CFD Analysis of Air Quality and Infection Risk in a Dental Office

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Abstract

A recent research paper https://aaqr.org/articles/aaqr-21-08-covid2-0213 published in 2022 demonstrates that Computational Fluid Dynamics (CFD) modelling is required for determining the optimal placements of air purifiers in specific indoor environments (particularly hospital wards) aimed at minimizing the virus infection risks. This would prevent getting negative effects such as having the high concentrations of pollutant/virus particles in the places occupied by people.

A brief technical note below illustrates an application of built in PHOENICS CFD aerosol model https://www.cham.co.uk/phoenics/d_polis/d_docs/tr313/tr313.htm#Solve%20aerosols for predicting a potential virus transmission from an infected patient in a typical dental clinic while using an air purifier to help mitigate the infection risk. The CFD results illustrate that a location of air purifier is an important factor in reducing the virus infection risk. In particular, Figures 2 and 3 (top picture) below show that the high virus concentration cloud touches one of the dental professionals in some cases with an air purifier switched ON. However, this cloud does not touch anyone in a case with an **optimized air purifier placement**, which was suggested by CFD modeling (bottom picture in Figure 3).

The outcome from the above research studies is as follows: CFD modeling is effective in developing appropriate/adequate mitigation measures aimed at providing safe and healthy indoor environments. It is not sufficient just to have a good ventilation system and an air purifier switched on in the office/clinic. The air purifier has to be located in a right place to minimize the risk of infection.

Conclusion

The CFD technology is capable of predicting the air quality and virus transmission in indoor settings and suggesting the effective mitigation measures to provide the safe and healthy indoor environments. ACFDA proposes applying the CFD technology (e.g., PHOENICS CFD software) on regular basis for predicting the indoor air quality and virus transmission in hospitals, dental/medical offices, schools, workplaces, etc. This would help in minimizing/reducing the risks of infection and improving the air quality using the appropriate placements of people, ventilation improvements and proper locations of air purifiers. The detailed information on PHOENICS CFD software, training and consulting services provided by ACFDA is available on www.acfda.org and from info@acfda.org.

