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Concerning the Role of Cigarette Smoke Particles on Aerosolization and Transport of COVID-19 through Face Masks

Salvador De Las Heras^a and Francisco J. Arias^{a*}

^a *Department of Fluid Mechanics, Polytechnic University of Catalonia, ESEIAAT C/ Colom 11, 08222 Barcelona, Spain*

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In this note the role of cigarette smoking in the aerosolization and transport of COVID-19 through face masks is considered. On one hand, it is known that COVID-19 spreads primarily through water droplets generated when an infected person coughs, sneezes or speaks, and on the other hand it is also known from available experimental data that cigarette smoke particles are hygroscopic, i.e., they can act as active condensation nuclei and then can potentially act as aerolizer agent of COVID-19 inside the alveolar region of an infected smoker. Utilizing a diffusion model for the effect of water vapor on the growth of cigarette smoke particles it is shown that they can double its radius around saturation conditions -as expected in the alveolar region. Because cigarette smoke particles are with sizes peaked around 0.25 micron, then the resulting particle after absorption of surrounding water will have a size around 0.5 micron of radius which are quite able to pass thorough practically any face mask and in addition transporting around 50 viruses or thereabouts inside its water film. Therefore the current strict law enforcement of many government with the mandatory use of face masks when at the same time the measures are relaxed with the habit of smoking is call into question. We feel that it is appropriate to air the subject at this time and to encourage a careful investigation and measures of the subject.

Keywords. *Airborne COVID-19; Condensation nuclei; Cigarette smoke particles.*

I. INTRODUCTION

Since 2020 with the outbreak of novel coronavirus disease (COVID-19) many countries have implemented restrictions on population as part of of public health policy for mitigating the spread of COVID-19, [1],[2]. One of them is the use of face masks -whether surgical masks or simple reusable cloth masks-among the general public. Although initially in western countries the measure appeared as a recommendation by governments, however, nowadays the use of face masks is mandatory in many of them and under strict control and surveillance. However, understandably certain essential human activities -including chatting on cell phones, drinking, eating, are allowed temporally and then relaxing the measures. Nevertheless, there is another activity which although no essential, it is permitted in many countries and yet its it no essential and contrariwise -as will be demonstrated, represent a serious risk for the spread of COVID-19.

than 5 μ m produced when an infected person coughs or sneezes,[4]. However, mounting evidence seems to suggest that covid can potentially spread by airborne transmission, i.e., via microscopic particles ($\leq 5\mu$ m) which are small enough to stay suspended in the air for hours,[5]-[8]. Airborne transmission is an important issue which jeopardize the effectiveness with the use of face masks because not only they cannot avoid the filtration of particles with diameters around microns, but also because the time of suspension is highly increased.

A. Cigarette smoke particles as Aerolizer of COVID-19

It is known that tobacco smoke contains hydrophobic particles i.e.e, particles which have an affinity for water and then they act as condensation nuclei meaning that under a moisture environment (for example the alveolar region), a water film will grow surrounding the particle. The effect of water vapor on the growth of cigarette smoke particles was for first time theoretically and experimentally investigated by Ishizu et al (1980), [9], as far as the authors know, and since then many works haven been conducted in several hygroscopic aspects of cigarette smoke particles, [10]. A simple early expression which fit well with experimental data is owing to Ishizu et al (1980),[9] which allow to calculate the particle growth ratio in radius at equilibrium

II. MATERIALS AND METHODS

Until not long ago it was believed that COVID-19 -henceforth covid, spread from person-to-person mostly through respiratory droplets with diameters larger

