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OPTOCO2FISH

CO2 sensor for Aquaculture & Ocean monitoring

The Challenge

Today, some 45% of fish consumed by humans, 48 millions tonnes in all, is raised on fish farms. The actual relating European market, of which Norway is the leader, produces 1.3 millions of tonnes of fish farming products every year, which represents an approximate value of 3 billion Euros. Due to the highly competitive market the aquaculture business is confronted with the challenge to increase its productivity.
The accurate measurement and control of CO2 can contribute to sustain the health of fish and in consequence guarantee the productivity of fish farms and the quality of human food. There are actually no on-line measurement systems available (titration tests and electro-chemical sensors), which are able to determine the CO2 concentration accurately enough over time for an efficient control of the CO2 concentration in intensive cultures. Furthermore there are still no reliable sensors on the market, which can be used for the measurement of dissolved CO2 in oceanography, but they are strongly requested by researchers for stationary and mobile applications.

Project Objective

The aim of OptoCO2Fish is to develop an Optical based CO2 sensor for the continuous monitoring of CO2 levels in aqueous solutions in the fields of fish farming and oceanography. The sensor will consist of a sensitive membrane, an optical unit, an electronic core and a mechanical enclosure.

Key Points

- Definition of precise specifications of the sensor and of the measurement unit by evaluation of user-requirements and producer knowledge
- Study of the effect of dissolved CO2 on farmed fish and determination of CO2 levels in different aquaculture production systems (sea cages, ponds, Flow through systems...)
- CO2 Sensitive membrane: synthesis of stable sensitive dyes followed by development of a sensitive membrane including protective layer
- Electronic core: development of an interrogation unit for decay-time measurement
- Development of production process of a sensitive membrane and calibration routine
- Appropriate field tests to approve the sensor specifications and usability

EATiP *Thematic Area of Relevance*

TA1: Product Quality, Consumer Safety and Health
TA2: Technology and Systems
TA3: Managing the Biological Lifecycle
TA4: Sustainable Feed Production
TA5: Integration with the Environment
TA6: Knowledge Management
TA7: Aquatic Animal Health and Welfare
TA8: Socio-Economics and Management

Key Words

Aquaculture, fisheries, coastal zone management, coexistence of activities in coastal areas

Project Information

Contract number:
232070
Research area:
SME-1 Research for SMEs
Duration:
24 months (16/03/2009 – 15/03/2011)
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SEVENTH FRAMEWORK PROGRAMME

Key New Knowledge Expected

New Technology
A new Opto-chemical Carbon Dioxide Sensor dedicated to Aquaculture and Oceanography, allowing:

- on-line measurement system to determine the CO2 concentration accurately enough over time for an efficient control of the CO2 concentration in intensive cultures
- reliable sensor for the measurement of dissolved CO2 in oceanography

Development of sensitive membranes
This is a three layers system consequently; sensitive membranes have been developed by testing donor / acceptor dye combination, polymer matrix and necessary protective coating. Best candidates have been tested for a detailed characterization (sensitivity, stability, response time...).

Literature Review
The literature review of the physiological effects of CO2 on different species of fish demonstrate that all teleosts show a highly comparable compensation mechanism for hypercapnia. Hypercapnia is a situation where the concentration of CO2 is increasing.
The effects and consequences of hypercapnia depend on the duration and concentration of exposure. For most species, mild effects are found at prolonged exposure to <5 mmHg. Chronic exposure to elevated CO2 concentrations (>15 mmHg) generally result in severe physiological disturbance, as well as secondary effects as inhibited growth and swimming behaviour, and can eventually lead to high mortality rates in several species.

Inventory of CO2 levels in farms
This task aims to establish dissolved CO2 concentrations in fish farms covering the most important production systems used and fish species cultured in the EU.

Report on the relative importance of the CO2 level in aquaculture
It must be noted that CO2 control is of high importance in Species - System combinations like salmon smolts produce in Flow through systems and Recirculation systems (RAS).

Potential Impacts

The literature review about physiological effects of CO2 in fish and high levels of CO2 in many systems in fish farms indicate that CO2 sensor could be efficient equipment for optimum monitoring in fish farms. Identification of promising dye-polymer combinations open the way to development of a prototype for preliminary test in laboratory and field test.

SME
- Enhance the competitiveness of European companies and strengthen the position of aquaculture in Europe against the worldwide competition.

RTD & Environment
- Develop a reliable sensor system for the research on effects of global warming due to CO2 emission.