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A portable, battery-powered unit for oximetry on small aquatic animals ☆

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Abstract

An indirect calorimetry unit is presented. The unit is specifically designed for field experiments, i.e. all components are small, light and can be powered by battery. The measurement method is the determination of total oxygen consumption in a closed chamber. Four different chambers are used for different sizes of aquatic animals. The complete unit price without a recorder is about US $1600. For data recording in the field, a simple, battery-powered portable computer can easily be connected through an A/D-RS232 converter unit (about US $250–$600) to the oximeter.

Keywords: Aquatic animal; Fish; Indirect calorimetry; Oximetry; Portable equipment

1. Introduction

Indirect calorimetry is still a practical and reliable method for the determination of fish metabolism in general. However, most of the measurement units available on the market are rather expensive and not portable. An inexpensive, portable unit would be desirable, especially for application in field studies. To suit these needs we

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designed a unit based on the requirements for field research especially in developing countries and for aquacultures. The restrictions of indirect calorimetry, especially when applied on amphibia, reptilia or fish, are well known. Many species can adapt their metabolism to a wide range of varying oxygen tensions by shifting their metabolism partially or totally to anaerobic processes [1–3]. In those cases, indirect calorimetry by oximetry is unusable for the determination of the total metabolic heat.

2. Experimental

2.1. Equipment

The portable oximeter unit presented is a closed chamber system. It consists of five main parts. (1) A microprocessor-controlled portable oximeter (Oxi 96, WTW, Weilheim, Germany). The oximeter has an automatic correction for water temperature, atmospheric pressure and salinity. An analog outlet for data recording is built in. The concentration of dissolved oxygen in water can be read out in mg l^{-1} or % saturation. (2) A portable magnetic stirrer. The stirrer is a proprietary design. It can be powered by internal or external 9–13.6 V d.c. sources like (rechargeable) batteries, an a.c. to d.c. wall adapter or a cigarette lighter outlet of a car. (3) A set of cylindrical measuring chambers of four different sizes (39 ml, ∅ 48 mm), (122 ml, ∅ 68 mm), (562 ml, ∅ 117 mm), and (977 ml, ∅ 150 mm) for different sizes of fish (Fig. 1). (4) An A/D (RS232) converter, and (5) a portable, battery-powered computer ("Palmtop- or Pocket-PC").

3. Results and discussion

The oxygen electrode is inserted into the center part of the measuring chamber during operation (Fig. 2). For fast, uniform distribution of the dissolved oxygen in water and the necessary steady stream of water to the oxygen sensor, a portable, battery-powered magnetic stirrer was constructed. A small Teflon-coated magnetic stirrer is sufficient to keep the water moving without disturbing noticeably the fish in the chamber. This setup also provides a basic, constant water stream against which any fish in that chamber has to work. This water stream helps to reduce considerably irregular movements of the fish during the measuring period, which would otherwise result in additional oxygen consumption by the uncontrolled additional work, which is difficult to account for. The size of a measuring chamber should be as close to the fish size as possible to reduce the total measuring time. Comparison of results between any of the two chambers of adjacent size with the same fish gave identical results for the total oxygen consumption and for oxygen consumption rates at different levels of oxygen tension.

The data are recorded either by custom software on a DOS-compatible, battery-powered, portable PC connected to the oximeter through a special A/D-RS232