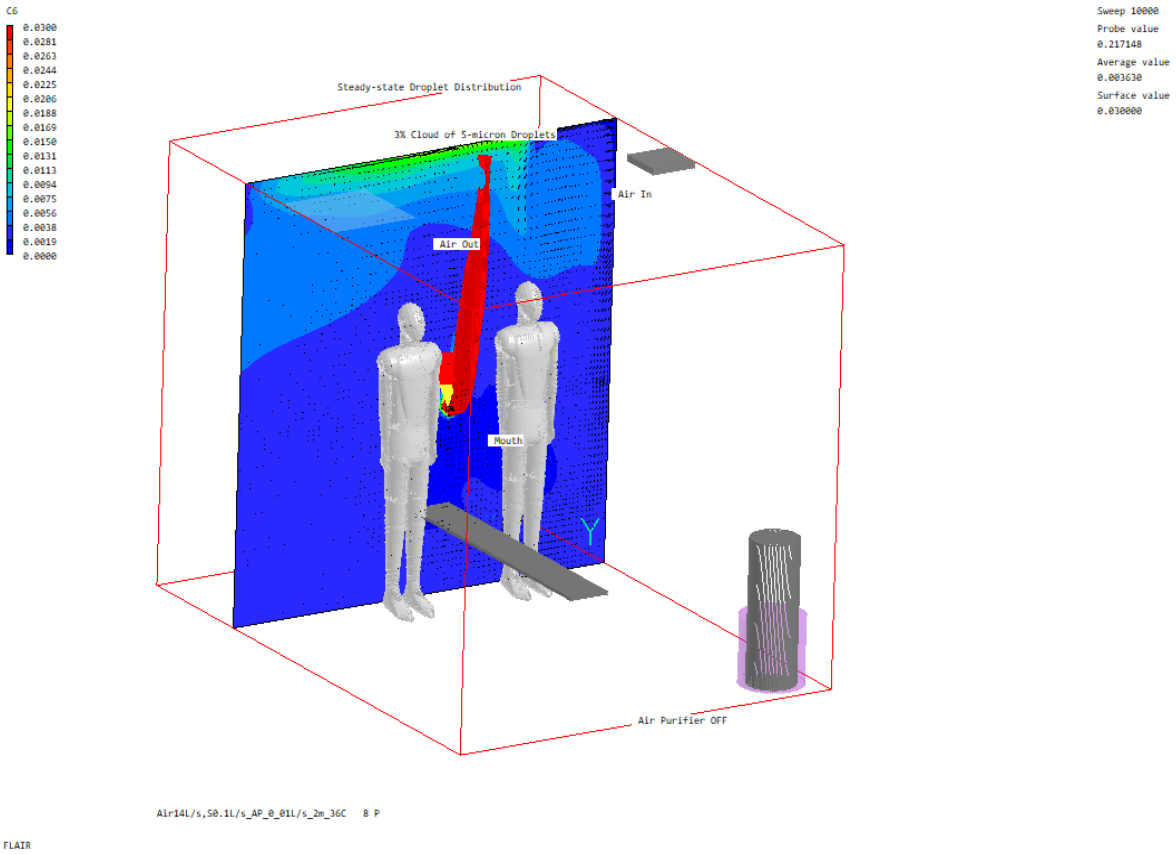

Fig.1. 3% cloud of 5-micron droplets at a ventilation rate of 14 L/s and a patient's breathing flow rate of 0.1 L/s in a case with an air purifier (AP) located in the front right corner and turned OFF. 3% cloud rises upward from the infected patient's mouth due to a buoyancy force caused by a temperature difference of 14C (36C-20C).

