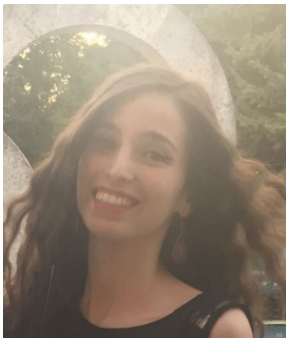
ANALYSIS AND CHARACTERIZATION OF THE INTERACTION AMONG BIOAEROSOL, AIRBORNE PARTICLES AND COMBUSTION RELATED PRODUCTS



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In front of the recent sanitary emergency, due to the Covid-19 pandemic, many scientists and researchers have focused on the possible causes of the violent spread of the virus, in particular in highly polluted areas. The literature, in this respect, seems to lean on a possible correlation between air pollution and respiratory viral infection. The role of air pollutants mostly depends on the probability of airborne transmission as aerosolization with particles potentially containing the virus.

Naturally produced droplets from humans (such as those produced by breathing, talking, sneezing, and coughing) tend to evaporate in the atmosphere, reducing the possibility to catch the virus; thus, if some conditions can retard the evaporation, the infectivity increases, leading to a higher vulnerability of people nearby.

Based on these considerations, my PhD thesis is going to focus on the study of the relationship among bioaerosol, airborne particles and combustion related products.

Bioaerosols represents all the particles released in atmosphere with a biological origin; they consist of both living and non-living components, such as fungi, pollen, bacteria, and viruses. Furthermore, they can transmit microbial pathogens, endotoxins and allergens to which humans are sensitive. During respiratory events, a bioaerosol of droplets, principally made by water, is produced. It is known that these droplets can interact with air pollutants, enhancing their lifetime and hindering their natural evaporation process.

The first literary evidence highlighted that relatively long lifetime of droplets in atmospheric environment in comparison with similar droplets of pure water is attributed to the presence of a monolayer of surfactant film and to the accumulation of soluble salts from chemical reactions (sulfate and nitrate salts). Surface-active organic molecules are common constituents of atmospheric aerosol particles; if these compounds are present as surface film, transfer into the atmosphere could be impeded, evaporation could be slowed, and the aqueous chemical reactions could be influenced.

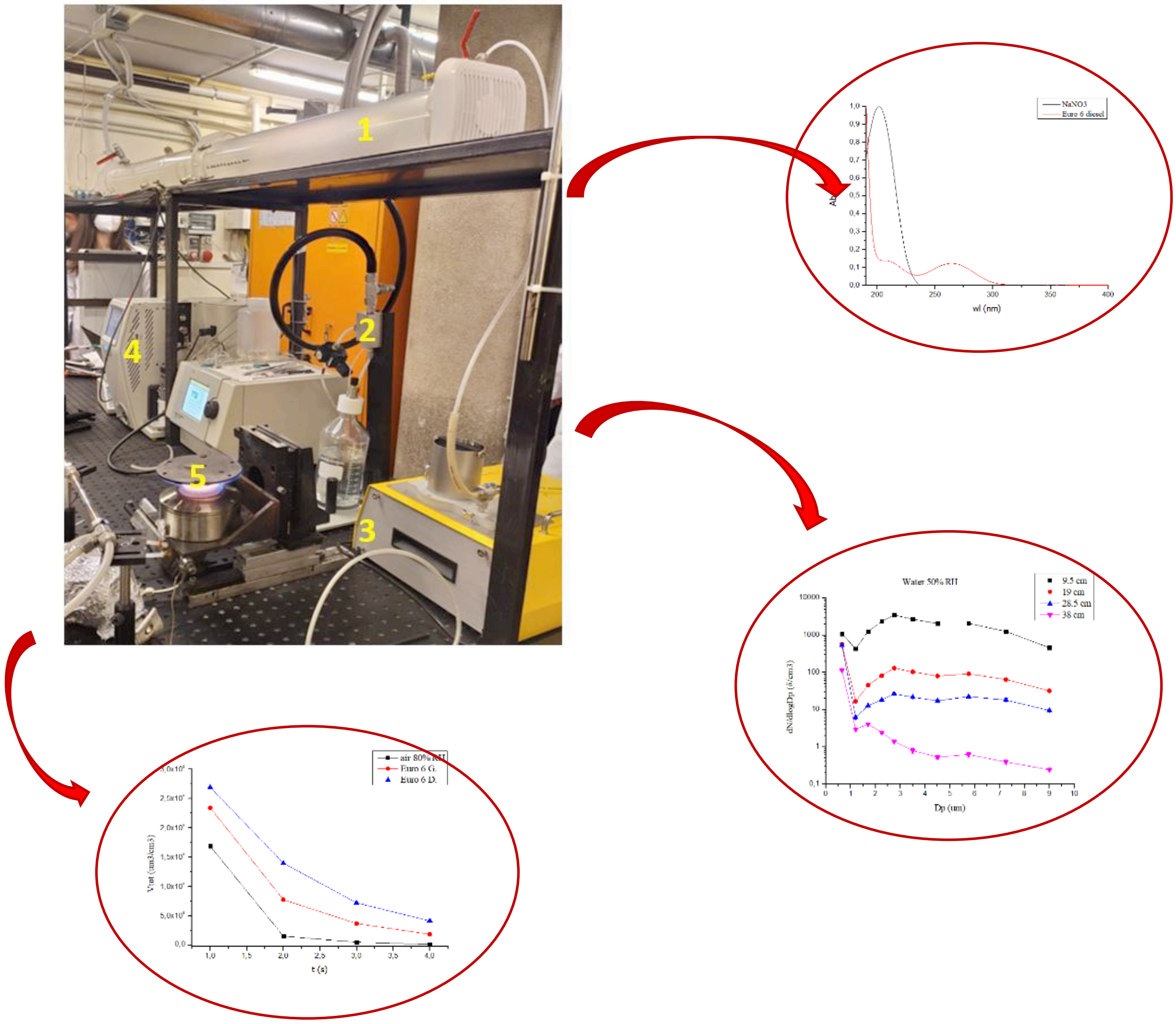
During the last months, more emphasis has been given to the analysis of the possible role of particulate matter: PM acting as a carrier through the aerosol, conveys the virus and increases its spread. Secondly, it has induced damage to the airways, increasing the inflammation state. Finally, very small (submicrometric) carbon particles seem to have a role as water condensation nuclei allowing for particle growth, when coated by organics, nitrates, ammonium, and sulfate.

During my first year as a PhD student, a preliminary CFD analysis of a droplets spray has been considered, in order to study the effect of temperature and humidity. Then, I am going to consider the pollutants' effect by changing the evaporation rate based on experimental data of the droplets lifetime in polluted ambient air.

My starting point in the experimental analysis was the design of a flow reactor for the study of the lifetime of aerosols in polluted ambient air. In a cylindrical laminar flow reactor, an aerosol of water droplets is emitted to set a target for subsequent evaluations. Then, exhausts emitted by internal combustion engines were bubbled in water; the obtained solutions were first characterized through an absorption spectra analysis, then aerosolized and sent to the flow reactor, in order to evaluate the particle number size distributions at different sampling points, considering the prefixed target.

Subsequently, diluted exhausts from selected vehicles were sent to the reactor along with an aerosol of water droplets to get close to a real situation. Evaluations like those reported for the bubbled solutions have been made. According to the experimental results, qualitative evaporation constants were evaluated following the d^2 *law* of the evaporation process and corrective factors were estimated to apply the law in the case of a polluted environment.

In the next months I am going to add the viral component to the system. The virus of reference is a GFP-adenovirus (targeted with a Green Fluorescent Protein), so its evolution can be followed by in-situ and ex-situ analysis.



Filomena Mattia, PhD student XXXVI cycle, May 2021