

Automated system of control and identification of sources of gas imbalance in the gas transportation system

Arthur Kostandyan

Abstract

The relevance of the work. The quality and efficiency of the gas supply system are determined by the amount of natural gas imbalance and are the main criteria for effective metering of the supplied gas. Currently, there are no examples of system solution and realization of tasks of operational identification of causes and sources of natural gas imbalance, providing decision-making for effective management of gas transportation systems. This problem is still relevant at present.

The aim of the work. The purpose of the dissertation work is to develop a simulation model and algorithms for identifying the causes and sources of natural gas imbalance in the pipeline gas transportation system.

Tasks solved in the dissertation work are:

- step-by-step modeling of the gas transmission system with parallel verification of the measurement system in real time;
- assessment of the causes of gas imbalance taking into account the unreliability of information;
- development of a logical scheme for localizing the causes of gas imbalance on linear sections of the pipeline (measuring system serviceability, unaccounted losses due to leaks and an algorithm for calculating the simulation model as a tool for identifying natural gas leaks;
- modeling of online monitoring of the measuring system based on the use of auto-associative neural networks using the apparatus of statistical analysis;
- information and expert support for formation and decision-making to eliminate the causes of gas imbalance, including:
 - development of an automated system for monitoring and operational control of facilities for the purpose of expert assessment of possible causes of gas imbalance and real-time decision-making;
 - estimation of the error of used measuring instruments directly involved in gas balance calculation.

Scientific novelty. Based on modern approaches and methods for assessing the efficiency of balanced operation of the gas transportation system, the scientific novelty is as follows:

- A comprehensive approach to the analysis of gas pipeline operation modes and causes of imbalance of natural gas transportation based on the construction of a simulation model taking into account the characteristics of compressors is proposed.
- A model for analyzing modes and identifying possible sources and causes of natural gas imbalance in the gas transportation system is developed.
- A logical scheme for localization of unbalance causes and an iterative algorithm for identification of natural gas leakage locations on linear pipeline sections have been developed.
- An intellectual system for diagnostics of the measurement system and assessment of measurement reliability in real time, correction of rough measurements was developed.

Practical significance. The developed system, designed for oil and gas industry facilities, includes the following functional modules:

- Statistical analysis of measurement system data, identification of gross errors their correction and localization of sources of gas imbalance;
- Identification of causes and sources of gas imbalance at linear sections.

The main provisions for the defense:

- Mathematical model of the gas transportation system, in order to identify the causes and sources of natural gas imbalance;
- Algorithm for identification of sources and causes of gas imbalance in the gas transportation system and places of gas leaks at linear sections of the gas transportation system;
- Algorithm for statistical analysis of measuring system data and identification of sources of gas imbalance;
- Mathematical models and algorithms for detection and localization of natural gas leaks in the gas transmission system;
- Subsystem for real-time diagnostics and calibration of the measuring system based on auto-associative neural networks.