It is concluded that the spatial approach to information based on electronic maps and corresponding geo-databases allows not only to take into account the geometric and technical features of each section of the pipeline, but also simplifies the solution of the management and monitoring tasks, increasing the level of safe operation of pipelines for various purposes.

Keywords: GIS, gas pipeline, gas supply, electronic cards, geo-database, gas accounting, monitoring, security.

INTRODUCTION

Each aspect of hydrocarbons exploration, processing, storage, distribution means some risks associated with environmental impact and issues to maximize effective and economically profitable operation (Strizhenok and Tcvetkov, 2017). But, often, all the risks are difficult to assess and expensive to foresee. By systemizing reliable scientific and technological information, it is possible to ensure the integrity of data on oil and gas sector objects at all stages of their life cycle (from design to liquidation) and significantly simplify the operation and monitoring of engineering network facilities.

MATERIALS AND METHODS

One of the reasons for this is the low efficiency of existing monitoring services (Pivovarova and Makhovikov, 2017). Often, the services for tracking the actual situation at the enterprises are limited to registering physical processes, while the competent and widespread use of geo-information technologies make possible the synthesis and analysis of observations, management decisions and adjustments of activities. So known cases from the world practice show the non-application of spatial analysis tools and the lack of integration of spatial information systems with existing control systems leads to serious emergencies and human casualties (http://www.exprodat.com/featured):

- PG&E admits violating federal law requiring pipeline inspections every five years – On September 9, 2010, a 30-inch-diameter segment of an intrastate natural gas transmission pipeline owned and operated by the Pacific Gas and Electric Company (PG&E), ruptured in a residential area in San Bruno, California. The rupture produced a crater about 72 feet long by 26 feet wide. The section of pipe that ruptured, which weighed about 3,000 pounds, was found 100 feet south of the crater. PG&E estimated that 47.6 million standard cubic feet of natural gas was released. The released natural gas ignited, resulting in a fire that killed 8 people and destroyed 38 homes, damaging 70 more. It was later discovered that PG&E failed to check nearly 14 miles of gas distribution pipelines for leaks for up to two decades when it lost track of 16 maps needed to guide mandated safety inspections of its system.

Maersk Victory jack-up sustains major damage - In 1996 the Maersk Victory jack-up sustained major damage when one of its legs broke through soft seabed limestone in St. VincentsGulf off South Australia. The incident happened while the rig was jacking up on location prior to spudding the first of two wells in the Stansbury basin on exploration permit PEL 53. The South Australia Department of Mines and Energy Resources (MESA) undertook an investigation and determined that the cause of damage was the failure of the sub-sea sediments beneath the rig. MESA concluded that there was a failure to fully evaluate the risks of the drilling location, a failure to fully evaluate the geotechnical data of the sub-sea sediments, and a failure in management systems and procedures for locating the rig.

- Anonymous North Sea example of incorrect rig positioning - During a jack-up rig move the engineer looking after the navigation didn't realize that he'd inadvertently changed the coordinate reference parameters he was using. Later radar positioning checks revealed it was 1.5 km off location, in another operator's block. The company in question had to move the rig at a cost of $750,000, and suffered reputation issues as the government reviewed its license arrangements (from the OGP Geomatics Committee geodetic awareness guidance notes document, which contains other examples of geo-reference integrity failures).

RESULTS AND DISCUSSION

Working in «GeoMedia Professional» using the «xMedia» module, it is possible to build a technological scheme for the gas pipeline network (GP) for various purposes. As a rule, gas pipelines are divided into main and distribution networks. The structure of the distribution gas network is a set of looped networks of main directions of gas flows and dead-end networks of branches. The type of gas pipelines can also differ: underground, aboveground, and underwater. Also, the GP differed on operating pressure - low, medium, high I and II categories. All this is taken into account when working in the program, while placing the appropriate fittings, gas consumption facilities, distribution points and filling in attributive information.

