The Application and Antifouling of KATERINA in Ocean Buoy

Guohua Zhang[a], Yingying Zhang[b], Shixuan Liu[c]

Shandong Provincial Key Laboratory of Ocean Environment Monitoring Technology, Shandong Academy of Sciences Institute of Oceanographic Instrumentation, Qingdao 266001, China

[a]zghscu@126.com, [b]triciayyz@163.com, [c]321_go@sohu.com

Keywords: Marine Radionuclide, Ultrasonic Cleaner, Fouling Organisms, Ocean Buoy

Abstract. Equipped with KATERINA, the buoy provided effective technical platform for on-site rapid monitoring of the marine radionuclide. Performance index and usage in the ocean buoy of KATERINA was introduced. Ultrasonic cleaning method in seawater was developed for preventing KATERINA from biofouling. Marine radionuclide data can serve for oceanographic research and marine resource exploitation.

Introduction

In situ continuous measurement for gamma spectrum of marine radionuclide is an important part of the marine environment monitoring [1-2]. Equipped with KATERINA produced by the Hellenic Centre for Marine Research, ocean buoy works automatically to observe the radionuclide data, and transmits these data to shore data center by Beidou system. Ultrasonic cleaner prevents the KATERINA from biofouling. The buoy for on-site rapid monitoring of radionuclide provides effective technical platform.

Radioactive monitoring System

As shown in figure 1, the radioactive monitoring system can be divided into sensor system, main control system, Beidou system, data center system and power system.

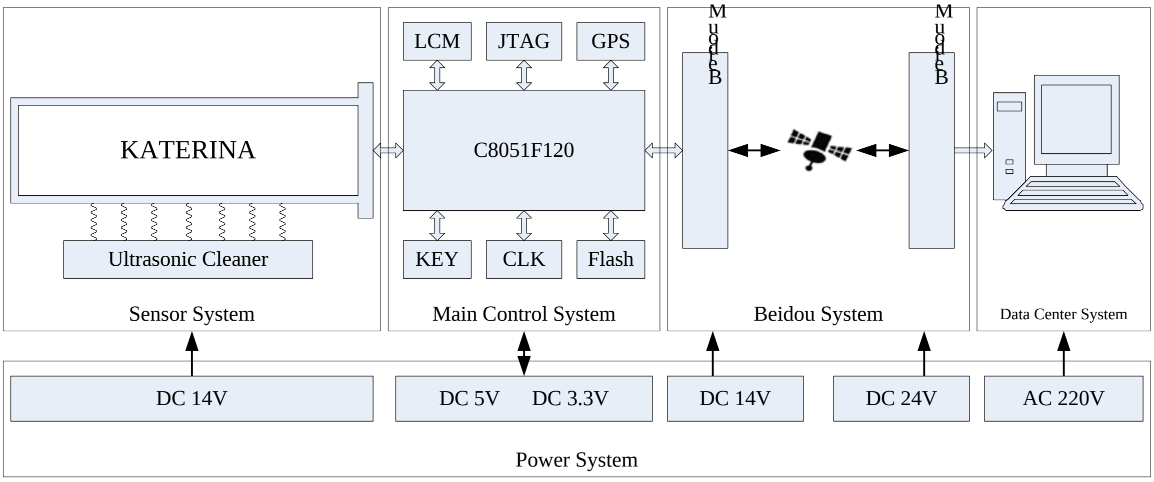


Fig.1 Block diagram of the radioactive monitoring system

Technical Indicators of KATERINA

The KATERINA system is an innovative underwater in-situ gamma-ray spectrometer, and can be developed by the Hellenic Centre for Marine Research. This apparatus is designed for quantitative radionuclide detection in the marine environment with maximum depth of deployment 4200m. The system provides activity concentration in absolute units i.e. Bq/m^3 or Bq/L using a updated method of quantification and taking into account the marine efficiency of the system [3].

As shown in figure 2, the KATERINA sensor consists of a 3”×3” NaI detection crystal, connected with photomultiplier tube, preamplifier and power supply, including also the electronics for signal amplification, data acquisition and storage. The electronic modules are especially constructed to fit inside the detector enclosure and the power consumption is relatively low. A watertight cylindrical enclosure has been designed, which houses the above-mentioned NaI crystal together with the appropriate electronics. The lifetime for the enclosure in the deep sea is at least 6 years. For easy mounting of the crystal, the unit (detector + photomultiplier + preamplifier) is mounted on a support sled. The sled is furthermore, permanently fixed with bolts, on the enclosure’s cup [3].

