AUTOMATIZED MOBILE STATION FOR DIAGNOSTICS OF INDUSTRIAL ATMOSPHERIC POLLUTION "ECOLID"

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A brief description and results of preliminary tests of a mobile station "ECOLID" are presented. This station allows us to measure mass concentration of gas and aerosol pollutions in atmospheric air of populated and industrial areas, to map the air basin state over a big city.

Mobile station is a part of a system for monitoring and vision of atmospheric pollutions over an industrial center. Route and underplume observations are carried out by means of such a station.[1] Moreover, this station is employed to choose new locations for stationary posts when creating an automated system of ecological monitoring of an industrial center. A series production of mobile stations is now organized only abroad. (Firms INTERTECH Corporation and Thermo Environmental Instruments, Inc., USA, Strohlein GmbH, Germany, Horiba, Japan, and others). In Russia only simplest laboratories of the "Atmosfera–II" type[2] based on the automobile UAS–452 are produced. Prototypes of more complex stations are in production at SPA "Himavtomatika" (mobile laboratory (ML) on a wheelbase of ZIL–131 automobile and the mobile ecological laboratory on a wheelbase of UAZ–452 automobile). Mobile stations have also been created at some inofficial structures of Moscow and St. Petersburg.

This paper presents a description and specifications of an automated mobile station for atmospheric monitoring, "ECOLID". This station was developed and constructed at Special Design Bureau "Optika", Siberian Branch of the Russian Academy of Sciences by an order from East–Kazakhstan management of ecology and bioresources (Ust'–Kamenogorsk).

The station "ECOLID" is designed for operative detection and measuring of concentrations of industrial gaseous and aerosol admixtures in the atmospheric air of populated area and industrial zones, mapping of the air basin state on the scale of a big city. A possibility of forming short–term prediction of evolution and transfer of dangerous gaseous and aerosol effluents is provided. Since the station is designed to carry out measurements of gaseous pollutions in an inhabitant zone as well as in an industrial zone, the requirements to dynamic range of measured concentrations of gaseous and aerosol pollutants are stringent enough.

The list of measuring instruments of the station, and the range of measured parameters are presented in Table I. Besides these devices the station comprises a computation complex of IBM PC/AT 286, a system of sampling and sample preparation, an air condition installation for an automobile van, and voltage stabilizer. Block–diagram of the station is shown in Fig. 1.

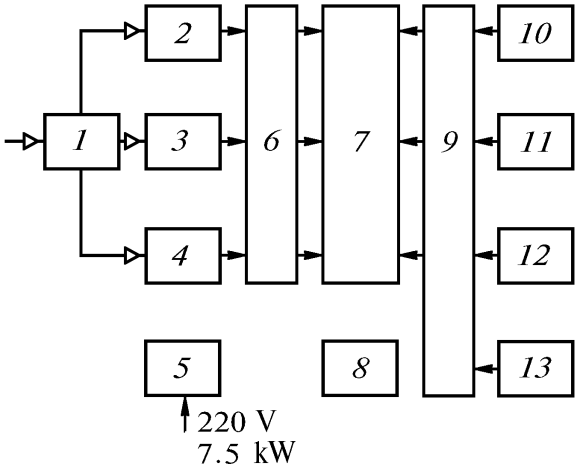

FIG. 1. Block–diagram of the mobile station. 1 – a system of sampling and sample preparing, 2 – gas analyser 667FF–03; 3 – gas analyser 645CL–04; 4 – gas analyser 623KPI–03; 5 – the system CL of stabilized power supply; 6 and 9 – interface blocks; 7 – control and computational complex; 8 – air condition installation; 10 – gas analyser MGA–11; 11 – laser densitometer LD–10; 12 – thermoanemorhumbometer TARM; 13 – acoustic sounder AS–10.

All equipment and devices of the station "ECOLID" are mounted in a van KM–131 on a wheelbase of ZIL–131 automobile.

