The Reliability in Natural Gas Distribution Systems

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Abstract: - The reliability of natural gas systems at high levels, considered in the design stage and analysis in exploitation as important parameters, ensures natural gas supply to consumers in appropriate conditions. The organization of natural gas operator, centered on increasing system reliability, ensure conditions satisfying customer requirements and maximizing profit.

Key-Words: - Natural Gas Networks Reliability

1 Introduction
The reliability is the capacity of a technical system to operate without malfunctions for a long period of time.

If we refer to the natural gas distribution systems, the reliability is defined as the safe operation systems and the continuity in the supply of natural gas to the parameters required by consumers (residential, industrial or commercial consumers).

The natural gas distribution in terms of quality is also considering other aspects:
- maximum transport capacity of gas flow;
- increasing the efficiency of the distribution activity;
- increasing the productivity in the natural gas distribution operator;
- establishment of prices that correspond to market requirements and determine maximizing profit of the operator.

2 Operating cost of distribution systems for different reliability and different pipe diameters
The increases reliability distribution systems have positive effects on the distribution operator, but also on its customers.

For the distribution operator increased reliability determines improving economic, technical, organizational performance and safety of the operating.

For customers increased reliability determines prices decrease and prevent malfunctions of natural gas supply.

In the graph below can follow the relationship between operating cost and reliability of distribution systems, for different diameters.

The conclusion is that the lower reliability, whatever pipe diameters determine the increase of operating cost of natural gas distribution system. To the same level of reliability the operating costs can be different depending on pipe diameter.

3 Reliability design of natural gas distribution systems
Considering the above can discuss about a natural gas distribution system reliability design which include the following stages:
- market analysis to determine the level of reliability required by the client;
- optimization level of reliability required by client according to operator capabilities and its economic indicators (investment cost, operating cost, incomes, profit, investment recovery period etc.). The reliability level required by the client should be considered...
as investment variants, by cash-flow method.
- designing the distribution system and determining the reliability level after the technical project;
- construction of natural gas distribution system, tests and inspections that will determine what is the reliability level of the system into operation;
- determining optimal periods for inspection of distribution pipes, determining the necessary works and the value of these works;
- comparing the results of the level of reliability determined at various stages for improving the existing model.

3.1 Basic data for the design reliability of natural gas distribution systems
The following figure can watch design stages reliability for natural gas distribution system, considering two models of maintenance: preventive and reactive.

![Diagram showing reliability stages](image)

It is found that by choice of preventive maintenance method the reliability over time is provided at a level much higher than in reactive maintenance methods.

For choosing a certain reliability level of a pipeline system are taking into consideration technical, economic and organizational aspects.

The preventive maintenance methods, including periodic inspection of pipelines and control of natural gas losses determines increased reliability. The surveillance of system determines identification of sensitive areas, with possible damage more frequently and establishing remediation and repair programs. By respecting theses programs the system is returned to reliability designed or to a new reliability established to be advantageous in the operation management.

Both for the preventive maintenance as well reactive to the three problems arise during operation:
- the external loss of metal (caused by corrosion or mechanical action);
- the internal loss of metal (caused by corrosion or erosion);
- leaks of components of natural gas network.

The most of pipe defects are caused by external corrosion: corrosion under insulation, galvanic corrosion, geological pile etc.

3.1.1 Detect insulation condition
The insulation defects are inevitable and they are due to the following factors:
- manipulation, transportation and assembling of pipe coupons isolated in an incorrect mode;
- nonexistent or law verification works by beneficiary;
- aging of the insulation in time;
- mechanical influences of the pipe (thermal expansion, land movements etc.);

In sections of insulation defects the metal pipe come into direct contact with the environment in which the pipe is buried. As a result it primed reactions that can lead to corrosion metal wall penetration and production of technical accidents.

Therefore fault locating isolation and repair them acquire great importance for users of buried metal pipes. Corrosion is metal destruction by chemical or electrochemical reaction with the environment in which it is in contact.

In soil and in water is always about electrochemical processes. In all electrolytes corrosion reaction, metal atoms pass as part electrically charged (ions) into solution. Thereby surface elements of metal deteriorate faster or slower.

