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# The water we would like

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## CONTEXT

Water is needed for our health: it maintains the health and integrity of every cell in the body, keeps the bloodstream liquid enough to flow through blood vessels, helps eliminate the by-products of the body’s metabolism, aids digestion, and other exceptional properties. High-quality water is needed to preserve health.

Unfortunately, the environment and all its sectors are differently contaminated. This dangerous state is closely linked to increased anthropic activities (industrial and agricultural) and the use of harmful substances released without control.

Old contaminants (pesticides and substances deriving from industrial activities) and new contaminants, called "emerging" (drugs, phytotoxins, body care products), can arrive in rivers, surface and deep water, and the sea if they are not removed from the wastewater.


These substances are harmful to human health because they enter the environment in quantities exceeding the natural self capacity purification of the ecosystems.

We can be exposed to water-derived contaminants in different ways. For example, people can ingest small amounts of pollutants by drinking water; they can absorb pollutants through the skin while bathing or showering and during recreational activities, such as swimming, windsurfing, and water skiing; they can inhale droplets suspended in the air or vapors while taking a shower. They can also ingest foods that have been contaminated with water-borne pollutants.

## OBJECT – APPROACH

To obtain pure water excluding any vehicle for infections and diseases and free of contaminants, our research team

***has applied***

(a) – traditional and innovative Advanced Oxidation Processes to reduce or eliminate water contamination;

***has determined***

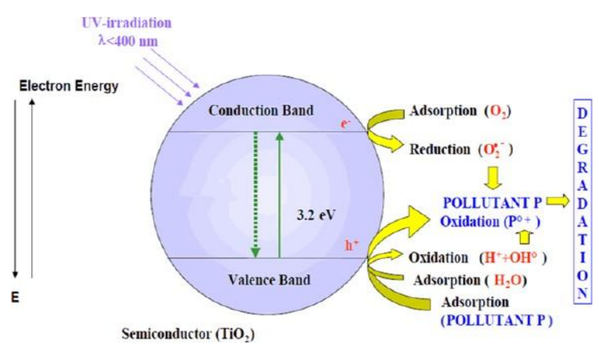
(b) the transient photoproducts that resulted from degradation processes, since some of these photoproducts could be more toxic than the parent compounds;

***has validated***

(c) the efficacy of the decontamination processes using ecotoxicology tests with MicroTox® system approved by the Ministry of Health (UNI EN ISO 11348-3: 2009)

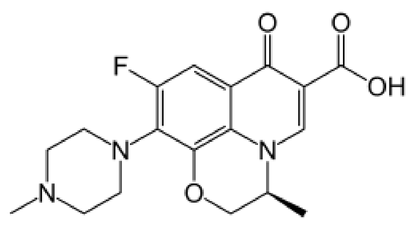
## AOPs PRINCIPLE

Advanced Oxidation Processes (AOPs) are promising ways to perform the mineralization of pollutants. AOPs are characterized by the in situ production of hydroxyl radicals, which are highly reactive species capable of oxidizing organic materials in a non-selective way.

