HEAT AND GAS SUPPLY, VENTILATION, AIR CONDITIONING, GAS SUPPLY AND ILLUMINATION

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RELIABILITY MONITORING OF HEAT SUPPLY NETWORKS

Problem statement. An analysis of structure, age structure and damageability of main heat networks has been performed.

Results and conclusions. A freeware geographical information system in aggregate with modules of heat supply reliability monitoring has been used for creation of a system of heat supply reliability monitoring. The system of heat supply reliability monitoring makes it possible to provide timely and coordinated support for administrative decision making under time deficit and in dynamic environment. The operation of heat networks with the use of system of monitoring opens up new possibilities for increase of their service life and reliability.

Keywords: monitoring, reliability, heat supply networks, geographic information systems.

Introduction

These days heating is supplied to large urban areas mostly by central heating systems. As heating becomes more centralized, length of heating networks and pipeline diameter increase.

Besides, there is a growing risk of pipeline damages, which it takes much longer to repair. In the operation process of heat networks, it is essential not only to provide consumers with reliable and well-functioning heating system with the prescribed technological parameters, to prevent heating network emergencies, but also to develop economic efficiency.

1. Heat supply network reliability analysis

In order to estimate heat supply network condition, an analysis was performed on the structure, age group and reliability indices of pipelines by PC Saratov heat supply networks [1]. The total length of the main pipeline by PC Saratov heat supply network of 200 mm and more in diameter is 123 km. The underground pipeline is 95 %, the above-ground one is 5 %. The length distribution of main heat supply networks by PC Saratov heat supply network is presented in Fig. 1. The analysis of Fig. 1b shows that 58 % of pipelines have been in operation for over 30 years. Due to the fact that the operating life of most of the pipelines exceeds the standard one, there is an increasing number of damages.

The damage number distribution of main heat supply networks by PC Saratov heat supply network in pipe inner diameter is given in Fig. 2, damageability distribution is in Fig. 3.

The analysis of Fig. 2 and 3 shows that damageability of main heat supply networks by PC Saratov heat supply network reaches 0.51 damages per km in a year· and is in average 0.17 damages per km in a year·, which is a high index.

a)

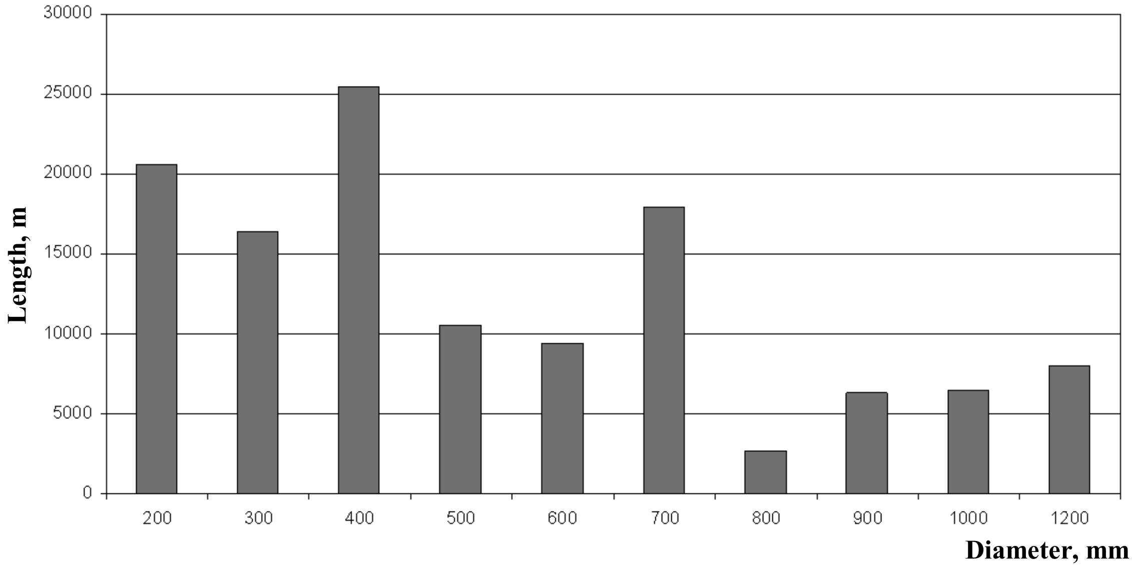


Fig. 1a. Length and age group of main heat supply networks by PC Saratov heat supply network in pipeline inner diameters: diameters distribution

b)