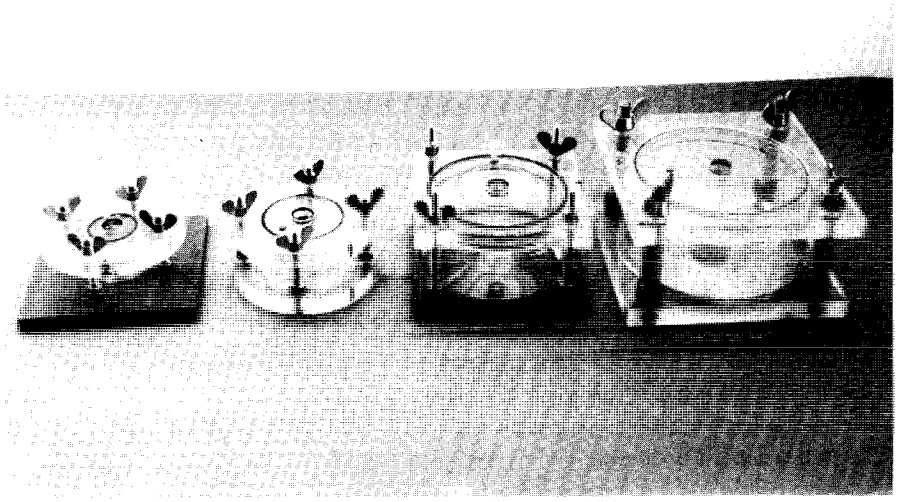

Fig. 1. Set of cylindrical oxygen measuring chambers as described in text.

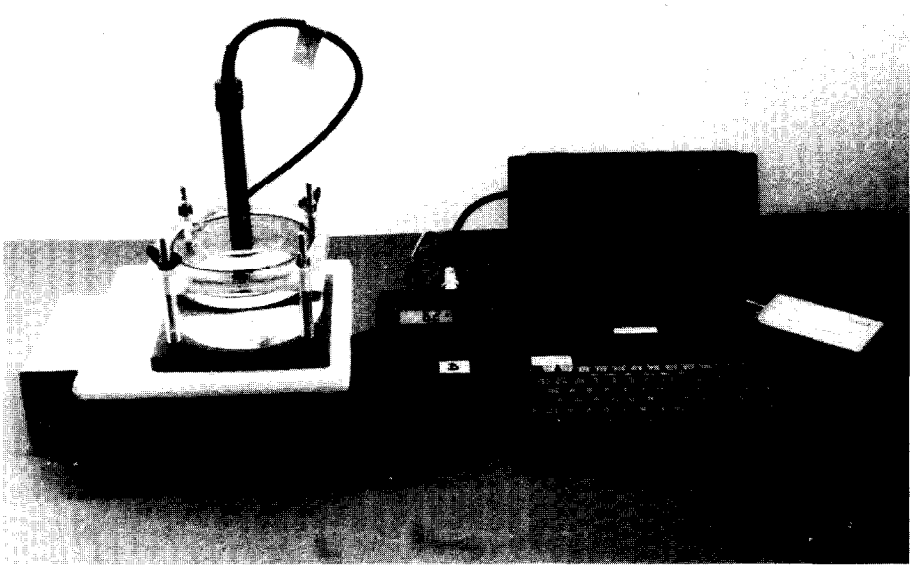

Fig. 2. Setup of the complete indirect calorimetry unit during an experiment.

converter. These data are stored to disk in ASCII format and can later be converted and exported by custom software. Alternatively, a Yt-recorder can be directly connected to the WTW-oximeter.

The calorimetric unit has been tested under laboratory and field conditions and under moderate and tropical climate conditions [4–7].

4. Conclusions

The unit is easy to handle, to maintain and to transport. It delivers reliable results. The complete unit can be powered either by any 9.6–13.6 V d.c. external power supply (line adapter, car rechargeable battery or 8 "AA" size alkaline batteries) or by an internal rechargeable battery (4–6 h per charge).

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References

[1] D.C. Jackson and K. Schmidt-Nielsen, J. Cell. Physiol., 67 (1966) 225.
[2] E. Gnaiger, J. Exp. Zool., 228 (1983) 471.
[3] C.S. Hammen, J. Exp. Zool., 228 (1983) 397.
[4] L. Fidhiany and K. Winckler, Jurnal Biologi Indonesia, in press.
[5] L. Fidhiany and K. Winckler, Thermochim. Acta, 251 (1995) 283.
[6] L. Fidhiany and K. Winckler, J. Ilmu-ilmu Perairan dan Perikanan Indonesia, II(1) (1994) 57.
[7] K. Winckler and L. Fidhiany, J. Photochem. Photobiol., 59S (1994) WAM-G2.