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# Occurrence of Emergent Contaminants in Water: Sources and Remediation Strategies for a Clean and Sustainable Future

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## ABSTRACT

The increasing occurrence of emerging pollutants in water has become a significant global environmental concern. Their persistence and potential adverse effects on human health and ecosystem integrity necessitate innovative mitigation strategies, emphasizing the development of sustainable water treatment technologies and regulatory frameworks to safeguard water quality. Photocatalysis has gained a huge interest amongst the numerous methodologies for wastewater treatment in view of its eco-friendly approach, high performance and low cost, involving chemical reactions in the presence of a light source and a catalyst to produce new substances or transform existing molecules into harmless forms.

**Keywords:** emerging contaminants, advanced oxidation processes, photocatalysis, water matrices.

## 1 Introduction

Emerging contaminants are natural or synthetic chemicals or biological agents that have been identified as a potential threat to the environment and the ecosystem overall [1]. They include dyes, pharmaceuticals and personal care products, pesticides, hormones, surfactants and heavy metals [2]. Despite their very low concentrations in the environment, these contaminants may behave as endocrine disruptive compounds since they eventually attack endocrine systems. Their persistent nature and hazardous effects towards human health require the understanding of their sources, occurrence, fate, transformation and toxicity for developing appropriate monitoring and remediation strategies [3]. Among all the remediation technologies, heterogenous photocatalysis showed excellent efficiency in the elimination of persistent contaminants in different water matrices.

## 2 Results and Discussion

Emergent contaminants may be liberated into the ecosystem via various sources, and are accumulated in the environment through different paths: point sources (landfill, wastewater, municipal sewage ...) and non-point sources (agricultural runoffs) [1]. A great amount of dye effluents is released from various industries: dye manufacturing, textiles, leather tanning, food packaging...[4], [5]. Pharmaceutical industries on another hand, release through their production, along with hospitals, one of the most dangerous effluents containing a massive proportion of emergent contaminants. Disinfection products and pesticides can be present in aqueous systems through agricultural runoffs mainly, and municipal sewage when washed away from agricultural products [6]. The presence of these emergent contaminants on trace levels can be detected thanks to the developed techniques such as liquid and gas chromatography (LC, GC), mass spectrometry coupled with liquid or gas chromatography (LC-MS, GC-MS), ambient mass spectrometry (AMS), high resolution mass spectrometry (HRMS) and biosensors [3], [6]. According to different studies, the persistent contaminants are present in water bodies in ppt or  $ng.l^{-1}$  as showed in table. I:



**Table 1:** emerging contaminants and their concentrations in different countries

Class	Emerging contaminant	Concentration	Country	Reference
Pharmaceuticals	Paracetamol	683 $ng.l^{-1}$	Portugal	[7]
	Trimethoprim	8815.2 $ng.l^{-1}$	South Africa	[8]
Pesticides	Atrazine	2890 $ng.l^{-1}$	Brazil	[9]
	Carbendazim	2970 $ng.l^{-1}$	Costa Rica	[10]
Hormones	Estrone	476.6 $ng.l^{-1}$	India	[11]

Many treatment technologies have been used to eliminate emergent contaminants including biological chemical and physical technologies. However, the advanced oxidation processes are of a great interest due to their ecofriendly properties and excellent degradation efficiency. Heterogeneous photocatalysis is particularly an efficient technology for emergent contaminants elimination. This method consists on a series of reactions between the target contaminant and a semiconductor catalyst, radicals are produced throughout the process that react with the persistent organic matter (target) to transform it into non harmful inorganic products [1].

### 3 Conclusions

Despite their presence at trace levels, contaminants of emerging concern pose a serious threat on human health and ecosystem well-being. Many studies shall be dealing with source identification, concentration detection, pathway bioproducts and long-term monitoring in order to understand their nature and find away the appropriate remediation technologies. It is important to take the necessary steps to protect the environment and human health, and to move forward a sustainable and clean future.

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