# A SMART SYSTEM TO DETECT VOLATILE ORGANIC COMPOUNDS PRODUCED BY HYDROCARBONS ON SEA WATER

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**Abstract**

Hydrocarbons are considered one of the most important and dangerous pollutants for environment in general, and for marine environment in particular. Their detection can be performed in several ways, employing different kinds of systems, such as fixed gas analyzers or gas chromatographs, to be mainly used in laboratory, or portable analyzers, having good performances but a considerably high cost. Within this paper an innovative approach to overtake this problem is proposed. An array of commercial sensors has been realized and placed into a cylindrical flow chamber, whose shape allows each sensor to receive the same amount of air. The chamber has been realized in polyether-ether ketone (PEEK), a very light organic thermoplastic polymer with good mechanical and chemical characteristics. The sensors employed, of the type piD (Photo-Ionization Detectors) - TECH Plus, distributed by Mocon-Baseline, Inc., are capable to detect the most of Volatile Organic Compounds (VOCs), among which the hydrocarbons' ones. Their reliability is considered among the highest in the electrochemical sensors' family. The piD sensors employed have three different sensitivities, and are indicated as "Silver Label" piD, "Bronze Label" piD and "Black Label" piD.

A control and acquisition electronics has been properly chosen, with Arduino Mega 2560, realized by Arduino™, employed as electronic board. A smart system, composed by the sensors array, the control electronics, and a purposely realized module with pumps and valves for air aspiration and expulsion, has been placed into an Autonomous Underwater Vehicle (AUV), and into a moored buoy, in order to detect the eventual presence of pollutants both dynamically (with the AUV sailing while performing a mission) and statically (with the buoy, moored in a given place) in a well-defined area.

The data acquired have been employed to trigger eventual alarms concerning illegal ship transits and/or oil spills in the protected environmental area of Tuscan Archipelago.

Alarms triggered have been divided into three categories, depending on danger magnitude, and to accomplish this aim an artificial neural network (ANN) of the type Kohonen Self-Organizing Map (KSOM) has been designed and realized, providing good performances (73.9% of true discrimination into the three given categories).

The system described above gave reliable results in detecting VOCs produced by some kinds of hydrocarbons (diesel fuel, gasoline, kerosene, crude oil), all of them detectable at around 100 ppm with “Silver” piD, 1000 ppm with “Bronze” piD and up to 5000 ppm with “Black” piD, and could probably form the basis for future low-cost systems capable to detect the presence of VOCs, for environmental, but also for biomedical purposes. Future research should probably deal with the increase of the sensors’ performances, first of all by narrowing the cross-sensitivities of the detectors, in order to allow the realization of a portable system capable to discriminate between different substances, and with a possible reduction of each sensor’s price. Moreover, it could be useful to increase the reliability of the sensors’ signal in particular environments, such as high humidity ones, being the output signal span not negligible when relative humidity (RH) is over 70%, and this fact could represent a limitation for the employment of such sensors in marine environment and/or very humid places.

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