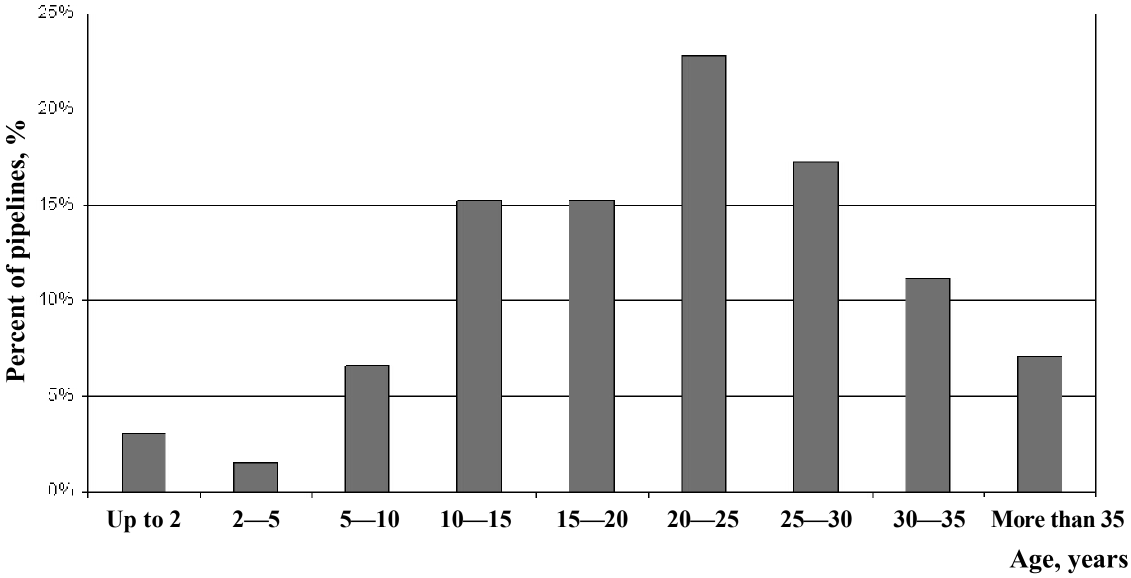
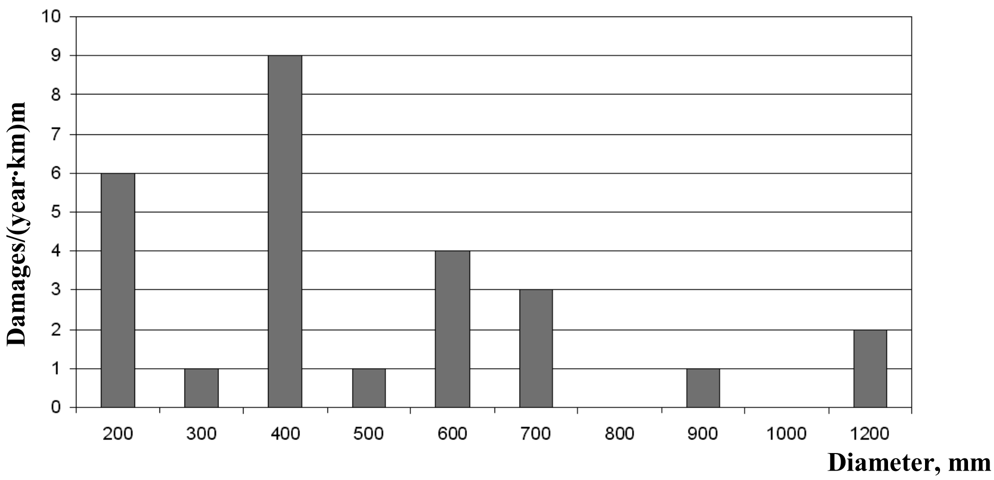


Fig. 1b. Length and age group of main heat supply networks by PC Saratov heat supply network in pipeline inner diameters: age distribution

a)



b)

