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INFORMATION SUPPORT OF AUTOMATED CONTROL SUBSYSTEM OF THE AIRPORT'S WATER-SAVING PROCESSES

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Abstract. The state of surface water near airports is extremely critical in Ukraine. Air transport enterprises lead to intense pollution of water facilities by industrial and household wastewater. Therefore, the urgent problem is the improvement of the quality of operation of treatment facilities at airports by introducing automated control systems. The efficiency of both technological purification systems followed by the operator-technology and the automated control subsystem used to help it in operation, largely depends on the quality of information provision.

This article is devoted to the development of the components of the information support of the automated subsystem that controls the processes of water saving of the airport. The core of the information support is the database. The theoretical results of the presented research are specified in the development of the components of information support, including the relational database operated under the control of the database management system PostgreSQL.

Keywords: water-saving processes, specialized airport enterprises, automated control subsystem (ACS), information support of the automated control subsystem, database subschema, standard design solutions, database management system (DBMS).

Introduction

The use of water after its purification for technological purposes used by specialized airport enterprises, is benefitial both for environmental protection and for economic reasons. As a result of the treatment of wastewater from a specific type of pollution, for this type of wastewater in case of their re-use, it is much cheaper (sometimes up to two orders of magnitude) for their complete purification. Almost always the treatment of wastewater is a complex of methods including the functioning of the technological treatment system in the use of automated control system, occupies a dominant place. As for the subsystem of automated control of the processes of water saving of the airport, due to the growing volume of data and the complexity of their organization, the effectiveness of its operation largely depends on the reliability of information provision. Information support of the subsystem of automated control of water-saving processes establishes: the composition of information, the definition of routes of information traffic, means of information transformation, data structure and conceptual model of the database.

We can highlight the following, among the information functions of automated control subsystem of the water-saving processes:

- continuous checking of compliance of the current parameter value with the regular and immediate operator response in the event of inconsistencies;
- fixing the time when the parameter went beyond the permissible limit and when it entered the permissible changes zone [Tmin – Tmax];
- change and registration by the operator's call of those parameters of interesting to him processes in the process of measuring the state of the object;
- informing the operator about the production situation at the control facility at the time of the problem (in case of volley wastewater discharge);
- calculation by calling the operator of some indicators of not directly measurable processes and characterize the quality of the purification process;
- periodic registration of measured parameters and

calculated indicators before emergencies.

Structure of information support

Structurally, the information support of the automated control subsystem of the processes of water-saving of the airport consists of the information support of functional subsystems (ISF) and information provision of modernization (designing) of the technological purification system (IPMD). The basis of the ISF is a database and it’s control system allowing to develop an interface with applications. Applied software provides the functioning of water-saving processes in optimal mode on the basis of economic, mathematical methods and models. ISP consists of a system-wide (SW) and functionally-autonomous information support. It reflects the specifics of each automation control subsystem (Timchenko 2004).

System-wide support includes:

- classifications of tasks containing reference data for the solution of functional problems;
- electronic arrays of these classifiers;
- electronic documents common to all subsystems;
- means of unambiguous description of data used in all subsystems.
- Functional-autonomous information support (FAIS) includes:
- classifiers of information and their corresponding electronic arrays necessary for solving problems in separate subsystems;
- means of unambiguous description of data used in separate subsystems.

Information support for the modernization and design of a technological purification system are a collection of means for identifying the object documentation, stages and stages of works on the modernization (designing) of the technological purification system includes:

- means of unification of the names of tasks of modernization and designing;
- a system of coding of design decisions;
- a system of designations and coding stages for the modernization (designing) of the technological system of purification;
- a system of coding of design documentation.

In the future, we will consider functional and autonomous information support of the automated control subsystem of the airport's water-saving processes. Routes of information movement of this subsystem are shown in figure 1.

I – software of the calendar planning and management subsystem of production air transport processes;

II – software of the automated control subsystem of the airport’s water-saving processes;

III – software of the automated control subsystem of technological processes of wastewater treatment.

