Chapter 1

Introductory Chapter: Granularity in Adsorption

George Z. Kyzas and Athanasios C. Mitropoulos

Additional information is available at the end of the chapter

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1. General aspects

Nowadays, a very promising technique for desalination and generally water purification is considered to be adsorption. Various classes of pollutants can be removed with adsorption process as dyes, heavy metal ions, organic molecules, and odors. Numerous adsorbent materials were synthesized having as major target the (possible) high adsorption capacity. Complex materials, organic (or polymeric) materials, and low-cost materials are some basic types of adsorbents used for water/wastewater purification. However, the "king" of the adsorbent materials is still the activated carbon. Activated carbon is a very strong candidate for adsorption applications due to its high porosity and large surface area for the majority of possible contaminants for removal. The two main types of activated carbon used in water treatment applications are granular activated carbon (GAC) and powdered activated carbon (PAC).

One of the basic advantages of adsorbent materials is the different shape/form that they can be produced; powders, microspheres/beads, granular particles, and monoliths are some important forms of adsorbents. However, special attention can be given to granularity of adsorbent materials given the wide use of this form not only in adsorption but also in many processes. The reason about granularity can be easily given taking into mind some examples of reality. Granular materials are characterized as simple materials with an increasing number of conglomerations of discrete macroscopic particles. However, if those materials do not present enough cohesivity, then only repulsive (strong) forces among them can exist, and the final shape of them is governed by (only) external boundaries and gravity. Granular materials do not behave similarly and present many differences from one material to another (of even familiar form of matter). All above indicate a basic triple concept: static friction, zero temperature, and the inelastic nature of their collisions (for moving grains). Granular materials play an important role in many of our industries, such as mining, agriculture, civil engineering, and pharmaceutical manufacturing. Also, they have a big impact on geological processes and

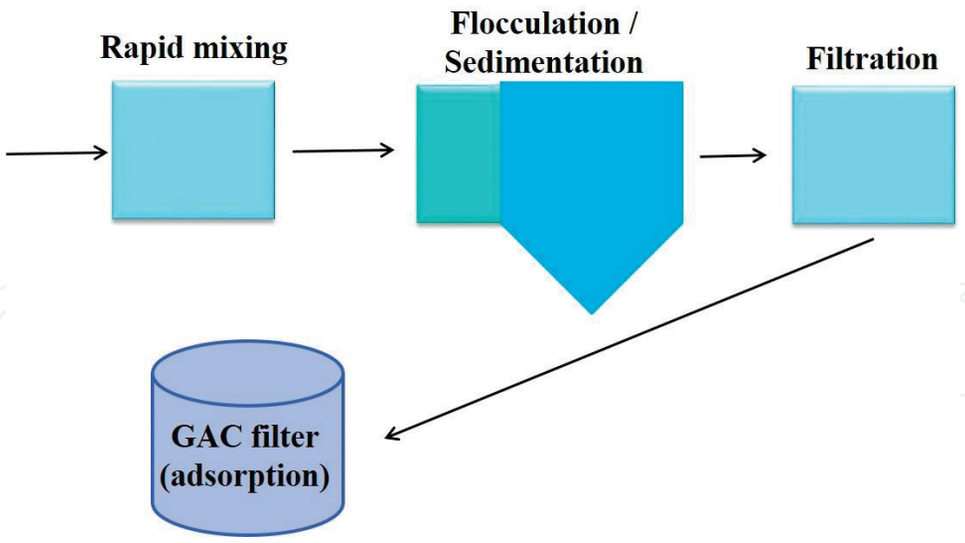

Figure 1. Post-filtration process for water purification using GAC.

erosion phenomena. So, the theory that everything eatable started out in a granular form can be easily supported and accepted. All above clearly show the importance of granular materials.

Taking into in consideration the importance of granular materials, researchers expertized in adsorption turn their interest to granular forms of activated carbons to treat and purify water (or wastewaters). From practical experience in areas where granular activated carbon (GAC) is used for drinking water treatment, it is clear that high levels of organic material in the source water result in a greatly diminished adsorption capacity and therefore a reduced lifetime of the carbon filters. It is a fact that these molecules interfere with the adsorption of other compounds present in drinking water (pesticides, taste- and odor-causing compounds, and other industrial micro-pollutants). However, few investigations have concentrated on the effect of adsorbed naturally occurring organic material on the surface properties of the carbon. The most common option for locating a GAC treatment unit in water treatment plants is post-filtration adsorption, where the GAC unit is located after the conventional filtration process (post-filter contactors or adsorbers) (**Figure 1**).

All above clearly indicated the use of granularity on adsorption technology of real industrial processes apart from the already widely known applications in engineering (mechanical, civil, electrical, etc.).

Author details

George Z. Kyzas* and Athanasios C. Mitropoulos

*Address all correspondence to: kyzas@teiemt.gr

Hephaestus Advanced Laboratory, Eastern Macedonia and Thrace Institute of Technology, Kavala, Greece