

Information Technology for Monitoring of Municipal Gas Consumption, Based on Additive Model and Correlated for Weather Factors

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Abstract. The present article deals with the practical implementation of information technology for monitoring the gas consumption of the city (regional centers) on the basis of proposals additive model and taking meteorological factors. Justified and suggested automating the monitoring system of gas consumption. The functional diagram of the formation of a database of measurements and framework developed of a database to store statistical data measurement of gas consumption and meteorological factors for interval accumulation hour, day and week.

Keywords: gas consumption, information technology for monitoring of municipal gas consumption, “Caterpillar-SSA” method, regression analysis, change-point detection method by Brodsky-Darkhovsky.

1. Introduction

This article deals with the practical implementation of information technology for monitoring the gas consumption of the city (regional centers) on the basis of proposals additive model and taking meteorological factors. Justified its main requirements and suggested automating the monitoring system of gas consumption. There was given a description of the functional diagram of the formation and accumulation of a database of measurements of gas consumption and meteorological factors. Suggested form of DB for storing of information for interval accumulation hour, day and week. The given example illustrates the results of applying automate system for monitoring of gas consumption of the city.

2. The definition of the problem

Basing on the statistical data of gas consumption measurements and municipal weather histories, it is necessary to suggest an information technology for monitoring of municipal gas consumption; to describe the functioning of information system, intended for data collection from Flowtech measuring complexes and weather histories; to develop a database structure in order to store data measurements in the following accumulative steps: an hour, a day and a week; to suggest an automated monitoring system for municipal gas consumption and an algorithms for statistical data processing, based on the proposed mathematical model and with regard to the weather factors available.

3. The objectives of the monitoring

Under the monitoring of municipal gas consumption processes, we understand the complex task, intended for a gas consumption measurement, a database formation and a statistical characteristics determination. Primarily, this is the determination of trend components and residual components within the gas consumption time units, the determination of tasks, put for a current and a long-term monitoring and prognosticating; the carrying out of a comparative analysis in order to find out the real-time and predictable values of gas consumption processes, which are mainly analyzed on the annual basis with the following data accumulative steps: a week, a day and an hour.

Under the monitoring of municipal gas consumption, we understand the following:

- 1) The current monitoring (operative and short-term), that is:
 - The measurement of current characteristics of gas consumption in the accumulative intervals: an hour, a day, a week;

- The data visualization of the gas consumption measurements and the weather factors by means of the corresponding charts. For example, a gas consumption chart, an operating pressure chart and an average temperature chart (by hourly and daily steps);
 - The visualization of hourly and daily charts in the form of an additive components summing up, as follows: a trend, quasi-harmonic components and a stochastic remainder.
- 2) The long-term monitoring:
- The measurement of current characteristics of gas consumption in the accumulative intervals: a week, a month, a quarter, a year;
 - The data visualization of the gas consumption measurements taken and the weather factors available by means of the corresponding charts. For example, a daily gas consumption chart and an average daily air temperature chart;
 - Basing on the mathematical model to carry out an analysis and a prognostication of the gas consumption, taking into consideration the temperature values, forecasted for the next day.

4. The additive model of the municipal gas consumption

As a result of a priori analysis of statistic data of measurements of municipal gas consumption in a regional center, there was determined a topology of the gas consumers and main factors, influencing the dynamics of gas consumption within an annual observation interval [1,2].

As the common mathematical model there was preferred a vector random process:

$$\Theta(\omega, t) = (\xi_1(\omega, t), \dots, \xi_n(\omega, t)), \quad t \in T, \quad \omega \in \Omega \quad (1)$$

where $\xi(\omega, t)$ is the random processes vector, associated with the technological parameters of gas consumption, as follows: a volume of the consumed gas, an operating gas pressure in a pipeline, an air temperature in a city, and a change of consumer's topology.

That is, the state of a gas consumption system at the defined moment is characterized by many random values. Since the measurement data are discrete, and the change of consumers' topology takes place at two main levels (central heating availability or unavailability), therefore, such mathematical model will belong to the models class with a discrete state and a discrete time of the system.

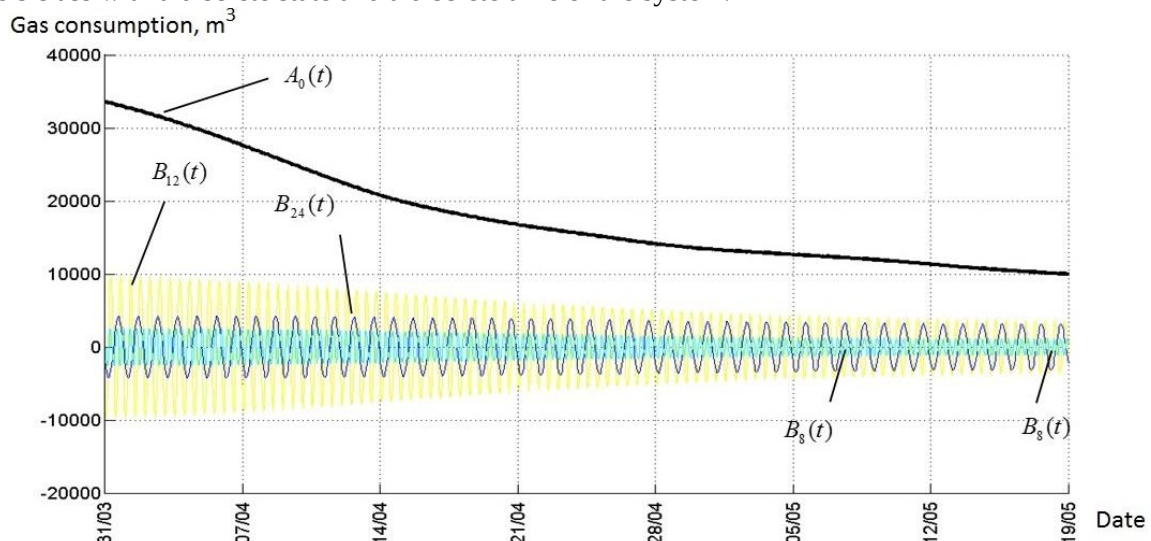


Figure 1: Graphic representation of additive components of hourly time interval data of gas consumption: $A_0(t)$ (trend) and $B_8(t)$, $B_{12}(t)$, $B_{24}(t)$ (quasi-harmonic) on the interval of 5 weeks during the spring 2009.

At the stage of a prior statistic processing, there was suggested that the singular spectrum analysis method [3] is to be used. The use of such a method, in essence, is the inverse task: basing on a time intervals analysis of a gas consumption it is necessary to create a mathematical model, because it could not be a priori given.

Depending on the actual steps in the accumulation of gas consumption statistic data, the definite mathematical model will be correspondingly changed. Thus, for the hourly time interval data of gas consumption, we will consider hereby the additive and mathematical models: