Model systems for exchange of liquid between different aerosol sources

Ryan Hyde
Supervisor: Dr. Adam Squires, Dr. Anton Souslov

UNIVERSITY OF BATH

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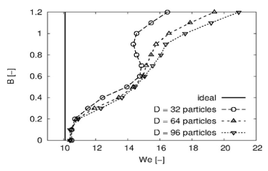
Aims of Project

Much work has gone into understanding the coalescence of aerosol droplets and the different conditions that two droplets need to be under to result in this phenomenon. These have especially been understood on a droplet-to-droplet basis, but less work has been done on a larger scale to understand the product of two aerosol clouds interacting.

This project aims to develop a model that deciphers whether there are instances where every droplet from stream A coalescences with a droplet from stream B and the resultant droplet has parts of each stream in it.

We also aim to explore different parameters that would affect successful collision rate such as viscosity of droplets and there is also potential for experimenting with relative humidity in this experiment.



Experiment composition

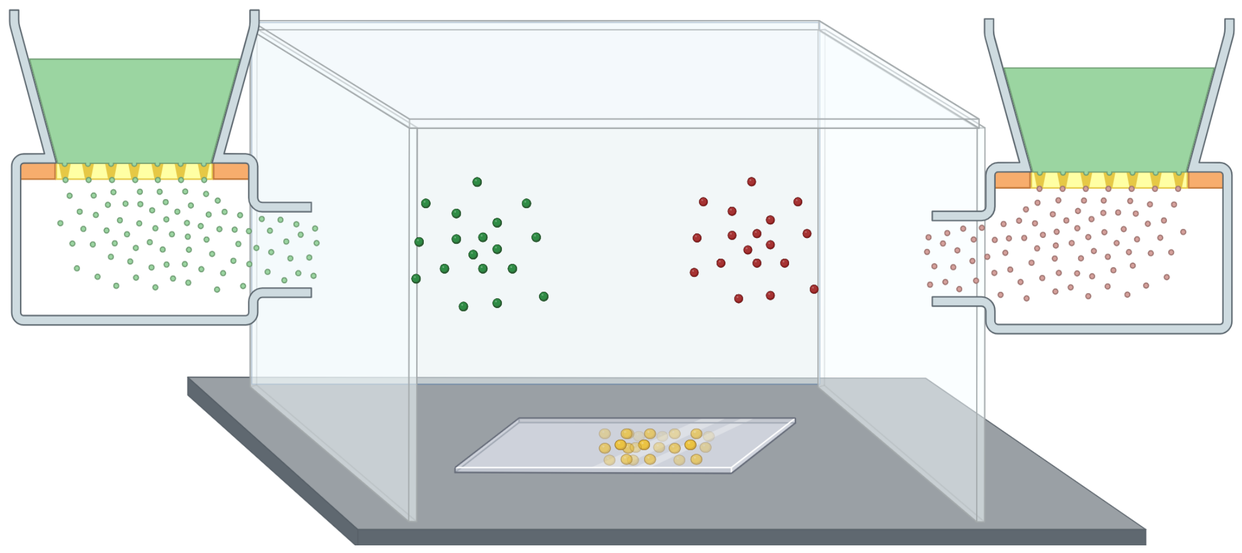


Figure 1: A figure showing a basic representation of the main experiment that we are looking to run

Explanation

Water clouds will be shot out of the ultrasonic nebulisers at the same rate and towards each other so that they meet in midair and collide.

This should hopefully make some yellow droplets that would settle onto the slide to be observed over different periods of time

Third hole for humidity monitoring possibly

Objectives

Objective 1:
This project aims to choose which modelling style is most appropriate then develop a fundamental model that explores whether there are instances where aerosol exchange between two streams is a complete process for each resultant droplet

Objective 2:
Construct and experiment that can verify the model that was created for this particular mechanism with two clouds of water that are dyed different colours.

Objective 3:
Use the findings from the original experiment to apply the mechanism to more realistic particles like known lipids e.g. lung surfactants and see whether results vary, and which points particles stop coalescing

Methodology

Modelling

COMSOL will probably be the programme of choice, but time will need to be taken as the initial calculations to display the trajectory, velocity and concentration of particles will need to be done as well as the properties of the chamber that the droplets will be modelled in.

Lattice Boltzmann Modelling (LBM) is a very good mechanism to use for a project like man as it has a great proficiency in modelling collisions and their behaviour in fluid flow simulations

Experimentation

This experiment will have different components which involve construction and purchasing of items as well as different experimental techniques. The chamber will need to be modelled and 3d printed

Fluorescent marking, microscopy and high-resolution imaging will also need to be utilised in order to quantify the results collected

Potential Challenges

One of the main challenges in this project would be the making of this model with its complexity and my personal proficiency with modelling. With models, they can also have many errors so it could potentially take a lot of time to create a model that works and that can have results that can be backed by the experiments that will be run.

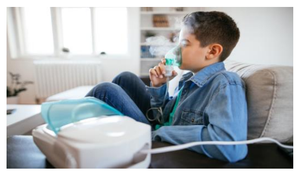
Another challenge with the model could be to use the correct model type to avoid wrong permutations and assumptions on the programmer's part. Work will need to be done to ascertain which model type would be best for this particle mechanism.

Another challenge would be with the slide. The question of how we can decipher whether droplets coalesced on the slide or in the air will always be there, so it needs to be looked into. A series of control experiments will need to be done with various time frames to also see to which degree that this could be a factor.

Because of the need for proficiency with the model, the experiment could have different conclusions to the model because of errors with the construction of the model.

Responsible Innovation

In future, this model could be very beneficial for understanding of aerosol exchange for more complex models that are more applicable to everyday human life. We could potentially see exchange between bioaerosols and pharmaceutical aerosols



We could also potentially see the exchange between rural air and urban air and explore the differences in air quality.

Dangerous advancements coming directly from this study are unlikely, but the step-up projects really could be used to make bioweapons and intentional cause adverse health to the public