Progress Seminar

Seminar Title	: Fluid dynamical analysis of drug delivery for various virus-bound pulmonary diseases
Speaker	: Sameer Kumar Verma (Rollno : 522me1012)
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Venue	: ME Seminar hall (Room No. ME001)
Date and Time	: 30 Oct 2024 (11:00AM)

Abstract

: This work investigates the efficiency of drug particle deposition in human respiratory airways for treating various pulmonary diseases. The simulation approach assumes that the particles are inhaled in the form of fine droplets or mist, which forms a thin layer along the airway walls where viruses typically reside to initiate infection. The computational methodology implies a combined Eulerian Wall Film (EWF) and Discrete Phase Model (DPM) approach to model the droplet dynamics. Here, the Lagrangian DPM method is used to track the movement of the droplets, while the formation of the liquid layer upon impact is resolved using the Eulerian thin film (EWF) model. Previous studies primarily relied on DPM alone, which is insufficient for capturing the post-impact behavior of drug layer deposition and its distribution to neutralize respiratory viruses.

Drug delivery efficiency is analyzed for the three different particle sizes, 1, 5, and 10 μm, inhaled at 15, 30, and 60 liters per minute (LPM). The findings suggest that particle size plays a significant role in the effectiveness of drug delivery. The film thickness of drug depositions increases consistently with the increase in particle size and inhalation rate. However, this increase is found to be prominent between 5 and 10 μm (~60%) range, compared to the increase between 1 and 5 μm (~10%) at generation level 4 (G4). Other deposition parameters, such as deposition fraction, density, and area coverage, show similar trends with increasing droplet size. Based on the analysis, it can be concluded that the particle sizes between 5 and 10 μm are optimal for better depositions at the targeted generations. Particles larger than 10 μm tend to get trapped in the oral cavity and do not reach the target regions, while particles smaller than 5 μm may penetrate deeper into the lungs and cause potential health problems.