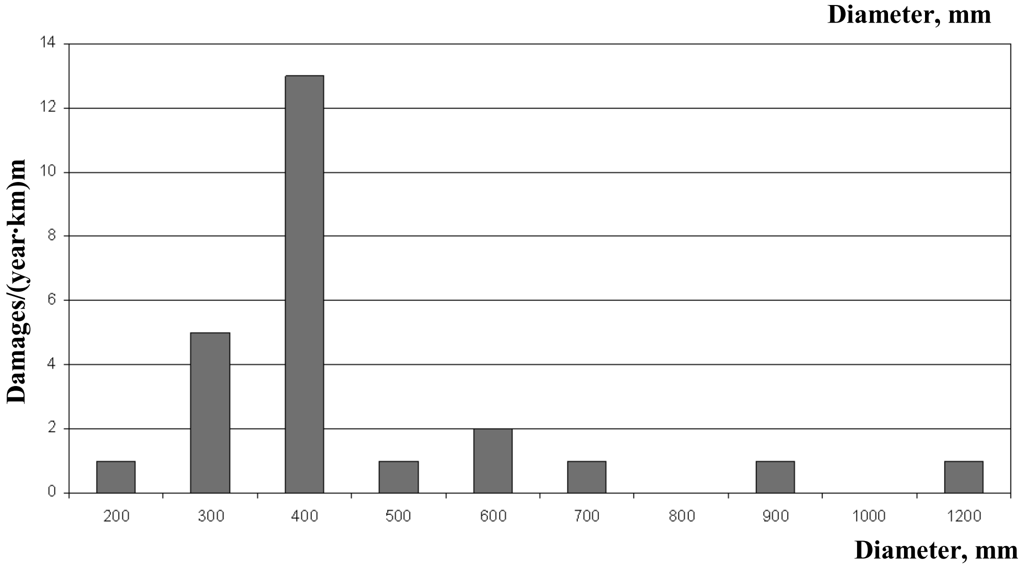


Fig. 2. Damage distribution of main heat supply networks by PC Saratov heat supply network in pipeline inner diameters: a) 2006; b) 2007

c)

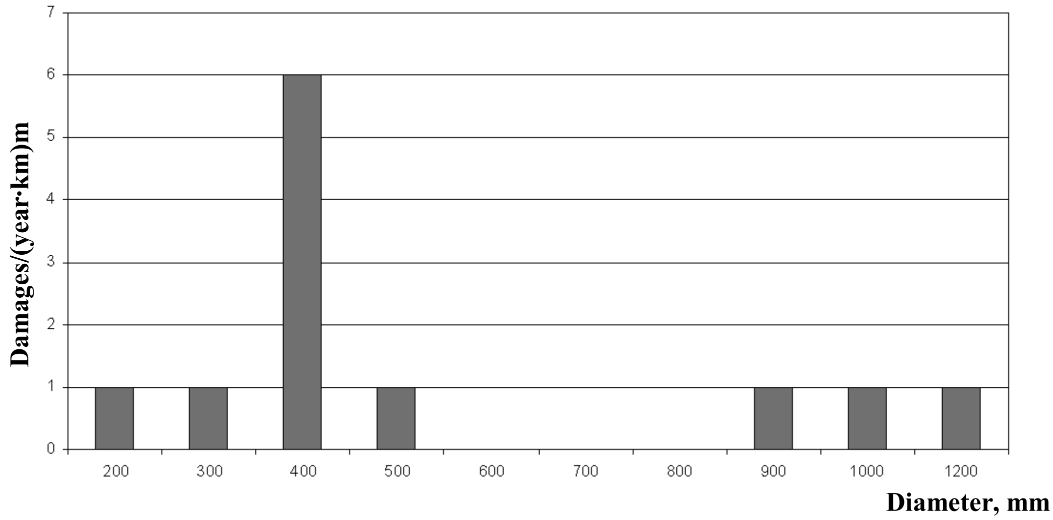


Fig. 2 (end). Damage distribution of main heat supply networks
by PC Saratov heat supply network in pipeline inner diameters: c) 2008