1 – a control computer;

2 – analog-to-digital converter, ADC;

3 – digital-to-analog converter, DAC;

4 – a switch;

5 – an indicator device;

6 – a recording device;

7 – a display;

8 – digital indicators the parameters of processes of sewage treatment;

9 – a control device used to control the processes of cleaning on the initiative of the operator;

10 – a scheme with the information about the deviation of parameters from the norm;

11 – a remote sensor for changing regulator settings;

12 – a sound communication device;

13 – remote control of wastewater treatment processes;

AM – actuating mechanism;

IS – interrupt sensor.

y_n – parameters of the technological process of cleaning; u_n – control influences; x_n – perturbing input parameters; S_n – sensors of parameters of processes of the wastewater treatment.

The composition of information support of this subsystem includes:

- regulatory and reference data (information about the maximum allowable concentration of pollutants, limit water consumption j-th production process, economic assessment of water in the region, the unit price of water flow j-th production process, specifications expenses providing scientific and financial plan and others);
- current information for the algorithms of automatic control (flow of waste water, physical and chemical parameters ingredient pollution characteristics reagents, water consumption for the normal functioning of j-production process, the multiplicity of dilution water k-th pollutant, given the level of reuse water j-th production process, etc.);
- accounting and archival information for the modernization (design) of the technological scheme of wastewater treatment (standard design solutions for typical cleaning processes, characteristics of the equipment and others).

Conceptual model of the database

For the repressiveness of information, the correctness of the concept on the basis where the components of the information support are formed and the reasonableness of the selection of important features and connections are important (Hudvyn 2006). The development of the information support of the automated control subsystem of water-saving processes was carried out on the basis of the methodology of programming the life cycle of the technological purification system. The development of the database of this subsystem is based on the methodology of computer database organization (Martin 1977), whose founder is Martin J. and his followers, Diet K. (Deit 2000), Rolland F. (Rolland 2002) etc., and will positively affect the practical implementation of information provision (Guan 2011). Functional use of information support is carried out within the local network, consequently, making it accessible to all process participants. Due to the relevance of the information the administration of the database is responsible, and the functional responsibilities of its employees should be stated in the organizational