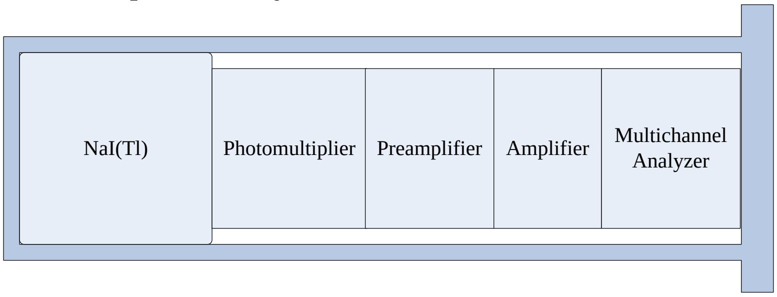


Fig.2 Block diagram of the KATERINA sensor

All the technical specifications of the KATERINA detection system are given synoptically in Table 1.

Table 1 Sensor Specifications of KATERINA

Sensor type	3″×3″ NaI(Tl)
Energy Range	Variable up to 4000 keV
Detection limit for ^{137}Cs	0.02Bq/L (24 hour integration)
Resolution	6.5%(^{137}Cs)
Spectroscopy	256, 512, 1024, 2048 channels
Operating temperature	-10℃ to +50℃
Maximum depth	400m
PC connection	RS232
Power Consumption	2.0-2.4W

Application in Ocean Buoy

Communication format of RS232 on KATERINA is shown in table 2 [4].

Table 2 RS232 Communication setup

Baud rate:	4800bps
Length of character:	8 bits
Stop bit:	1 bit
Parity:	None

To get status, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,0);

To get data, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,1);

To set group, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,5);

To set resolution, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,6);

To get/set preset, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,7);

To delete data/time, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,8);

To start/stop acquire, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,9);

To enable the system, the main control sends commands to KATERINA by the following C statements.

ComPutChar(COM,p);

Figure 2 is the flow diagram of KATERINA.