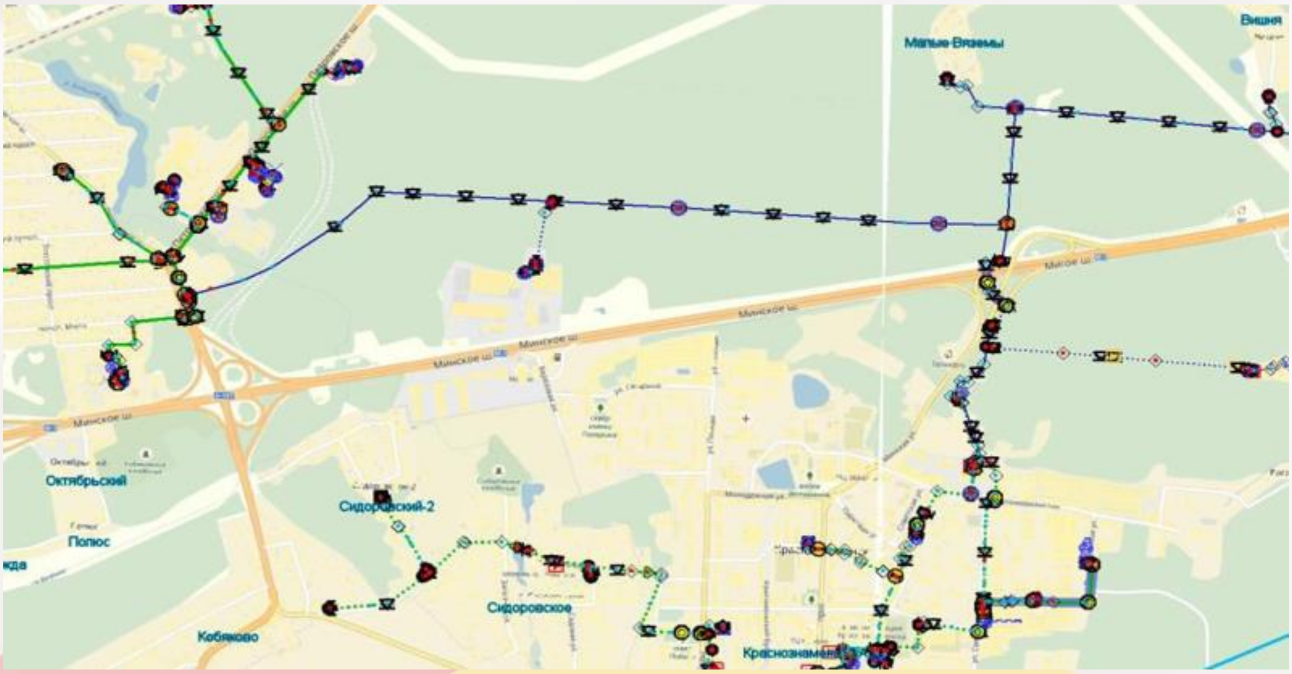

Figure-1. Fragment of the GP network of high pressure I and II category.

By scanning the executive plans scale 1: 500 - 1: 2000 produced vectoring gas facilities (GF) of the layers, the linkage topology GF filling characteristics. The attribute information of objects is always indicated:

- the name of the document file for accounting in the electronic archive;
- number of executive documentation on accounting in the electronic archive.

As a rule, the GIS-project includes the following thematic layers:
The «Gas Pipelines» layer - gas pipeline segments are vectorized by linear objects, i.e. the segment of the gas pipeline is a section of the gas pipeline having the same characteristics over its entire length (diameter, laying method) and bounded on both sides by other OGX (reinforcement). On maps and diagrams, GP segments are displayed by a polyline that defines the pipeline route.
The objects of the «Armature» layer can be represented in the form of three objects: low pressure, medium pressure or high pressure fittings. Displayed by vector objects and oriented along the GP segment. Data on diameter are taken from the execution plan and from the welding circuit.
For each layer, all attributive information is described in detail, for example: the type of gas pipeline lying (underground, overground); Wall thickness; A feature of the locality (rural or urban settlements), etc. The final view of one of the sections of the gas pipeline is shown in Figure-2.