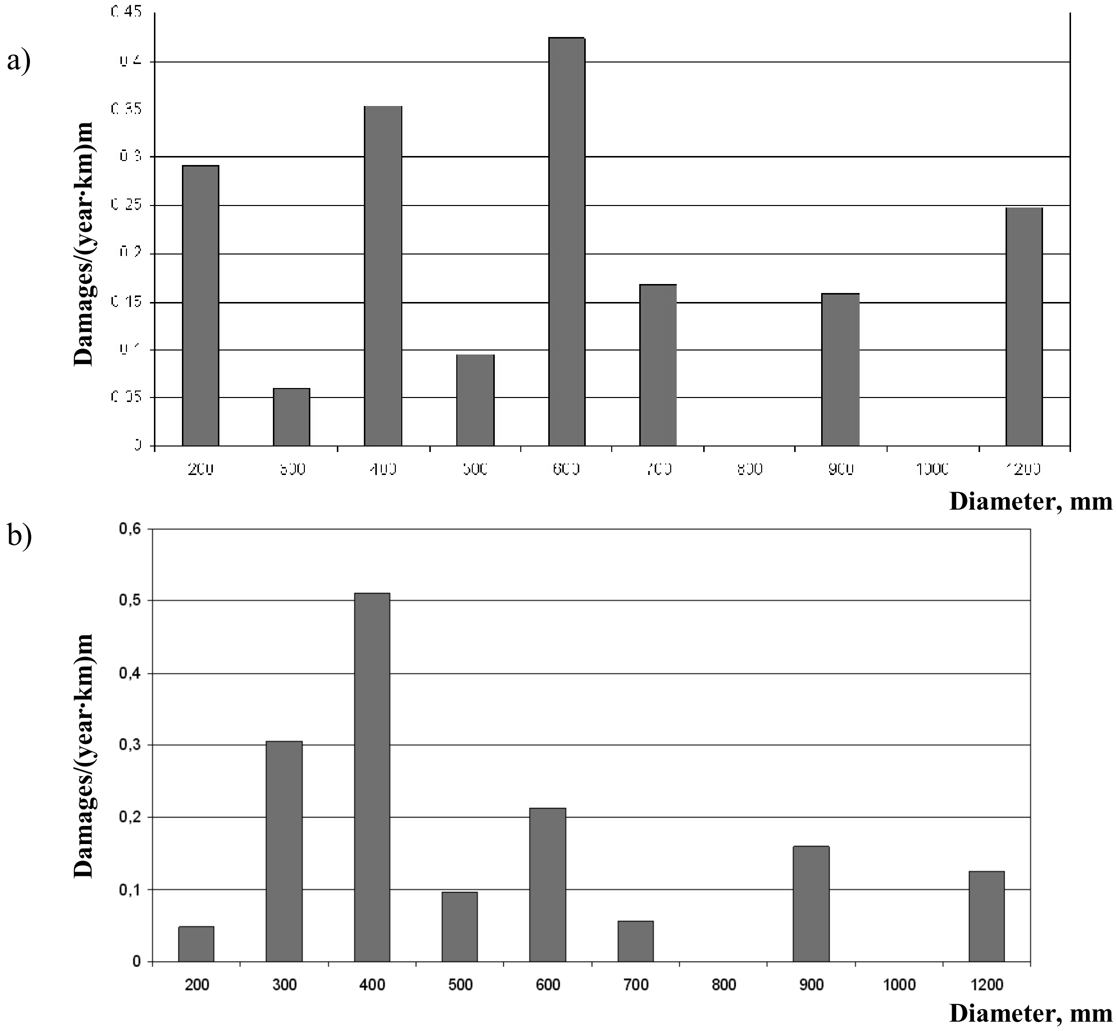


Fig. 3. Damage distribution of main heat supply networks
by PC Saratov heat supply network in pipeline inner diameters: a) 2006; b) 2007

c)