* Corresponding author: Tel.: +93 73 98 666; francisco.javier.arias@upc.edu

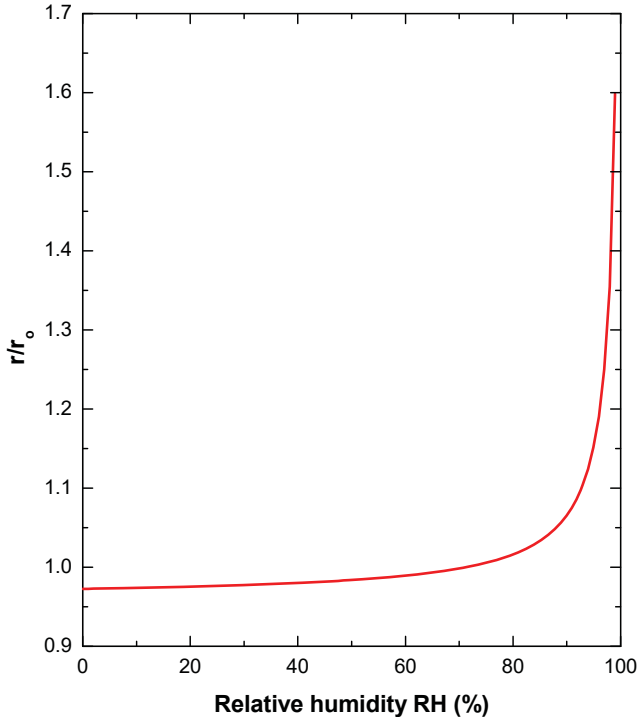


FIG. 1. Dependence of cigarette smoke particles on relative humidity, after Ishizu et al [9].

$$\frac{r}{r_o} = \left[s \cdot \frac{M_w}{M_s} \cdot \frac{RH}{1 - RH} + (1 - w) \right]^{\frac{1}{3}} \quad (1)$$

where r is the cigarette smoke particle radius, r_o is the particle radius before water absorption; s portion of water-soluble part in smoke condensate; M_s and M_w overall molecular weight of water-soluble part of smoke and molecular weight of water, respectively; R_H relative humidity; and w portion of water in smoke condensate. Using the proposed parameters, [9], $s = 0.61$; $M_s = 340$ g/mol; $M_w = 18$ g/mol; and $w = 0.08$ we obtain the curve shown in Fig. 1. It is easy to see that the theory predicts that cigarette smoke particles doubles in radius at about 99.5% humidity and then it can be assumed as a referent value for the alveolar region where water vapor is at saturation. Likewise, if the cigarette smoke particle has an initial volume V_s then will be able to transport a layer volume of water ΔV_w around $\Delta V_w \approx V_s(2^3 - 1)$ or $\Delta V \approx 7V_s$, i.e., seven times its own volume.

• Discussion

Cigarette smoke particles have a relatively stable distribution of sizes ranging from 0.1 to 1.0 micron and peaked around 0.25 micron i.e, with a volume 0.065 cubic micron, [11], therefore the final particle radius after water absorption should be around 0.5 microns (a factor 2 according with Fig. 1) and the total volume of water transported seven times its own volume or 0.46

cubic micron. By comparison, each SARS-CoV-2 virion is approximately 0.1 micron in diameter or 0.004 cubic micron. So, if assuming a discrete volumetric packing factor around, say, 0.3 each smoke particle may potentially transport around 30 viruses at least.

III. SUMMARY OF RESULTS AND CONCLUSIONS

In this note the role of cigarette smoking in the aerosolization and transport of COVID-19 through face masks is considered. It was found that because the hygroscopic properties of cigarette smoke particles they can double its radius with a water layer in the alveolar region. With cigarette smoke particles with sizes peaked around 0.25 micron, that means that the resulting particle will have 0.5 microns with a surface layer of water being able to transport around 50 viruses. With this airborne size there is not any practical face mask able to prevent its filtration. Therefore the strict law enforcement of many government with the mandatory use of face mask when at the same time the measures are relaxed with the habit of smoking is call into question. We feel that it is appropriate to air the subject at this time and to encourage a careful investigation and measures of the subject.

NOMENCLATURE:

M_s = overall molecular weight of water-soluble part of smoke
 M_w = molecular weight of water
 r = smoke particle radius
 r_o = particle radius before water absorption
 R_H = relative humidity
 s = portion of water-soluble part in smoke condensate
 V_p = volume smoke particle
 ΔV_w = volume of water transported by a smoke particle
 w = portion of water in smoke condensate

subscripts

p = smoke particle
 w = water

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