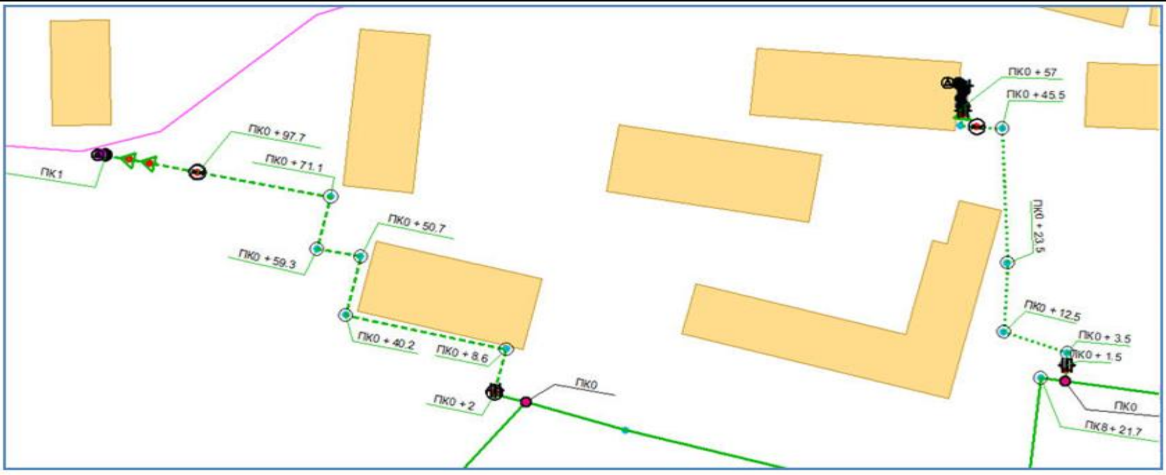

Figure-2. Result: topographic base, gas pipeline, reinforcement, tie-ins, transitions, staging.

Application of GIS-program «NextGIS QGIS" for determination of technical condition and monitoring of main gas pipelines

Another notable GIS package, actively used recently in the oil and gas sector of the Russian Federation, is «NextGIS QGIS» - a full-featured desktop GIS. Where «QGIS» is a well-established GIS-system developed by the international developer community (http://gisgeography.com/qgis-arcgis-differences), and «NextGIS» is a plug-in module presented by Russian specialists.

The company «Gazprom Space Systems» uses the program «NextGIS QGIS» to determine the technical condition of the linear part of the main gas pipelines and develop recommendations for preventing or reducing the negative impact of natural and man-made factors (http://kosmos.gazprom.ru). The data of space optical survey (0.5 m), aerial unmanned survey (0.1 m) and ground-based geodetic measurements are used. As a result, orthophotomaps of main gas pipeline routes, thematic GIS with monitoring results, reports on detected violations and detected dangerous factors are obtained (Figure-3).

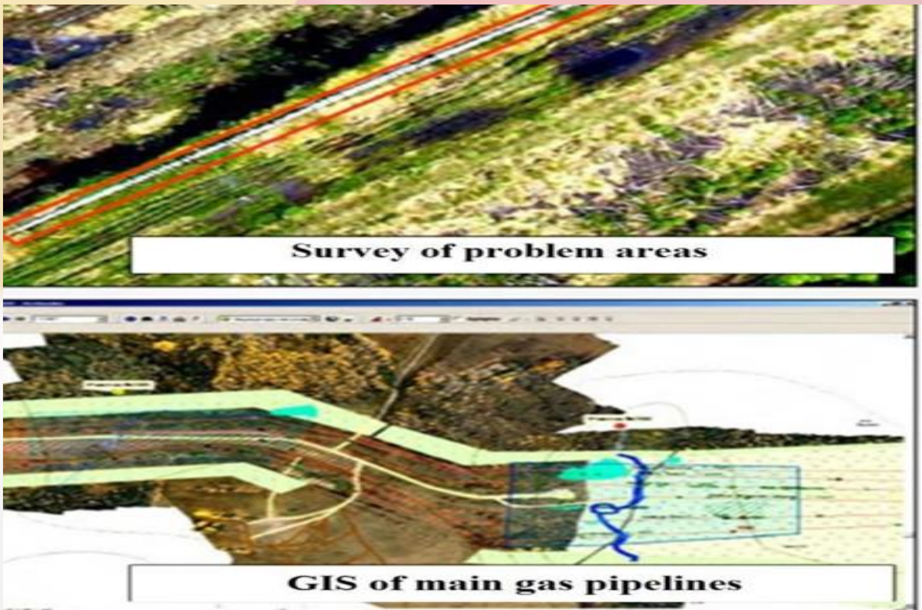

Figure-3. Geotechnical diagnostics of main GP

CONCLUSION

Summarizing, it is possible to say with certainty that today geo-information systems are becoming more and more widespread in gas supply, becoming an important management tool at gas facilities, where the main activity is the process of uninterrupted natural gas supply to consumers. Monitoring of networks through GIS is necessary to screen and predict emergencies occurrence probability such as leakage in remote or abandoned pipelines, emission during transportation of gas that may arise due to low temperatures, icing, and the possibility of flooding, terrain heterogeneity, forest fires, seismicity, complex geological conditions (landslides, karsts) and the human factor (Kuanyshev et al. 2011, Chappell 2017). Gas pipelines must be monitored to achieve high efficiency, maximum safety, minimum downtime and high product quality standards and environmental protection.

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