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Numerical Simulations of Microchannels with Functionalized Surfaces for Fluid Treatment with COVID-19

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Extended Abstract

Fluid dynamics analysis tools have played an important role in combating the COVID-19 pandemic. Studies that focus on understanding the behavior of virus-laden particles in the air provide health organizations such as the WHO, the Centers for Disease Control and Prevention (CDC) and the European Center for Disease Prevention and Control (ECDC) with information sufficient to prescribe measures to reduce the spread of the virus. Some of these measures include interpersonal distances of 1.5 to 2 m from each other, although there is evidence to show that this may not be enough. From the studies carried out and published, it is observed that they focused on: transmission routes; droplet and aerosol dynamics in air; aerosol infection and effects of ventilation; and possible mitigation alternatives in environments to prevent the spread of COVID-19.

On the other hand, virus detection techniques such as ELISA (Enzyme-Linked ImmunoSorbent Assay) and PCR (Polymerase Chain Reaction) are able to identify the virus without knowing the virus chains, which sometimes may be in concentrations low and undetectable. To try to solve this problem, an increase in virus concentration (enrichment) must be carried out by specific equipment and reagents.

In this context, Microfluidics emerges as a potential technology to provide a solution to this issue. Defined as science and technology applied to structures with dimensions ranging from tens to hundreds of micrometers, the so-called microfluidic devices. These microdevices can be used for different virus capture, enrichment and detection procedures, using very reduced reagents and sampling volumes.

Therefore, in this work we will analyze the application of Computational Fluid Dynamics (CFD) concepts to assess the efficiency of microchannels with functionalized surfaces in order to reduce or eliminate the viral load of an airflow in rooms destined for the treatment of COVID- 19. For this, the same functionalized surfaces of biosensors available in the literature will be used, in addition to knowledge of modeling and simulation, mass transfer, moment and heat in microfluidic devices. The proposed numerical model was verified and validated against experimental data from literature for the adsorption/desorption of DNA hybridization and also with analytical solution of the flow field. The performance of different devices configurations was also assessed by changing the channel height, inlet velocity and inlet concentrations. Thus, in the future it will be possible to use a system of microchannels with functionalized surfaces to treat the air in these rooms before reaching the central air treatment system, reducing the viral load that the air filters in this central have to deal with, reducing the costs of maintenance.

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