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New materials for water cleaning

(1st classified essay)

How many of us, when opening a house tap, are aware of how an essential good as drinking water is becoming increasingly rare and precious? And this problem is not just about countries of the so called Third World, as we can erroneously think, but it is also present in many European countries. Just think about the frequent drought periods nowadays characterizing Greek, Italy or Spain during most part of the year.

This critical situation is not only due to the population growth, the decrease in water resources and the climate changes, but also to the pollution of natural water by substances commonly used in everyday life: drugs, herbicides, personal care products, etc. These compounds are defined “emerging contaminants”, and several studies demonstrated they can reach natural waters after their domestic or industrial use. The water purification technologies currently in use can only partially remove these pollutants; as a consequence, we have to deal with the environmental pollution and the toxicity for the human beings.

Recently, several studies have been developed, with the challenge of discovering and testing new technologies for the removal of emerging contaminants from water systems. Among these solutions, the development of new materials, cheap and eco-friendly, to be used in water purification technologies have recently gained great importance. They are called “adsorbents”.

To briefly illustrate how these materials could act, you have to imagine that they are able to work as “filters", retaining the contaminants. As a result, pollutant molecules are successfully removed from water sources (Figure 1). But that’s not all! Some of these adsorbents are also able to promote, by means of the solar radiation, the degradation of the pollutants previously retained. In such a way, while destroying the pollutants, the material regenerates itself and can be used again and again!

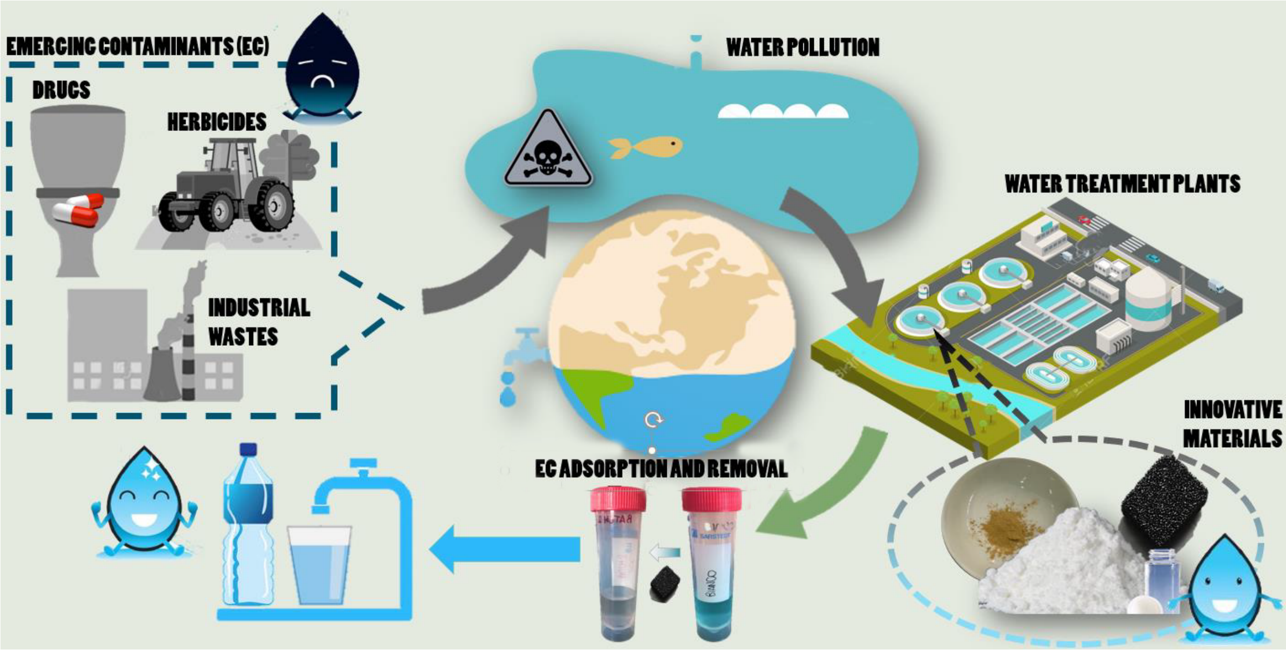

Figure 1. The application of adsorbents for water cleaning

In recent years, several types of adsorbent materials have been developed: dusts, having the advantage of great dispersion in the aqueous medium, thus resulting in a better contact with the pollutant, or monolithic adsorbents (similar to Lego bricks), giving fewer mechanical and hydraulic resistance (dust adsorbents may create obstructions) and that can be more easily removed after use.

Since these materials should directly interact and retain contaminants, the study of their surface composition is a crucial goal. During the synthesis step, specific components are added, to tune the surface of the adsorbent. As an example, if the pollutant to be retained has a positive charge, it would be the best solution to incorporate a negative charge in the material, in order to create an electrostatic interaction between them (remember: charges of opposite sign attract themselves, charges of the same sign repel themselves). Another goal is trying to obtain substrates that can be applied to the widest range of pollutants.

An aspect not to be underestimated is the economic impact of these materials. In fact, it is easy to understand how an expensive adsorbent can hardly be applied on industrial scale, even if very effective in removing pollutants.

For this reason, innovative adsorbents deriving from organic waste materials, properly treated with thermal procedures in the absence of oxygen (the so-called pyrolysis), has started to be intensively studied: they are called “Biochars”. Thanks to thermal treatments, biomasses develop different functional surface groups (which act as anchor for capturing the pollutants) and an internal porosity (their structure becomes similar to a sponge), characteristics which promote the retention of compounds.

It is easy to understand the potential of these adsorbents, allowing both the purification of water sources and the reuse of waste biomasses, becoming from different productive areas (agriculture, food processing, etc.). Cool, isn’t it?

The application of these materials to the removal of emerging contaminants from water is still in the preliminary step. The general hope is that promising results obtained in laboratories and pilot plants (systems that simulate water treatment plants in small-scale) can lead to their rapid application in an industrial scale.

Their use, in fact, would be another step in the direction of reusing waste materials within a virtuous ecological cycle (from waste to resource). This objective fulfils the principles of the “circular economy”, a regenerative economical system in which wastes should be recycled and reused in a zero-km philosophy, producing positive effects on the same territory.

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