For example, a flow of electric current of only 1 mA results in a dislocation of material about 8 g steel per year.

For locating pipe uses electromagnetic field that form due to current injected into the pipe with the frequency of 100 Hz (after righting current network with the frequency of 50 Hz).

This method is inserted into the pipe a low frequency signal (1÷10 KHz) which cause over a
insulation fault to occur a very high intensity of low frequency signal.

Thereby by the pipeline route survey can be determined “voltage funnel”, recognizable by increasing the received signal. Such as maximum “voltage funnel” is a fault isolation.

After locating fault isolation is useful in the second stage to measure voltage funnel near fault detected. It is important to determine whether it is a defect or pipe is in contact with a foreign metal installation. Over a defect determine the potential symmetrical peak. To contact of a foreign installation, the low frequency is almost constant over foreign installation.

The practical experience in recent years demonstrated that it is not sufficient to execute potential measurement into certain points. It is necessary to measure potential step by step pipeline.

3.1.2 Identification defects by determining the loss of natural gas

The determination of the loss of natural gas is a reactive method to determine pipe state. All the same is a widely applied method in distribution systems.

The method consists of intake air in an enclosure where – by different method – compare properties with air properties that are found in a neighboring room (standard room).

For of natural gas leak detection in pipes it is used these physical methods:
- diffusion through the membrane;
- radioactive isotopes;
- infrared spectroscopy;
- flame ionization;
- catalytic combustion;
- thermal and electrical conductivity.

The efficacy of this method depends on the following factors:
- frequency of use of the equipment for detection gas leaks;
- soil type;
- mode laying pipes.

Control interval shall be differentiated according to various portions of the network state. A new pipeline, designed properly, control does not require at least 3-5 years.

After passing this period, according to the control mode used and the network state, can be fixed for the next period the control at predetermined intervals.

They are taken into consideration the number of defects per kilometer of pipeline, type, character and location of the defects.

If state pipeline analysis reveals a low damage is required to remedy that defect at low cost, in a short time. In case is identified a section of pipe with damaged insulation or reducing the thickness is required a solution to reinsure pipeline function.

3.2 Increased reliability for the natural gas distribution systems using scientific management

The natural gas distribution systems are comprised of pipes different diameters and operating at different pressures, but can be considered homogeneous systems. These homogenous groups can be considered processes (activities) which to apply scientific management. The processes as defined transform inputs (human resources, capital resources and know-how) into distribution services to customers, at a corresponding degree of satisfaction with the profit.

Schematically flow of information and feed-back are presented in the following figure:

Fig. 2
The functioning of this process can not be accomplished without applying managerial functions for each homogeneous group and apply functions for each process in the organization of the distribution operator.

Integrated logistics engineering must be found as part of the production function that must analyze each homogeneous group of pipes.

Integrated logistics management is in charge of planning reliability indicators pipes that compose each process, allowing a system to obtain the general reliability distribution.

Information collected from the field – by the above methods – allow us to formulate multiple variants on the reliability of a system. It can determine which are the ways to improve it in conditions of customer satisfaction and maximum profit.

The choosing an alternative and reliability strategy, adopted by the operator, is factors that allow formulation of reliability plan for each process and for distribution activity.

Planning level of reliability shall be accompanied by the creation of optimal conditions for realization of the reliability.

The organization involves the definition operational and functional departments, definition of posts, recruitment, selection and training personnel, and hierarchy and leadership activities.

An important function of logistic engineering management is the control function that involves monitoring the implementation of reliability plan.

The control function proposes correcting deviations or modification of reliability plan. Also the control function can indicate inefficiency for other functions (research development, financial accounting, marketing, human resources).

The above indicates the real importance of functional changes in the activity of the natural gas, regarding to the concept of reliability.

4 Conclusion

The conclusions are the followings:
- the operating cost of distribution pipes increases with decreasing reliability for all pipe diameters;
- the increased costs simultaneously with the decreased reliability is determined by costs associated with remedying defects, penalties paid to customers, gas losses, fines etc;
- the increased level of reliability determine average maintenance cost reduction, with reduces prices applied by licensed operator;
- the same degree of reliability for a distribution system composed of pipes of different diameters involve different operating costs for each pipeline. [1]

References: