CFD Modeling Of Water Filtration Via Diatomite + Graphene Filtering Device

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Abstract

Nanofiltration membranes and devices capable for adsorbing contamination, foreign ions, bacteria and viruses, are used in water treatment for different purposes and in biotechnology for separating target biomolecules from impurities. Diatomaceous earth is most often used as a filter aid for water treatment or for pre-filtration. To date, there are no filter systems containing porous graphene, which has strength and small pore sizes, and diatomite, a porous natural sorbent with a large internal volume and sorption capacity. The combination of these materials will create an effective filter for deep water purification from various kinds of contaminants and for other purposes.
Diatomite serves as an absorbing substance (sorbent) filling the space between graphene membranes. In this case, the hydrodynamics of the flow of an aqueous solution will obviously depend on the pore size of both graphene and diatomite, on the pore distribution in these materials, on the density of diatomite, cotton wool, which serves to retain the sorbent, as well as on temperature, pressure, and ion concentration (pollution) in aqueous solution.
In this work these parameters are determined experimentally or specified by separate calculations. Thus, the flow of an aqueous solution through such a filter was modeled using a commercial finite element solver in the computational fluid dynamics (CFD) package of the Comsol Multiphysics software, where the Navier-Stokes/Darcy equations for porous media are solved. Different densities of the work substance were calculated and compared to experimental data. In this study several commercial devices were analyzed. The estimated adsorption and desorption rates of ions estimated and a proper model was introduced that can explain various transport properties of water solution in the micro-pores of the membrane.

Figures used in the abstract

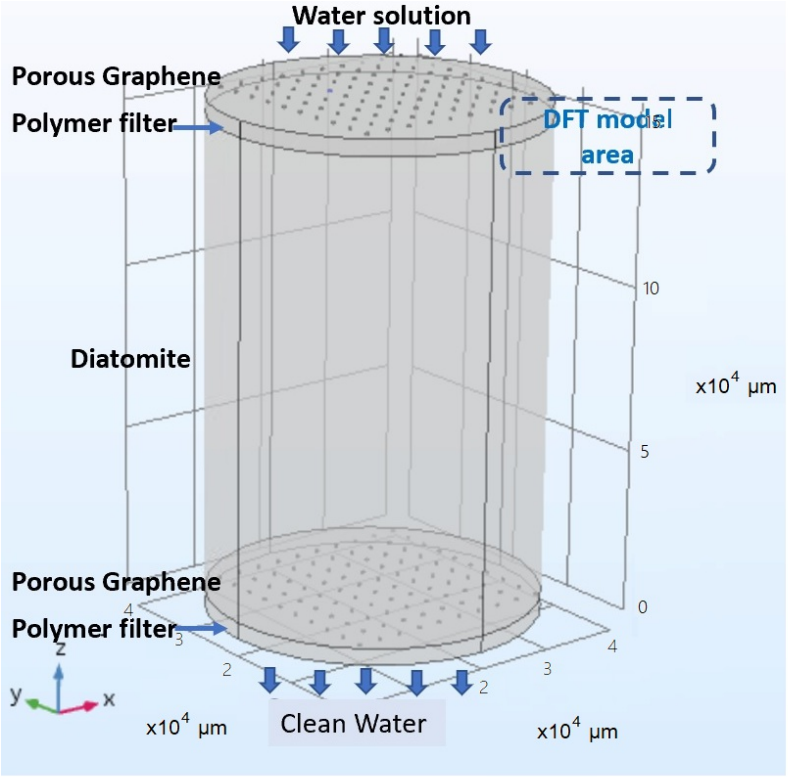

Figure 1 : The proposed vertical cylindrical filtering system consists of a diatomite sorbent laid between layers of cotton and bounded by porous graphene membranes that fixed on a polymeric porous substrate. The combination of a sorbent with a high sorption capacit