Energy Sources for Autonomous Unmanned Underwater Vehicles

Vyacheslav Vladimirovich Slesarenko, Valeriy Viktorovich Knyazhev

Laboratory of non-conventional energetics, Institute of Marine Technology Problems FEB Russian Academy of Sciences
Vladivostok, Russia

ABSTRACT

The article is devoted to a problem of power supply of autonomous unmanned underwater vehicles for long terms of independent work. For this purpose, it is possible to use the autonomous unmanned underwater vehicles of hydrogen fuel elements, the nuclear energy sources, and renewable energy of ocean. Wave converters and additional solar charge accumulators of autonomous unmanned underwater vehicles (AUV) for the long work maintenance are considered in the application article prospects.

KEY WORDS: Autonomous underwater vehicles; glider; renewable energy; solar; wave converter.

INTRODUCTION

Autonomous underwater vehicles (AUV) are effective means for supervision and measurements performance in depths of ocean, seas and other water areas. The problems arise during the work of vehicles in ocean, when the course and time of independent work ranges are limited. It is caused by difficulties of energy sources supply, high power consumption and small dimensional characteristics of devices. Such sources as fuel elements and nuclear radio isotope energy are considered. In addition, there are environmental and renewable energy sources for AUV power supply.

MICRO, MINI AND SMALL AUV

For power supply micro, mini and small AUV first of all it is possible to use renewable energy sources. The new type of small AUV – underwater glider has been rather developed. On these vehicles there is no impellent installation for reduction consumption of energy, reliability and autonomy increases. Glider represents an independent sea bed vehicle which moves in a vertical direction by means of change of buoyancy and in horizontal - at the expense of wings and the stabilizers established on the cases of the device. Buoyancy changes by means of the vehicle external volume change. Energy for performance of the next motion cycle is delivered in the bottom point of a trajectory where work is connected with increase in vehicle volume. In glider it is the movements of internal masses (i.e., batteries) which control the pitch and yaw of the vehicle. The vehicle is intended for sliding from one point to the other, or to stabilize the set point by estimation of speed and direction of a current on the basis of consecutive definition of position and, then, self-adjustments for sliding in a demanded direction during descent or lifting. Correction of current position is carried out according to GPS when the device is on a surface. The energy most part is consumed on buoyancy change, energy is also necessary for the device management, controlling , measuring and system navigating. For this reason, for main parts of ocean warm surface water and cold deep water (Wood, 2009), it was offered to use the difference of temperatures on a surface and in depth for buoyancy regulation of glider. The depth of immersing is regulated basically by design features of the device. Thus, the difference of ocean temperatures should be not less than 10 °C. Heat take from warm superficial water and take away in cold deep water during device moving through a thermowedge (a layer at ocean with a considerable vertical negative gradient of temperature). It is transition caused by change of an internal working liquid condition. In warm layers of ocean it is warmed up and extends, and on depth cools down and compressed. The change of a liquid condition leads to a volume change. That provides an adequate change of the device buoyancy (with unchangeable weight) to make possible lifting and lowering with comprehensible speed. This variable buoyancy can be received from the environment energy underlies as a resource of energy for glider movements.

Solar energy also can be used for power supply of glider. Solar photo-electric batteries, established on the top part and on the wings of glider will provide charging of storage batteries while the device is found on a surface.

The glider moving speed is not high. The working process is one of the factors of speed limiting (with sea current above 0,2 km/s). However it is necessary to overcome a current to use the energy of ocean currents for device moving. Speeds and directions of currents at ocean are not uniformed for depth and time of days. The vehicle, like plankton, regulating buoyancy can choose horizon with a current of the necessary direction. And on an ocean surface also it is possible to use a wind power. The device, similar to the Portuguese man o’ war (lat. Physalia physalis), can move in the presence of a fair wind to the necessary area and after that to plunge under water for mission performance.

In Institute of Marine Technology Problems FEB RAS the problems of the AUV power supply system application with additional charge from the converters and using renewed energy sources are solved. The Institute of Marine Technology Problems FEB RAS together with Autonomous Undersea Systems Institute (AUSI), the USA has already designed and created solar AUV (SAUV) (Fig. 1) (Ageev, 1999; Ageev, 2001; Ageev, 2005). The panel of solar batteries is mounted in the top part of the vehicle. At night the device carries out an active part of the program-task, and during light time it emerges on a