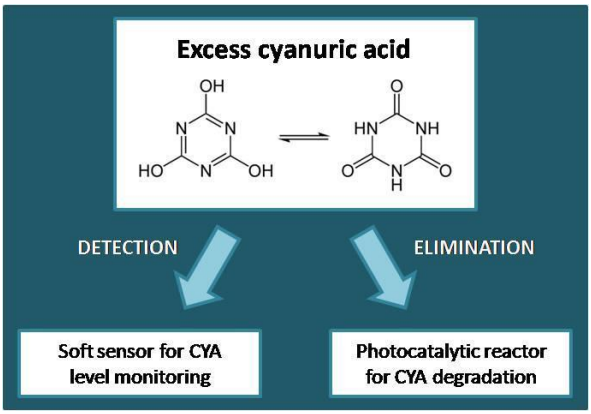
Web: http://poolsafeweb.com

PUBLISHABLE SUMMARY

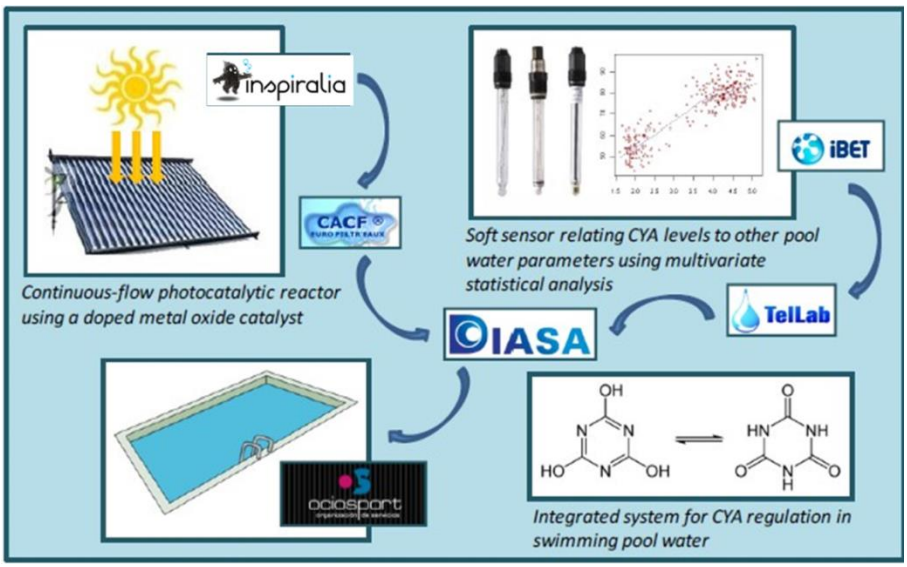
Background

Microorganisms in swimming pool water can pose a serious health threat and pool disinfection is therefore compulsory by law in all developed countries. The most common disinfectant is chlorine, which is always found in its active form, hypochlorous acid (HOCl), in pool water. HOCl is rapidly decomposed by UV light, losing its bactericide effect, and a continuous supply is needed to maintain safe levels of microorganisms in pool water.
Cyanuric acid (CYA) stabilises HOCl and is added to pool water to slow down the degradation of HOCl. CYA does not degrade however, and the CYA concentration therefore rises steadily over time. At high CYA levels, chlorine is overstablished, rendering it ineffective as a disinfectant. This increases the risk of recreational water illnesses (RWIs) and acceptable levels of CYA are therefore regulated by law. Currently the only viable solution to this problem is to replace some of the pool water with fresh water, which poses environmental concerns due to the large consumption of water this implies. The effects of high CYA levels also have a negative effect on the image of the swimming pool facility and can lead to a loss of business. There is therefore a strong need to find a way to break down CYA in pool water.

POOLSAFE will provide an effective and efficient solution to the CYA problem through the development of a soft sensor to monitor the levels of CYA and other pool water quality parameters, as well as a simple, cost-effective method for degrading excess CYA, using photocatalysis. With its two-fold method of ensuring that CYA never reach a hazardous level, POOLSAFE will reduce the environmental impact of swimming pool maintenance by eliminating the need to periodically replace the pool water, provide improved safety to bathers by ensuring that chlorine lock and the subsequent lack of sanitation is prevented, and ensure compliance with health and safety regulations for pool water.



POOLSAFE proposal has been promoted by four industrial SMEs, Diasa Industrial-DIASA (SP), T.E. Laboratories-TELL (IR), Euro Filtr'eaux-FILT (FR), Ocio Sport Rioja-OCIO (SP) acting as end user, and two Research Centres, Instituto de Biologia Experimental e Tecnologica-iBET (PT) and Tecnologías Avanzadas Inspiralia S.L-INSP (SP).



