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In-cabin air quality –electrostatic field to capture sub-micron size particles

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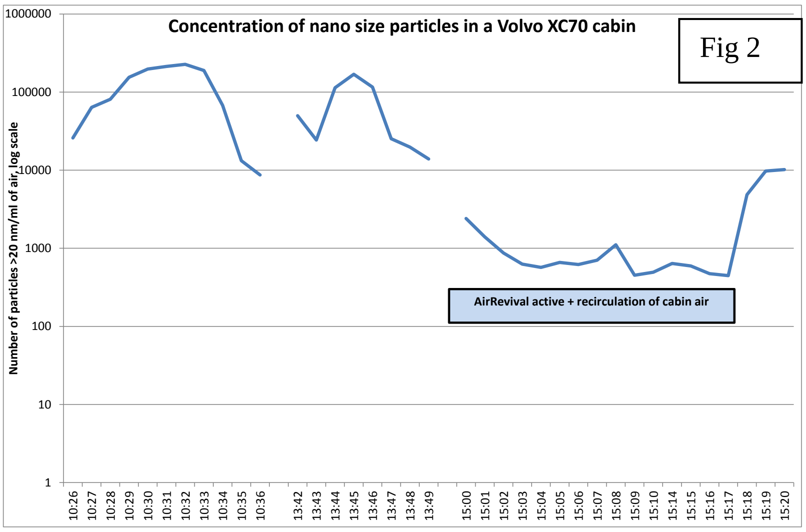
INTRODUCTION: Traffic is regarded as the main reason for the air pollution problem and it seems obvious to try to reduce the particulate bioload affecting those travelling. Recently Volvo Cars introduced their Interior Air Quality System forcing the cabin air to be recirculated in case of a high level of noxious gases shutting out carbon monoxide, ground-level ozone and nitrogen dioxide. Ionization is another component of Mercedes AIR-BALANCE package. Considering the fact that it is the nano-size ultra-fine particles (UFP) that are known to cause the "oxidative" stress of the immune system one may ask if even the most well designed HEPA filter would sufficiently affect the in-cabin air particulates or is there a need for additional means by which the sub-micron class particles may be captured. An electrostatic field of sufficient strength may serve as an additional tool to clean the cabin air from sub-micron size particles.

METHODS: The electrostatic field was generated accordingly; a 45 cm long electrically conductive polymer band with built-in free ending carbon fibres was placed in the rear window of the cabin. The conductive polymer was connected to -7 kV at <10 mA enabling the flow of electrons between the emitting band and the window plane (exposed to a positive charge). Fig. 1 provides an illustration of the AirRevival™ technology (AR), (Neoventor AB, Kungälv, Sweden). Measurements were made in the cities of Hong Kong and Berlin using P-Trak 8525 portable unit (TSI Inc, USA) with a capacity to record particulate matter >20 nm.

RESULTS AND DISCUSSION

Figure 2 illustrates data obtained when driving a Volvo XC70 through the city centre of Berlin. The concentration of particles varied from 10 000 to 250 000/ml of ambient air when driving with the external air inlet open and fan operating at half speed. With the AirRevival system activated + the cabin air recirculating, the



concentration of nano size particles dropped to 635/ ml (average). With the doors opened, the particles rapidly returned to the 10 000-level. Thus, the combination of using the internal filters through recirculating the air and one AR unit provided a substantial decrease in nano-size particles. The impact of recirculation only as compared to recirculation + AR is illustrated in Figure 3 with data obtained from two Volvo XC models. In all tests, the cabin fan was run at half speed. As expected, with a larger cabin or more polluted air, the primary volume of air cleaned by electrostatic mechanisms would have to increase by using both rear side windows for dirt deposition.

The health hazard of air pollution is related to particle size and nano size particles with their large relative surface serving as a binding site for free metal ions constitutes an important component in the pathophysiology of oxidative stress (Miyata and van Eeden, 2011). Drivers and passengers in heavy traffic are at special risk for UFP exposure (Fruin et al. 2008) and epidemiological data show an association between exposure in traffic and the onset of myocardial infarction within 1 hour afterward (Peters at al. 2004). Thus, it appears most relevant to investigate potential technologies to reduce the bioburden of cabin air. Recirculation within the enclosed cabin space optimising the ability of existing filters to capture UFP would be the first step but additional technologies are required (Pui et al, 2008).

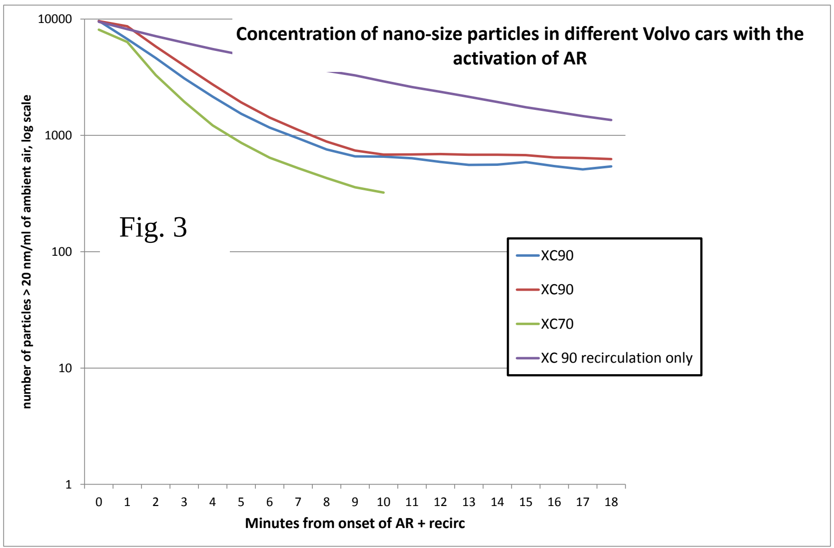


Fig. 3

CONCLUSIONS

The initial data from the study indicate that electrostatic mechanisms substantially add to the in-cabin air cleaning properties of ultra-fine particulates compared to the standard filtering technology when recirculating the cabin air.

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