A&QT-R 2002 (THETA 13)
2002 IEEE-TTTC International Conference on Automation, Quality and Testing, Robotics
May 23-25, 2002, Cluj-Napoca, Romania

Problems of improvement of the measuring information and control of water environments

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Abstract

For study and analysis of a condition of the water environments are necessary to have the adequate information on its condition. The condition of water environment is characterized by the large number of physical, chemical and biological parameters. For the authentic control of a condition of water environment it is necessary to do huge number of gaugings of these parameters. Therefore the problem of control of pollution of water environment can be successfully solved only with the help of automatic, constantly working analyzers and systems containing these analyzers. Tasks and means of improvement of quality of the analytical measuring information, control and regulation of water environments are described below. The characteristics of modern monitoring systems are given and the requirements to components of these systems are formed. The real automated monitoring system of control of a level of water environments pollution is described which can be successfully used for the control of a level of pollution of environmental air too at inclusion in it of the appropriate means of measurement.

Key words: automate, monitoring, control, system, software.

Introduction

Controllable water environment is quick-changed dynamic object, the control of which condition by not automatic methods is complicated and economically is not justified. Agrees [1], if the number of the analyses makes more, than 3 - 4 times per day, are economically expedient use of the automated systems. At use of the automated monitoring systems of waters cost of the information 2 - 6 times are lower in comparison with laboratory methods [1, 2]. Use of the automated monitoring systems of water environments pollution (AMSWEP), besides opens wide opportunities to application of modern mathematical methods of the theory of systems, methods of management and planning, system and applied programming at the solution of tasks of a hydrology, hydrochemistry, hydrobiology, with the purpose of increase of reliability, efficiency of the accepted decisions and deeper study of processes occurring in controllable water environment.[1]

For last of 40 years the works on creation of the automated monitoring systems of water environments pollution (AMSWEP) all over the world were developed [3]. The purpose of these systems consists in decrease of water environment pollution on the basis of supervision, control, prognosis and management of drops.

The technical requirements to AMSWEP are determined by set of tasks put before them. Primary tasks realized by these systems, are [3]:

- automatic supervision and registration of concentration of pollutant substances;
- the analysis of the received information with the purpose of definition of an actual condition of natural environment;
- acceptance of emergency measures on struggle with pollution;
- the prognosis of the tendency of pollution;
- development of the perspective recommendations for improvement of a condition of water environment.

From enumerated of tasks realized by AMSWEP, it is obvious, that it should consist from following of functional blocks:

- automatic control and measuring stations (ACMS), giving an opportunity to collect the data in their wide range about meanings of water environment controllable parameters;
- equipment of the data transfer (EDT) for transferring of the information from ACMS in the center of the collection and processing of the information (CCPI);
- CCPI , where are carried out the automatic collection of the information, call of ACMS, synchronization of their work, transfer of commands and service of inquiries from ACMS, reception and accumulation of the information on storages, processing received from ACMS of the information with the purpose of an estimation of a condition of water environment, prognosis of its change and development of the recommendations for improvement, and also transfer of the necessary information in ACMS of higher hierarchy.

At designing of AMSWEP it is necessary to solve a number of organizational, scientific and technical and economic tasks [3]. Organizational tasks are meant definition of a place and status of the given system in existing organization of the control of a condition of water environment, as degrees and about expected changes in this organization.

The solution of scientific and technical tasks means a choice and substantiation of structure of system, complex of means (CM) proceeding from volume both complexity of functional tasks and requirements to efficiency of the accepted decisions, conditions of compatibility of the given system with others, is lower also by higher systems. The choice and substantiation of methods of the solution of functional tasks is necessary. The accepted organizational and scientific and technical decisions should be proved by economic accounts.

