DESIGN AND DEVELOPMENT OF AN AIRCRAFT-BASED MODULAR SYSTEM FOR COLLECTING METEOROLOGICAL DATA

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One of the causes of the weather forecast low accuracy problem on the territory of the Republic of Belarus is analyzed. A solution to this problem is suggested. The approach to the problem of obtaining meteorological data in hard-to-reach regions and places with chemical or radioactive contamination is proposed as well.

Keywords: weather forecasting problem, mini-weather stations, aircraft, meteorological data collection.

The main problem of weather forecasting on the territory of both Belarus and Russia is often the low accuracy of forecasts, especially long-term ones. The main cause of inaccuracies in weather forecasting is the small number of weather stations. However, the installation of a larger number of weather stations is fraught with serious financial costs both for their construction and equipment, and for further maintenance. In addition, such weather stations are static objects.

One of the solutions to this problem is mobile weather stations, which can be installed anywhere. As a carrier for these mini-stations, aircrafts such as airships or aerostats can be considered. Such unmanned objects do not require large financial costs for their assembly and maintenance.

The purpose of the work is the development of a prototype of a mobile weather station on an accessible elemental base and its further placement on an aircraft.

Figure 1 provides the information on the density of weather stations on the European territory.

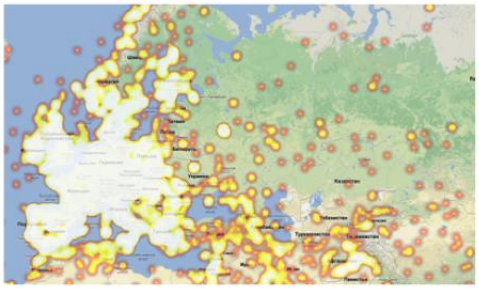

Fig. 1. – Location of weather stations in Europe

As it can be seen, the density of weather stations varies from country to country. On the territory of Belarus there is a dense cluster of weather stations in the capital and in its vicinity, but further down the country the number of weather stations becomes less. In neighbouring Russia, separately located weather stations placed far from each other can be seen. Taking into account local conditions there is not enough information for an accurate forecast.

The creation and installation of a mini-weather station, which can be placed on an unmanned aircraft, which is easy to assemble and maintain, into the general network of weather stations, will allow to collect a larger amount of weather data. Their operational processing will increase the accuracy of weather forecasting.

To implement such a weather station, it is proposed to create a simple and flexible system based on one of the analogues of the Arduino microcontroller, namely IskraNeo microprocessor. The purpose of this system is to collect data on air temperature, humidity, pressure, wind speed, illuminance. Providing it is installed on an unmanned aircraft, the information about such parameters as altitude, geographical latitude and longitude, speed of movement, and weather data collecting time will be required.

The system hardware for collecting and transmitting weather data will contain the following components:

– the DS18B20 waterproof temperature sensor;
– the DHT22 temperature-humidity sensor;
– the BMP180 barometric pressure and altitude sensor;
– GPS-module for collecting data on the location of the weather station, altitude, local time and speed;
– GPRS-module for sending messages to a contact phone.

This system should be autonomous, thus accumulators that can be charged from solar panels integrated into the system are required. All elements of the system are available and relatively easy to program. For pro-

gramming of the system node interaction, C / C ++, Java, and Android frameworks will be used. The database management system is MySQL.

The second part of the proposed system is the design of an aircraft capable of carrying a mini-weather station. It is proposed to use an airship as an aircraft. Attaching a mini-weather station to an aircraft will allow receiving data from the most hard-to-reach regions, including areas exposed to chemical or radioactive contamination.

At this stage, the system requirements are being determined and a working draft of an aircraft for the installation of a mini-weather station is being developed.

QUANTUM-CHEMICAL CALCULATION AND SYNTHESIS OF NEW ANTHRAQUINONE COMPOUNDS FOR BIOLOGICAL APPLICATIONS

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A number of anthraquinone compounds have been calculated and predicted by non-empirical chemical-quantum calculations. Their equilibrium geometric parameters, electronic, IR and NMR spectra have been predicted and discussed. Antioxidant properties of them have been calculated.

Keywords: non-empirical method, antioxidant activity, anthraquinone, UV/Vis, optimization.

Anthraquinones are a group of functionally diverse aromatic compounds structurally related to anthracene, also known as 9,10-anthraquinone, 9,10-anthracenedione, anthradione and anthracene-9,10-quinone [1]. They are moderately strong and chemically stable, have provoked broad investigation of anthraquinones based structures as dyes and colorants [1].

Computational methods

A Pentium IV personal computer (CPU at 4.80 GHz) with the Windows 10 operating system was used. The initial geometry optimization of title compounds was performed with HyperChem (Version 8.0 Hypercube, Inc., Alberta, Canada). For all the ab initio calculations, Gaussian 16 was employed. The molecular properties of the compounds were calculated by PM6 method. Lowest energy structures of the species were computed by conformational analysis. Geometry optimization was performed at the PM6 density functional theory with the same basis set. For the geometry optimization of parent molecules restricted approach was applied, while for the free radicals the unrestricted was used. For computational calculations of radicals H atom was removed from OH groups of optimized most stable structure of the neutral molecules. Harmonic vibrational frequencies were computed at the same level of theory for both neutral molecules and radicals to estimate zero-point energies and vibrational contributions to enthalpy. The O-H bond dissociation enthalpy was calculated at 298.15 K using following formula:

$$BDE = Hr + Hh\text{-}Hn \quad (1)$$

where, Hr is the enthalpy of the radical generated through H-abstraction, Hh is the enthalpy of hydrogen atom [-0.4962 Hartree] and Hn is the enthalpy of neutral molecule. The following formulas were applied to calculate electronic properties of the title molecules and their radicals [1]:

$$IP = -E_{HOMO}\ (eV) \quad (2)$$

$$EA = -E_{LUMO}\ (eV) \quad (3)$$

$$\eta = (IP - EA)/2\ (eV) \quad (4)$$

$$S = 1/2\eta\ (eV) \quad (5)$$

$$\mu = (IP + EA)/2\ (eV) \quad (6)$$

$$\omega = \mu 2/2\eta\ (eV) \quad (7)$$