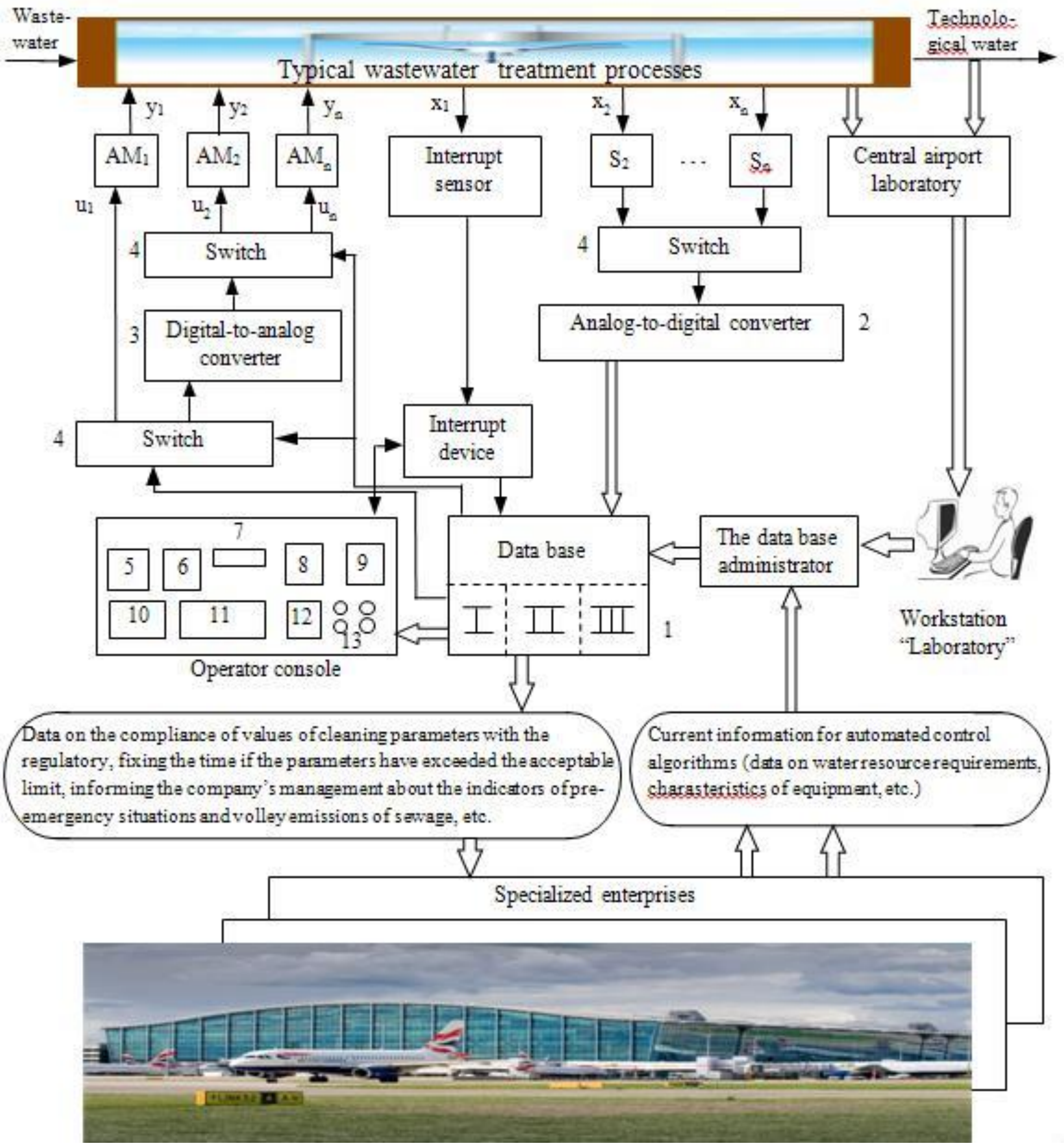

Fig.1. Structure of information flows of automated control subsystem of the airport's water-saving processes

support of the IASC.

Before entering data in a database, their authenticity is checked by special algorithms. As noted, the core of the information support is the database and database management system. If the purpose of the database was only to store data, its structure would be simple. The reason for its complexity is determined by connections between different data elements. Thus, the data structure should be described in a formal way. Description of the logical data structure is used by software database management system (DBMS) when processing user requests (or applications) for information. That is why the first task in the databases development is to develop a conceptual model data (overall logical structure of the database – schema or subschema DB). In the future, it is necessary to select a database management system to maintain database.

In developing logical description database of ACS by water-saving processes required data set for control was identified. Data presented at the logical level user reflect its view of the database at solving specific problems. The introduction of such data representation level significantly reduces the processing of requests, increases the database safety and expands the scope of their use.

The database schema for an automated control system for harmful emissions control systems includes two tree-like structures. The root of each tree is a record including the code and the name of the purification (sewage treatment or purification of gas emissions) - the upper level of the hierarchy. The subsequent level of the hierarchy, subordinated to the first, is represented by records reflecting the typical methods of purification and their codes. The lower level of the hierarchy makes entries for control tasks of the typical cleaning processes.