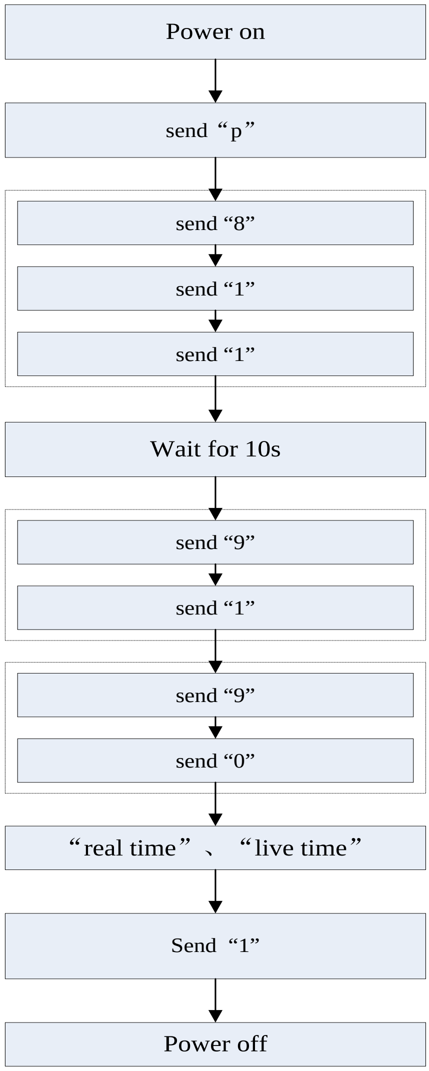


Fig.3 The flow diagram of KATERINA

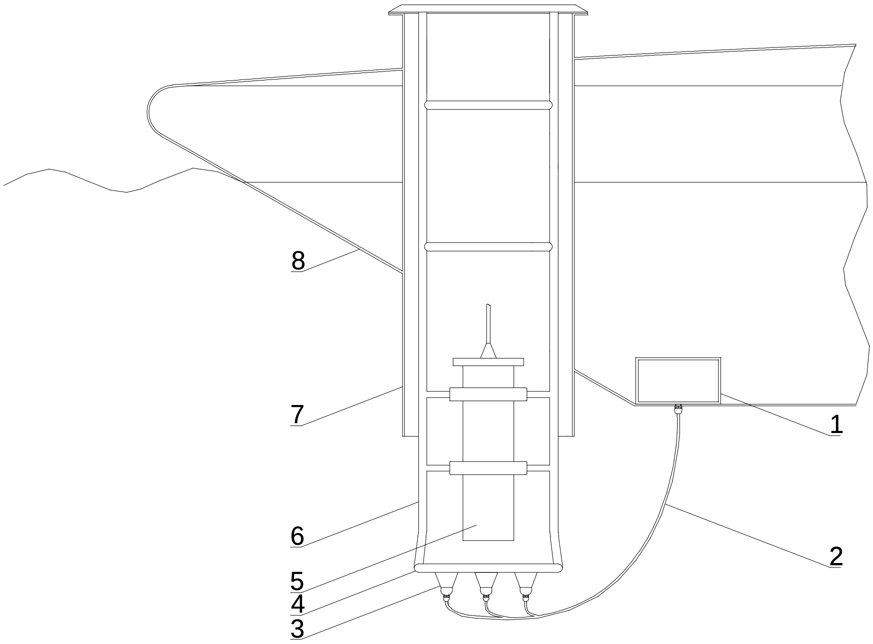
Ultrasonic cleaner for KATERINA

Biofouling, the generic name given to the undesired biological adhesion to surfaces, has been a staple mark for KATERINA since its very beginning. As shown in figure 3, the biofouling of KATERINA has resulted in the unstable or even none operation of system. A variety of approaches for inhibiting biofilm formation have been proposed. The use of toxic compounds within protective coatings has been a common practice in the past, but their adverse environmental impact is now limiting the appeal of such strategy [5].

Along with high intensity ultrasonic development, ultrasonic cleaning already has been widespread in more and more application production and life. The principle of ultrasonic cleaning is to come into being cavitation effect[6]. Figure 4 is installation instruction of KATERINA and its ultrasonic cleaner. The supersonic cleaner mainly includes three parts: supersonic generator, supersonic transducer and plate sound source. Plate sound source driven by transducer creates ultrasound waves over against the KATERINA. This cleaner can prevent the KATERINA from biofouling and is very significant for ocean monitoring field.

Summary

The real-time monitoring and measurement of the marine radionuclide is the main content for marine scientific expedition, protection of the marine environment, marine environmental assessment, the development of marine engineering, marine disaster prevention and mitigation and military oceanography are all regarded it as an important parameter. The performance parameters and the computational formulas of the KATERINA were introduced in detail. Ultrasonic cleaner was developed for preventing KATERINA from biofouling. Ocean current buoy for on-site rapid monitoring of current provide effective technical platform.



1, supersonic generator; 2, cable; 3, supersonic transducer; 4, plate sound source; 5, KATERINA; 6, support; 7, vertical shaft; 8, ocean current buoy

Fig.4 Installation instruction of KATERINA and its ultrasonic cleaner

Acknowledgement

This work was financially supported by the International Science & Technology Cooperation Program of China (2013DFR90220), the National Natural Science Foundation of China (41406106)，the Natural Science Foundation of Shandong Province (ZR2013DL007)，the Natural Science Foundation of Qingdao (14-2-4-66-jch) and the Shandong Academy of Sciences Foundation for Development of Science and Technology.

References

[1] Vlastou R, Ntziou I T, Kokkoris M, et al: Monte Carlo simulation of g-ray spectra from natural radionuclides recorded by a NaI detector in the marine environment. Applied Radiation and Isotopes (2006)

[2] Chernyaev A, Gaponov I, Kazennov A: Direct methods for radionuclides measurement in water environment. Journal of Environmental Radioactivity (2004)

[3] Operation Manual for KATERINA System. HYDROSCOPIO S.A.

[4] Communication Commands Manual for KATERINA System. HYDROSCOPIO S.A.

[5] Rodolfo E. Perez: Examination of the Effects of Localized Electric Signals on the Inhibition of Undesired Biological Adhesion. Madison: University of Wisconsin-madison (2008)

[6] Hui Wang: Research and Realization of an Ultrasonic Cleaner with Constant Power and Frequency Tracing. Baoding: Agricultural University of Hebei (2004)