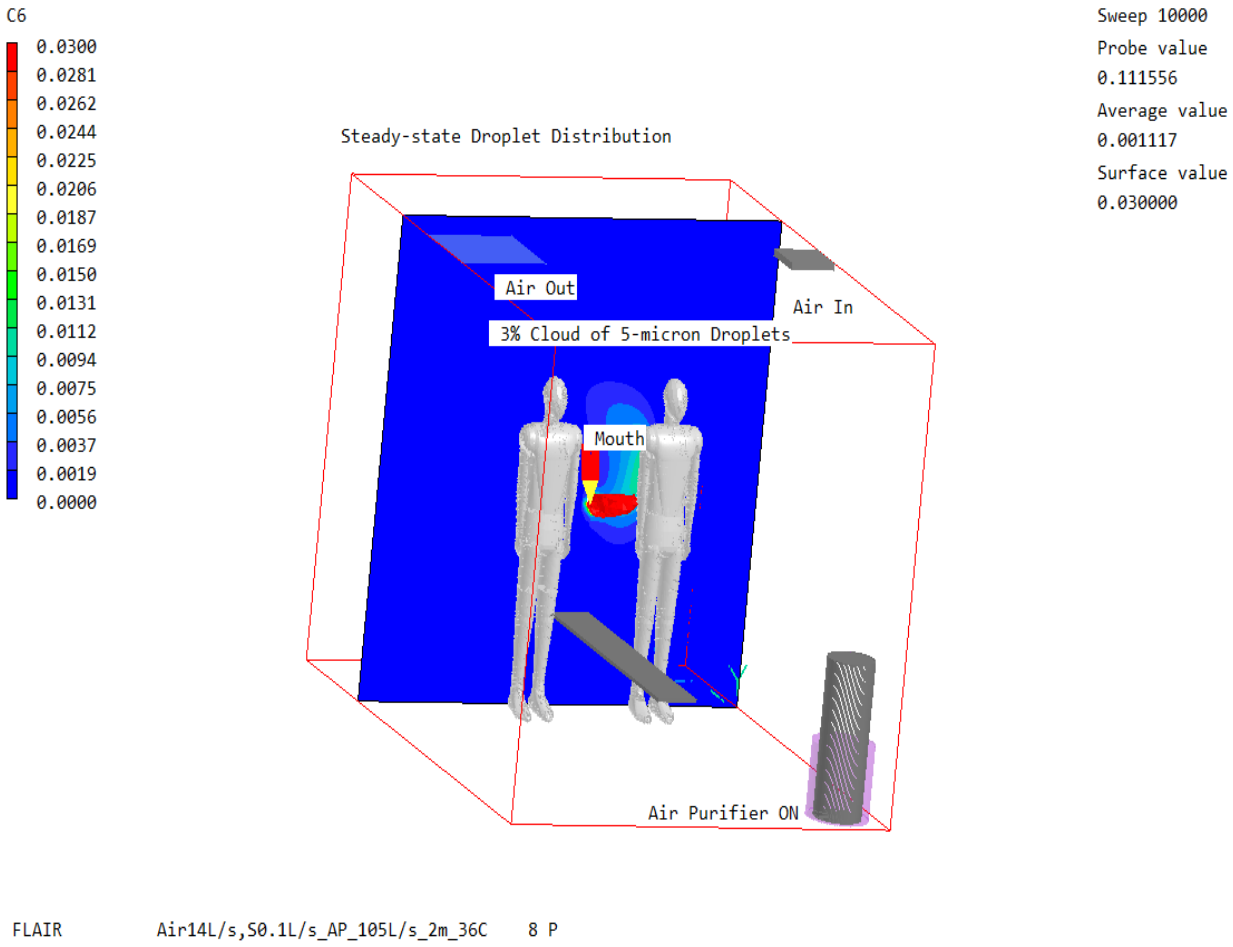

Fig.2. 3% Cloud of 5-micron droplets at the 14 L/s ventilation rate and the 0.1 L/s breathing flow rate in a case with air purifier turned ON at a flow rate of 105 L/s. The AP position is not appropriate as the 3% cloud touches the dental assistant.

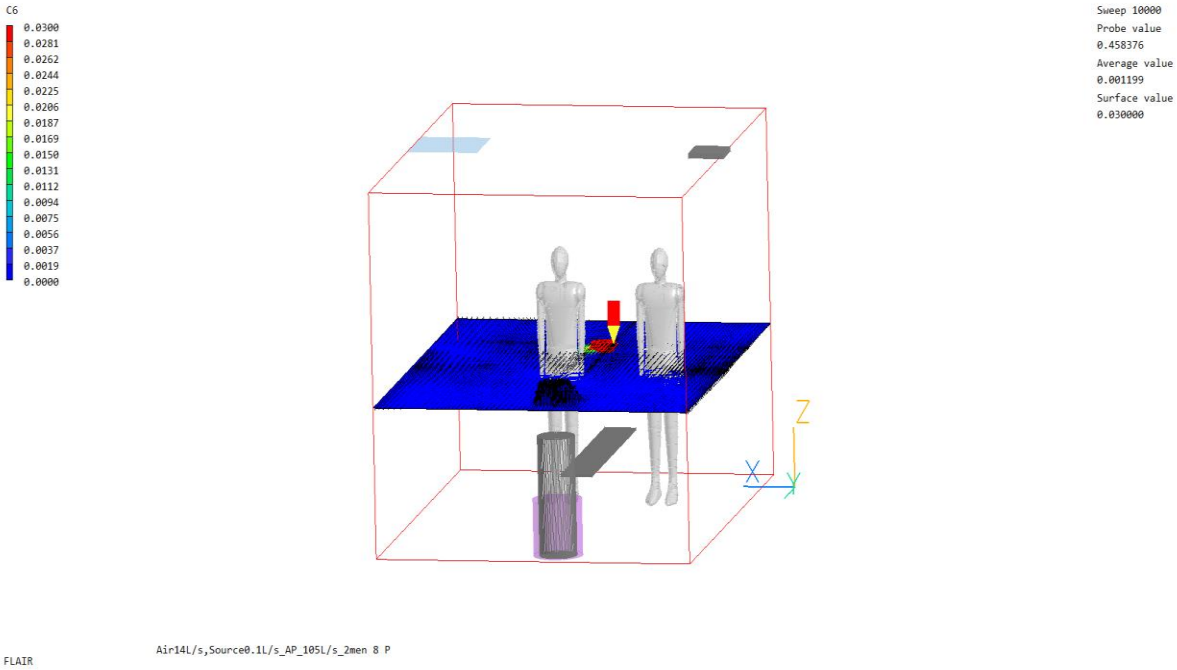

Fig.3. 3% Clouds of 5-micron droplets at 14 L/s ventilation rate, 105 L/s airflow of air purifier (AP) and 0.1 L/s breathing flow rate in two cases: a central AP position (top picture) and a 'half-way' AP position (bottom picture). 3% cloud almost touches the doctor in the first case and does not touch anyone in the second case. CFD is capable of providing a guidance on selecting a safer AP position.