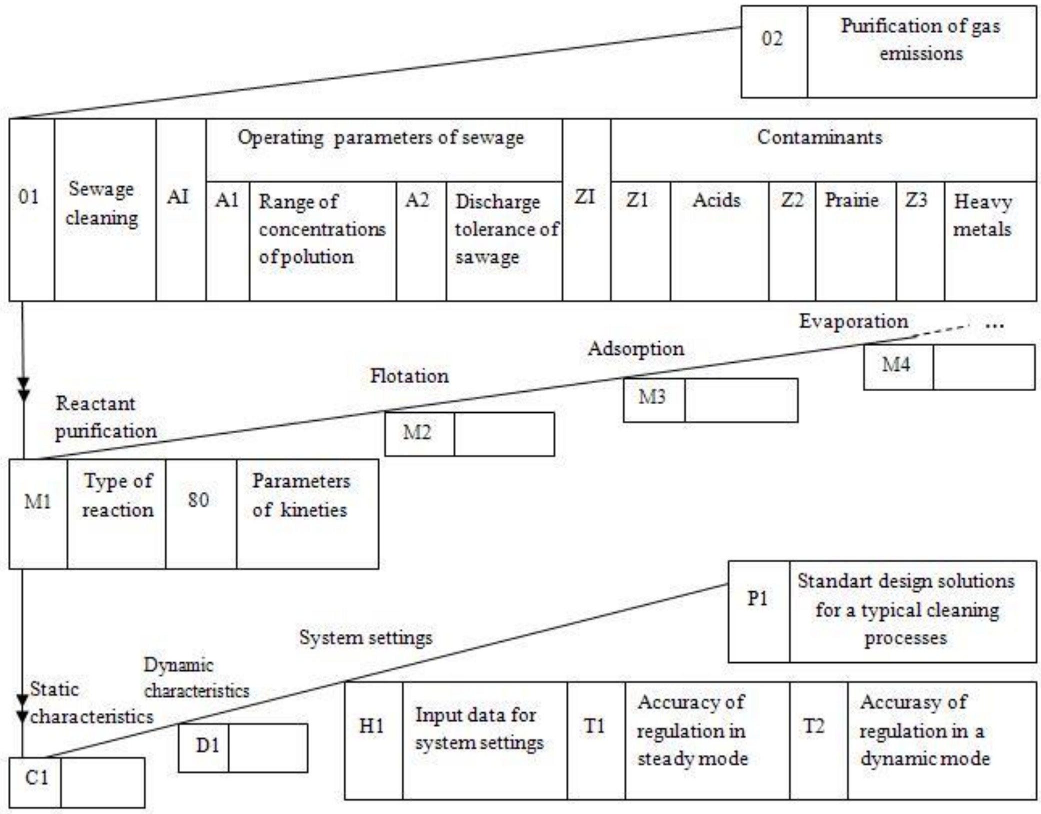

Fig. 2. Database subschema for automated control subsystem of the airport’s water-saving processes

The links between the data shown in figure 2 are presented in the form of two-dimensional tables (advantages of the relational data structure are well-known). This is done step-by-step for each communication between the data, using normalization. The tables are constructed in such a way so that information about the links between the data elements is not lost.

A prerequisite for establishing a connection between two relational relationships is the presence of at least one common attribute and is the key providing the connection (for further data retrieval).

Based on the developed subschemas of the database, the normalized database form can be written as follows:

- The initial relation: WASTEWATER COMPOSITION (type of purification code, code of regime parameters of sewage, code of pollutants);
- Induced relation : CLEANING METHODS AND REPAIR TYPES (type of purification code, purification code , code of reaction type, kinetics parameters, code of regime parameters, code of pollutants);
- Induced relation: POLLUTING SUBSTANCES AND THEIR PARAMETERS (code of the type of purification, code of regime parameters, code of the type of pollutant, physical and chemical parameters of the pollutant;
- Induced relation: REAGENTS AND THEIR PARAMETERS (code of the type of purification, the code of the method of purification, the type of the reagent code, the physical and chemical parameters of the reagent).

Each tuple has a key-identifier, for example (type of purge code, purge code, reagent type code).

The key of the relation may contain, in addition to the primary, secondary keys and as a result the tuples of this relation are uniquely identified.