The devices are assembled on individual buffers fixed at the racks and tables of welded construction. Acoustic sounder is placed stationary outside the van. Thermoanemorhumbometer (TARM) is placed at a small mast above the roof of the van (Fig. 2).

The devices MGA–11 and LD–10 which are moved out of the van through small windows in the hatches during measurements are shown in the figure too.

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TABLE I.

Type of device	Measured parameter or species	Unit of measauruements	The range of measurement	Error of measurement	MPC in an inhabitant zone air (daily average)[1]
Fluorescent gas analyzer 667FF–03	Sulfur dioxide SO_2	mg/m^3	0–0.2 0.2–1.0 1.0–5.0	±0.012 mg/m^3 ±(0.05+0.15 x) mg/m^3	0.05
Chemiluminiscence gas analyzer 645CL–04	Nitrogen oxide NO Nitrogen dioxide NO_2		0.0026–10 0.0026–10	±0.013 mg/m^3 ±0.013 mg/m^3	0.06 0.04
Nuclear–absorption gas analyser MGA–11	Mercury vapour Hg		0.032–4	±0.020 mg/m^3	0.30
Flaming–ionization gas analyzer 623 KPI–03	Methane CH_4 Sum of hydrocarbons C_xH_y Sum of hydrocarbons without methane		0–50 0–50 0–50	±5% ±5% ±5%	
Laser densitometer LD–10	Dust		3–18	25%	0.05
Ultrasonic thermoanemo-rhumbometer TARM	Wind velocity Wind direction Air temperature	m/sec deg ° C	0.4–40 0–360 –40 … +40	0.1 m/sec 10′ 0.5° C	
Acoustic sounder AS–10	Height of inversion layer	m	30–500		

Note: Units of measurements presented in third column apply to the range and maximum permissible concentration (MPC) values.

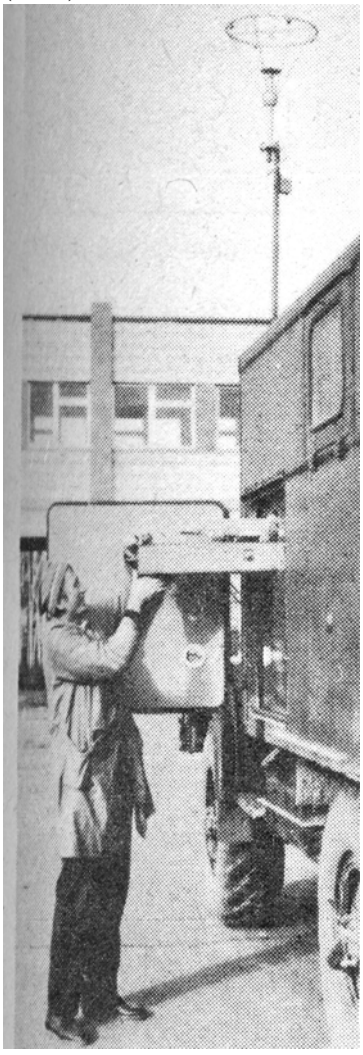

FIG. 2. External view of the station.

Measurements of the mercury vapor and dust concentration are carried out using multipass optical cells. There is an opening in the van's wall below these devices for sampling the atmospheric air pumped through a system of sample preparing to the other gas analyzers of the stations. The atmospheric air sampling is done at height about 1.5 m from the earth's surface.

In the regime of making measurements and collecting information from the instrumentation the whole station is automatically operated under programmed control of an IBM PC compatible processing block. The program contains the data on measuring instruments, with the help of which one can obtain an information during the operation, an algorithm of preliminary processing of signals, etc. After polling all devices or only those which are specified by the operation program the data file is transferred to a computer where data are graded, put in the data base, and used for construction of a gas map and prediction of the transfer of gaseous and dust emission. Time interval between the pollings and time of data averaging are defined by the magnitudes set by operators from a keyboard.

The map with the values of concentrations of pollutants and meteorological parameters is displayed on the screen of a color monitor or printed in a shade gray by a printer. Moreover, the tables containing the control points, time of measurements, measured values of concentrations of pollutants and meteorological parameters, and title of the point can be printed out also. Histogram of relative values of measured concentrations with the passport data of point of measurements may be displayed additionally.