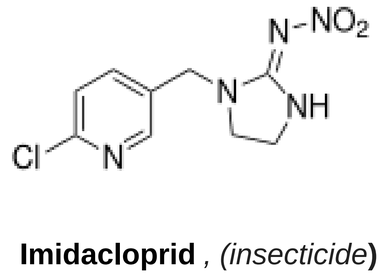



**Mechanism of $TiO_2$ catalytic degradation of organic pollutants.**

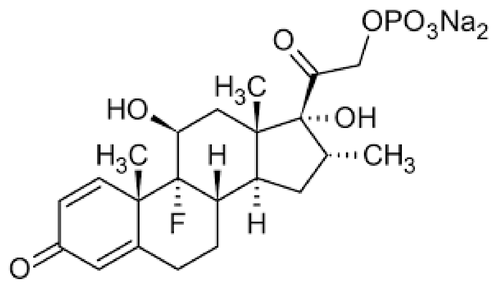
## SOME CHEMICALS STUDIED



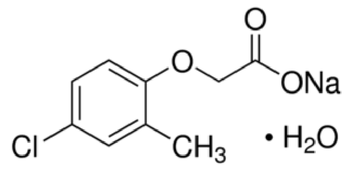
**Levofloxacin**, *(pharmaceutical)*



**Imidacloprid** , *(insecticide)*

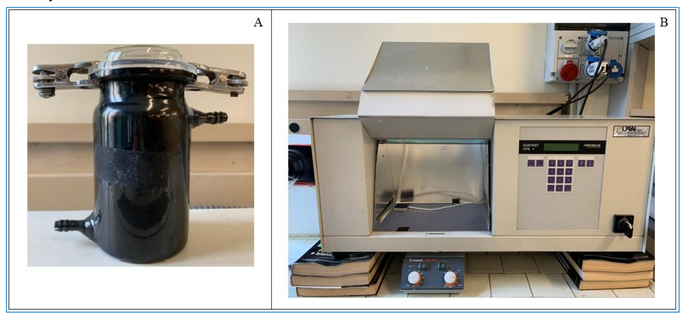


**Dexamethasone Sodium Phosphate (DSP)** (*pharmaceutical*)



**MCPA sodium salt monohydrate** (*herbicide)*

1)

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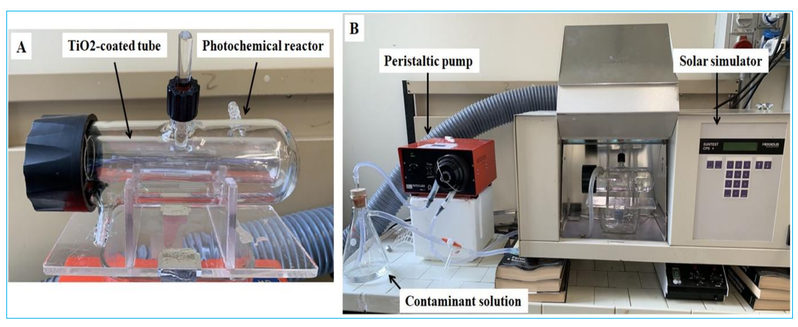



**Photodegradation system used for experimentation: 1) Photolysis, and Photocatalysis with $TiO_2$ suspended in a liquid phase; A: Reactor; B: Solar simulator. 2) Photocatalysis immobilising $TiO_2$ on borosilicate tube surface; A: Photochemical reactor in continuous; B: included with the irradiation system.**

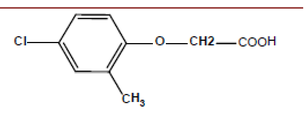
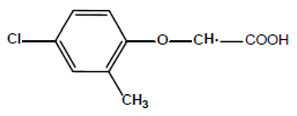
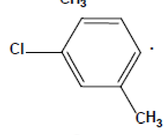
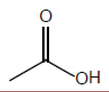
**HPLC-DAD and LC system coupled to a hybrid LTQ-FTICR (7-T) mass spectrometer (MS)**


**MicroTox® system**

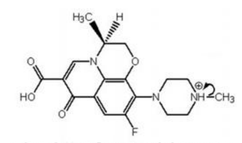
## ……..SOME RESULTS

***Identification of transient photoproducts : (a) MCPA, (b) Levofloxacin***

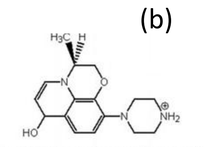
(a)

| No. | Name | Structural formula |
|---|---|---|
| 1 | MCPA |  |
| 2 | 4-chloro-2-methylphenylmethanoate |  |
| 3 | 4-chloro-2-methylphenol |  |
| 4 | Acetic acid |  |

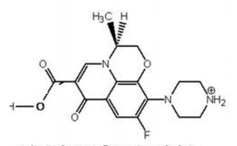
(b)



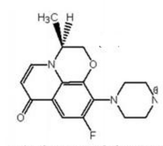
4-(5-Carboxy-8-fluoro-3-methyl-6-oxo-2,3-dihydro-6*H*-1-oxa-3a-aza-phenalen-9-yl)-1-methyl-piperazin-1-ium



4-(6-Hydroxy-3-methyl-2,3-dihydro-6*H*-1 oxa-3a-aza-phenalen-9-yl)-piperazin-1-ium



4-(5-Carboxy-8-fluoro-3-methyl-6-oxo-2,3-dihydro-6*H*-1-oxa-3a-aza-phenalen-9-yl)-piperazin-1-ium



4-(8-Fluoro-3-methyl-6-oxo-dihydro-6*H*-1-oxa-3a-aza-phenalen-9-yl)-piperazin-1-i

During the various photocatalytic degradation processes of studied compounds, the formation of degradation products was observed, even for a short time, which showed toxicity towards *Vibrio fisheri*. Fortunately, the residues showed no toxicity when the degradation process was completed. It is clear that to obtain clean and reusable water, we must consider various environmental parameters. It is necessary to continuously monitor all the procedural phases and intervene in case of unexpected issues.