AMSWEP are a component of monitoring systems. The monitoring represents complex system of supervision, estimation and forecast of a condition of an environment with the purpose of its protection against of anthropogenous influence. By scope of controllable territory, frequency of the control, volume and functional assignments of soluble tasks, classes of used engineering distinguish the following kinds of monitoring: local (operative),

regional (regime) and global (super-temporary). The characteristics of these monitorings are given in the table 1 [4]. The creation state and interstate of monitoring systems behind a condition of an environment is in the long term supposed. The experience of creation of such systems already is present in a number of western countries.

The table 1.

№	Parameter	Sort of monitoring		
		Local (operative)	Regional (regime)	Global (supertemporary)
1	Area covered with separate system, км2	10 – 100	20 – 2 . 10^6	Up to 10^5 – 10^7
2	Distance between items of selection of tests, km	0.01 – 10	10 – 150	Up to 3.10^3 – 5.10^3
3	Periodicity of investigated processes	Days - months	Years	Decades, century
4	Frequency of supervision	Minutes - hours	Decade - month	2 - 6 times per one year
5	Number of observable components	3 -30	120 - 1500	10^3 – 10^6
6	Accuracy	Shares of Maxi-mum Allowable Discharge (MAD)	Up to 30 %	The tenth shares
7	Efficiency of distribution of the information	In real scale	Through 1 - 3 months from the date of selection of tests	Years from the date of selection of tests

The short description of AMSWEP, included in local monitoring system and developed in view of the above-stated principles and requirements is resulted below. About of metrological maintenance of these systems it is necessary to tell, that the mistakes of measurement results are caused by set of the various factors. They are methodical, tool and casual mistakes. The methodical mistakes are connected to set of the factors: with taking of the indication of the transducer before end of transient process, make like line of a scale of the device, inaccuracy of dosage and dilution, with wear process of details and units of the device etc. Tool mistakes are caused by inaccuracy in development both manufacturing of units and blocks of measuring devices. The casual mistakes are determined as fluctuations of external environment, and specificity of behaviour itself of measurement system as a whole, in particular, by inside canal casual noise, by heterogeneity of measurement environment etc.

Because of essential difference between the factors of distortion of results of measurement, the methods and means of wrestling with them can be various. In particular, for reduction of methodical mistakes of measurement, the methods of improvement of dynamic characteristics of means of measurement, structural methods of correction of errors of results of measurement, graduation and check of means of measurement, mathematical and imitating modeling of measuring devices, complexes and systems are widely used with the purpose of automation of their designing and of the metrological analysis.

For reduction of tool mistakes it is necessary a wide use of methods of automatic designing of means of measurement in view of simplification of their manufacturing, improvement of professional skill of the manufacturers of measurement means, use of high-quality materials and modern means of manufacture, increase of the working control above process of manufacture and ready production, use of modern manipulators and robotics during manufacture with the purpose of its complete automation.

For struggle with mistakes caused by casual mistakes, the wide application is found of methods of mathematical statistics. In particular, methods of a filtration, planning of optimum experiment, regressive analysis, correlation and dispersion analysis, processing of temporary numbers etc. [Primak A.V. (1991)]. Correct use of these methods allows reduce influence of casual fluctuation on the results of measurement up to practically acceptable limits.

In view of these principles we develop the automated monitoring system of a level of pollution of water environments, which is intended for the operative, authentic and objective control, study, analysis and management of a condition of controllable object, perspectives of its development.

The automated water quality control system operates within data processing center. It is realized on the basis of IBM compatible computer with the use of commuted dropped off communication lines and gets measurement information on the concentration of parameters monitored from the automated water quality analyzers via the data transmission unit of MODEM type. Information software as well as mathematical software is realized as a system of application programs. The automated water quality control system functions within the MS DOS operating system and can include very much (practically any number) of analyzers, each of them measuring up to 20 various ingredients.

Main features of the system are: operative processing of measurement information, validity of the results obtained, rapid adaptation to changes of controlled objects parameters without human intervention, simplicity of maintenance, flexibility when using the system for monitoring and analysis, visual presentation of the results obtained.