The station is maintained by two operators. Power consumption from the ac line of 220 V voltage at 50 Hz frequency does not exceed 7.5 kW, including the power consumed by a climate installation. The station operates at the temperature of ambient air from –10 to +35°C. It takes not more than 80 minutes to prepare the station for operation. This time is needed for putting the whole set of measurers into a readiness state. Gas analyzers being in the station and laser densitometer have been tested in SPA "Mendeleev Scientific–Research Institute" and have the corresponding certificates. Ultrasonic thermoanemorhumbometer have been also certified. Preliminary tests of the station on measuring pollutions have been carried out in the different parts of Tomsk.

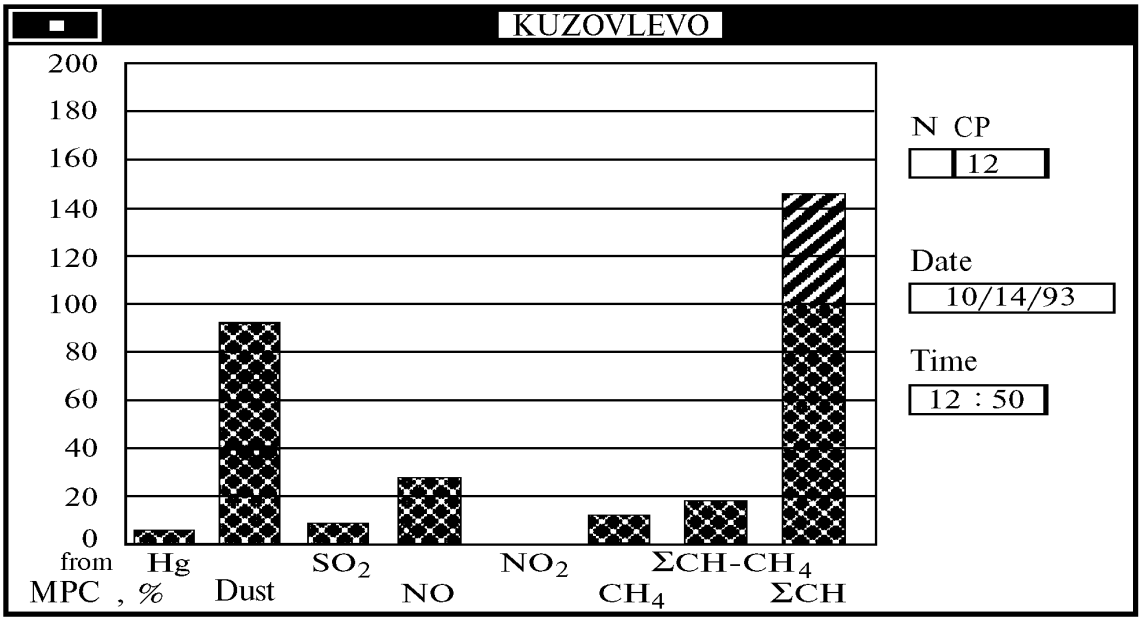

FIG. 3. Histograms of the measured relative concentration magnitudes of pollutants.

All measuring instruments of the station were produced at Special Design Bureau "Optika", Siberian Branch of the Russian Academy of Sciences. Gas analyzers 667FF–03, 645CL–04, 623KPI–03 are produced in cooperation with Kiev Scientific–Research Institute "Analitpribor". These instruments are close analogs of the devices earlier developed in Kiev and use the same principle of operation.[2] However, in contrast to these devices they have better performance characteristics, especially those concerning the automation of the measurement procedure and data processing. A description of the operation principles and construction of a gas analyzer MGA–11, ultrasonic thermoanemorhumbometer TARM, and laser densitometer will be presented in the next issues of this journal. Note finally, that the arrangement and construction of this station make it possible to increase the number of pollutants under control by using additional gas analyzers.

REFERENCES

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