Selection of database management system

The implementation of the logical data model will be primarily related to the choice of a specific DBMS for management tasks at IASC of the airport. This task is uneasy and many factors need to be considered when deciding. Here it is necessary to predict the prospects for the development of the chosen airport in terms of the expansion of functions and tasks, and to study the market of software (Zhuchenko 2017). Two approaches of assessing DBMS are distinguished. The first approach relates to the choice of DBMS from the user's point of view, and the second is purely technical and is related to the system performance. Taking these two points of view into account, the choice of DBMS can be done on the basis of the following indicators.

1. *General characteristics*. These characteristics include the type of database logical model, type of computers, operating system, quantitative restrictions DBMS; manufacturer, volume of RAM for the system, type of system (open, closed); the language of the system (own, CI, etc.); the number of versions, indicating the demand for the system and attempts by the manufacturer to improve the system.

2. *Software application support tools, in particular*:

- availability of query language based on SQL or other language;
- availability of embedded programming languages.

3. *Network support tools*. The ability of the DBMS to work on the network for water-saving processes control tasks was as follows:

- the ability to work in a local network;
- availability of automated means of tracking the coherence and integrity of the network data when collectively using data;
- tracking mechanism for transaction execution time. This mechanism is needed to prevent the system from blocking when using data collectively.

Currently there is no generally accepted analytical method for selecting DBMS. Therefore, experts in the field of data management to solve this problem use: methods of simulation; experimental research with the help of field tests; heuristic method where the evaluation of comparative characteristics are of the type "yes-no", "is - absent", "good - satisfactory - bad" (Zhuchenko 2016).

With the use of simulation techniques in the development of a simulation model of DBMS there are additional problems in assessing the accuracy of the model. Obtaining comparative characteristics of DBMS with the help of field experiments is associated with significant labor costs. Therefore, the choice of DBMS for subsystems of the water-saving processes and controlling aviation production processes was carried out on the basis of the above indicators.

The PostgreSQL database management system operates in the Unix, Windows operating system environment, and supports the relational data structure. The maximum size of the database for this DBMS is not limited, the maximum size of the table is 32 TB, the maximum size of the record is 1.6 TB, the maximum size of the field is 1 GB, the maximum number of entries in the table is not, the maximum number of fields in the record - 250-1600 (depending on the types of fields), the maximum number of indexes in the table is not a limit.

The following important feature of this DBMS is the ability to develop applications for automated control tasks in programming languages such as PL / Java, C ++, C-compatible modules, PL / pgSQL, etc.

In addition, PostgreSQL DBMS has high-performance transaction and replication mechanisms as well as a SQL-based query language allowing the client-server architecture to be used by the automated control system on the local network. In this way, the PostgreSQL DBMS meets the requirements for functioning of the subsystems of the water-saving processes and controlling aviation production processes.

Conclusions

In the presented article the structure of the information support of the automated control subsystem of the airport's water-saving processes is proposed, as well as the specific composition, traffic routes and data structure.

The authors developed a conceptual model of the database for subsystem as the main component of the information support. For each link between the data, normalization was made to allow for a relational data structure with significant advantages over hierarchical and network structures.

The architecture of a client-server database for an airport’s integrated automated control system for controlling aviation production processes will not only save data on the central computer, but also perform basic data processing operations. The specificity of this architecture is to use the language of SQL queries. The user will receive not files, but only the selected data.

The presented approaches allowed making a choice of DBMS for the functioning of the database. PostgreSQL database management system supports a relational data structure, it has a built-in programming language system allowing application programmers to develop application software for a control subsystems on a single information basis. The choice of DBMS to maintain the vital functions of the database based on the established indicators - another result of this work. Further development of the database will be associated with the accumulation of data on the statistical, dynamic characteristics and standard design solutions for typical cleaning processes. Information of the third lower level of the subschema of the database will be recorded as sections of the factual database. New prospective Automated Information System of automated control subsystem of the airport’s water-saving processes will be commissioned in the nearest future.

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