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Project Objectives

POOLSAFE will develop a monitoring system to ensure that adequate levels of pool chemicals are maintained at all times, reducing both the risk of RWIs and the health problems caused by the overdosing of pool chemicals.

- POOLSAFE will provide constant monitoring of CYA levels, ensuring that only the absolutely necessary amounts of chlorine and CYA are added to the pool. This will reduce the risk of health related problems caused by overdosing of pool chemicals, as well as provide savings to public pools by reducing spending on unnecessary pool chemicals
- POOLSAFE will be a fully automated system, which will reduce the risk of human error by pool monitors that do not have a technical background taking measurements, as well as save time, since pool water quality measurements will no longer have to be done manually.
- By ensuring that adequate levels of pool chemicals are maintained at all times, POOLSAFE will reduce the risk of RWIs and the associated cost of their treatment
- By eliminate excess CYA before it reaches unacceptable levels, POOLSAFE will eliminate the need for periodic pool water purging, saving pool managers money and providing environmental and societal benefits through water savings.
- The elimination of excess CYA before it reaches unacceptable levels, therefore maintaining adequate pool sanitation, will also preventing the formation of algae and the degradation of pool plaster.
- By ensuring pristine pool water conditions at all time, POOLSAFE will improve the image of establishments using this method, thereby increasing their revenues.
- POOLSAFE will help pool managers meet the pool water quality regulations by maintaining CYA level at all-time well below legal limits and reducing the use of other pool water chemicals such as chlorine.

Consortium Members

PARTNER	SHORT NAME		COUNTRY
Diasa Industrial S.A.	DIASA		SP
T.E. Laboratories	TELL		IR
Euro Filtr'eaux S.A.R.L.	FILT		FR
Ocio Sport Rioja S.L.U.	OCIO		SP
Instituto de Biología Experimental e Tecnológica	iBET		PT
Tecnologías Avanzadas Inspiralia	INSP		SP

Achievements

The final POOLSAFE prototype was built at month 21 and comprises a photocatalytic reactor and a multisensor. The multisenor is based on the Arduino platform (open-source electronics hardware and software platform) and measures six parameters directly and CYA indirectly) acting as control system based on the CYA values.

The photoreactor design consist on two glass tubes of DURAN borosilicate, and two UV lamps (Philipps) emitting black light from a fluorescent tube supported on a metallic structure and inclined around 40º. The new developed photocatalyst based on Trilobes coated by a TiO2 based material was placed inside the glass tube in a packed bed.

The geometric parameters (radius, length, flow rates, etc.) were defined following the volume and concentration requirements, and the inputs obtained from the lab experiments.

A study by means of numerical simulations, more specifically, through a Computational Fluid Dynamics (CFD) analysis provided by ANSYS FLUENT was carried out to optimize the hydrodynamic performance of the photocatalytic reactor. This CFD study helped to find the optimized design for the final annular reactor prototype. The most potential design is the one with two inlets and two outlets in the annular plane due to the appearing lower pressure drop, while the residence time remains constant.

Two mathematical models were developed based on on-line measurements given by the commercial multi-sensor HORIBA U-52. Both models resulted from non-linear PLS modelling using quadratic and interaction terms of the inputs, and were developed using data from: the lab-scale pool, pool water samples (used for children swimming classes and taken daily and supplemented in the lab with different amounts of cyanuric acid), and water samples from an exterior open-air swimming pool treated with Diaclor and used daily by a family with four children.

The installation of POOLSAFE prototype (photoreactor and sensing system) was carried out on the 10th of May 2016 in a children's pool due to the smaller volume of water it contains, as well as the high organic load and corresponding high disinfectant and CYA levels required to maintain hygiene standards in a swimming pool managed by OCIOSPORT in La Rioja.

The performance of this prototype was evaluated by a number of on-site tests carried out at this facility first without users and once the swimming pool was opened to the public under real conditions. Both, the photoreactor and sensor were connected and the standard conditions of water treatment were applied. It was organized that each day at approximately the same time the reading of the sensor device is taken (six parameters). Also the content of CYA in the swimming pool will be measured with the photometer in-situ and a sample taken and analysed in the laboratory by GC.

Using POOLSAFE system has been estimated a 70% of reduction in the waste of water and having CYA under control it is possible saving up to 60% in disinfectant products. The measurement of CYA will not be necessary, therefore a saving on measuring reactant has been estimated in 19.6 €/season.

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