Information software realizes the following tasks: automatic interrogation of water quality analyzers included into the system; reception, deciphering and recording of the measurement information coming from the automated analyzers onto the carriers, control of analyzer's operating modes (start of the analyzer, inquiry for an additional measurement, change in step of analyzer's operation, arbitrary sampling, inquiry for information recovery after the troubleshooting in case there has been a break in analyzer's connection to the data processing center); display of the current and retrospective measurements on the video terminal screen, support of communication between the operator at data processing center and data base (generation, updating and liquidation of system's directory and files), control

of timely reception of measurement results from the analyzers,
information output in accepted forms according to the user's order (24-hourly printout per analyzer; printing of master reports per analyzer for a day, a decade, a month; printing of reports on the violation of hydrological regimes), data archiving, processing of information coming from sanitary or mobile hydro chemical laboratories as well as stationary hydro chemical laboratories within surface water control system and printing of reports for 24-hours, a decade, a month, a quarter and a year; display of information on the video terminal by dispatcher's order.

A special attention is paid to displaying of information which includes graphical displaying of change in parameters controlled with time, visual interpretation of the states of water body controlled and of water quality control system, statistic processing of measurement results per each parameter and presentation of results of this processing in easy-to-use form, etc.

Mathematical software of the system realizes the following tasks:

- preliminary statistic processing of the measurement results (calculation of the minimum, maximum and mean values of the ingredients measured in a given period of time);
- calculation of trends for the temporal series; calculation of auto- and inter-correlation functions for the temporal series; classification of the state of the tests media in a discrete moment of time and evaluation of adequacy of the control (printing of alarm warnings; alarms in case of natural environment contamination);
- calculation of the predicted values of the ingredients controlled with a given lead value;
- classification according to the predicted values and calculation of adequacy of the decisions mode;
- detection of trends of change in the state of media controlled;
- selection of optimum step for the discrete control of water quality;
- analysis of the ingredients measured for "anomaly" (i.e. abrupt change in the concentration of given ingredient);
- search for a contaminers;
- calculation of the maximum permissible discharge.

Communication with the information software and use of the information accumulated in the system for drawing up reports, carrying out hydrological, hydro biological, hydro chemical and other studies by methods of applied mathematics as well as visual presentation of the results obtained is carried out on the basis of the given menu on the computer display: system adjustment, operation with a database, reports, research, forecasting, mobile hydro chemical laboratories. In each menu respective submenus are realized. In particular, *system adjustment* - start, commands, initialization; *operation with the database* - generation of a file directory, file generation, file preparation, file nullification, communication with the information base, file annulment, maintenance of standardized information; *reports* - information display, operational paper, 24-hour report, master report over a decade, master report over a month, master report over a quarter of the year, master report over six months, annual master report; *research* - plots of the parameters measured, statistical study of the parameters measured, regression analysis of

the parameters measured, correlation analysis of the parameters measured, forecasting of the values for the parameter measured; forecasting - routine, short-term I, short-term II, comparison. The following possibilities are realized in the submenu "commands": change in the measurement step, extra measurement, arbitrary sampling, regeneration of the information; "Generation of the file directory" offers the following: formation, abridgment, broadening and annulment of the directory. "Regression analysis" enables the regeneration of auto- and inter-regression between the parameters measured. Results of the each task are presented in the form of a text, table or plot, which can be output to the computer monitor, printer or plotter, if any.

The system may include water quality analyzers together with air monitoring analyzers. It may be adapted to user's specific conditions.

The conclusion

In work are described the basic principles and methods of creation of the automated monitoring systems of a level of pollution of water environments, methods of improvement of quality of the analytical measuring information, control and regulation of water environments. The characteristic of modern monitoring systems and their place in general process of the control and regulation of a level of pollution of natural water objects are given. The short description of the local (operative) automated monitoring system of a level of pollution of water objects developed under the direction of the author of the given work is given. The list of all basic tasks sold in the given system is given.

During the report on the computer will be shown the work of the given system on the measuring information generated by imitating models of pollution of water objects.

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