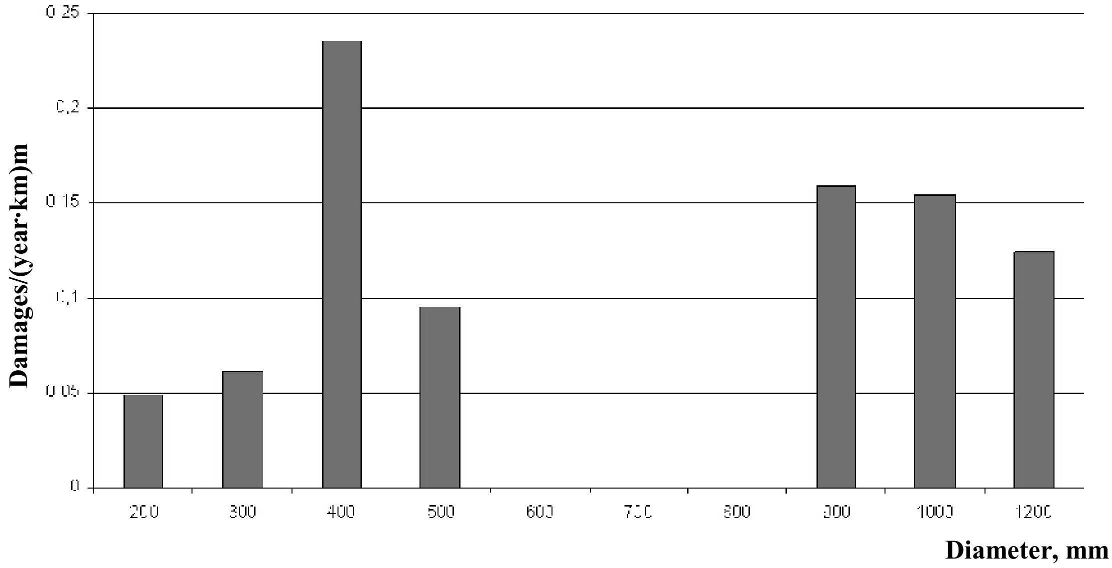


Fig. 3 (end). Damage distribution of main heat supply networks by PC Saratov heat supply network in pipeline inner diameters: c) 2008

Hence, due to the ongoing pipeline aging, it is more and more urgent with each year to provide heat supply network reliability.

2. The monitoring system elaboration

The aim monitoring system elaboration is the informational support and validity enhancement of prospective engineering solutions in the area of operation, technical maintenance and repair of heat supply networks, which will increase their reliability and durability.

The information on pipeline technical condition is made up of a great number of indices, the monitoring of which is unfeasible without the application of up-to-date information technologies which include a complex system of observation, estimation and prediction of heat supply network condition. A geo information system (GIS) was chosen as a basis for heat supply network reliability monitoring system.

A geo information system is a group of up-to-date computer technologies created for preparation of maps and analysis of objects and events on a spot. The application of the technologies making up geo information systems allows to combine the work with traditional databases (indexing, access and further statistical data analysis) and the work with special data as with the single information medium [4, 6, 7].

It allows chances for special analysis and geographical information visualization. These features make geo information systems different from the classic data storage, editing and analysis system. GIS allows to unite together all the data obtained in the heat supply network designing, building and operating process [2, 3, 5].

A freely spread geo information system is used together with reliability monitoring modules with the purpose of the monitoring system elaboration. The following serve as the basic information for reliability monitoring system: design documentation; executive documentation; certificates and equipment technical passport; welding joints examination protocol; ground characteristics; pipelines repairs schemes; pipeline diagnostics results; pipelines schemes with detected and removed defects; isolation system data, etc. Pressure test results which allow to detect most defects is a vital information source.

The data obtained in the monitoring process are variously analyzed. Unlike the traditional statistics operating averaged access characteristics, the monitoring systems ‘adjusts’ to the data with the adaptive use of the association, classification, clusterization method, time series analysis and prognostication. Besides, the application of geo information systems allows to conduct spatial and retrospective data analysis.

A factor analysis apparatus is used to describe the influence of the factors determining heat supply network reliability, which gives an opportunity to find out the number of active factors and reveal their relative intensity and feature structure of the factors, i. e. to show by which feature and to what extent the action of this or that factor is conditioned. It also allows to reveal the factor structure of the features, i. e. to show the influence rate of each of the factors on heat supply network operation. The application of the analysis results allows to consider the influence of various factors on heat supply networks technological reliability.

The prediction of the remaining source life and heat supply network reliability indices is an important monitoring element. Based on the whole information on heat supply network elements, extrapolation of their potential behavior patterns is carried out and the optimal moment for operation cessation or for the next examination. Monitoring also allows to prolong resources and operating lives of heat supply network elements.

3. Program realization

The main goals in the process of creating the program modules of the monitoring system were to make an item convenient for use, to combine modularity and extensibility and to have a sufficient operating speed. For this to be achieved, the medium of *Microsoft Visual C++.NET*, a part of the *Microsoft Visual Studio—2008* pack. The pattern library for the language *C++ Windows Template Library* was used for creating a user graphic interface.

The relational database management system (SMDB) was used for storing and processing large data volumes. A free database management system *MySQL* distinguished by its small size, high opearing speed and simplicity of integration.

The application programming *MySQL C API* interface was used for the integration of the database contianing program modules.

Conclusions

Heat supply network reliability monitoring system provides informational support for management solutions made by technical and repairs staff of structural subdivisions in the context of a rapidly changing environment and lack of time. Generally the monitoring system helps to form technical policies of an organization in terms of providing heat supply network reliability.

The application of the heat supply network reliability monitoring system allows to plan the repair workload and heat supply network transposition and to estimate resource demands for performing repair jobs.

Thus, heat supply network operation with the use of the monitoring system opens up new resources for increasing their resource and reliability indices.

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