Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021
CSME Congress 2021
June 27-30, 2021, Charlottetown, PE, Canada

Numerical Simulation of Unsteady Two-phase Flow of Airborne Transmission Control in Dental Practices

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Abstract

Occupational Safety and Health Administration (OSHA) identified dental workers at highest risk of contracting COVID-19. This is because aerosol generating procedures (AGP) during dental practices generate aerosols (<5µm) and droplets. These particles travel with varied speeds, in varied directions, and for varied durations. If these particles bear infectious virus, their spreading causes airborne transmission of virus in the dental room, exposing dentists, hygienists, dental assistants and even other dental clinic clients to the infection risk. An unsteady Computational Fluid Dynamics (CFD) simulation of two-phase flows based on a Discrete Phase Model (DPM) is carried out to study the spreading of aerosol and droplets in a dental room. The simulation includes momentum, heat, and mass transfers between the particles and the air flow. Aerosols and droplets are modeled once as pure water and once as multicomponent droplets, including evaporative and non-volatile matter parts. Then the results are compared. Two simulation models with multicomponent aerosols and droplets are conducted and compared: model (a): a regular dental room, model (b): a dental room with a local flow sink. Simulation focuses on the control of aerosol and droplets spreading. A suction collector is added near the source of aerosol and droplets, creating a flow sink in order to remove the particles. The effects of the suction flow on the aerosol and droplets travel are studied. The results showed that considering aerosols as pure water droplets cannot be an appropriate assumption and underpredicts the potential risk of aerosol spreading. The local suction flow can remove aerosols, and also reduce the spreading of droplets.