Dedicated to innovation in aerospace

CORSICA: NLR-RIVM meeting

Aircraft airconditioning system and exposure simulation |
5.1.2e 17/9/2020

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Overview

- Air conditioning in aircraft (simplified system views)
- Modelling
- SARS-CoV-2 related inputs and outputs

Airconditioning system in aircraft

https://www.aviationhunt.com/aircraft-air-conditioning-system/

Normal operation (with all ambient air suppliers)

https://aviation.stackexchange.com/questions/17641/how-does-air-conditioning-work-on-a-commercial-airliner

Cabin compartments

https://patentswarm.com/patents/US10414505B2

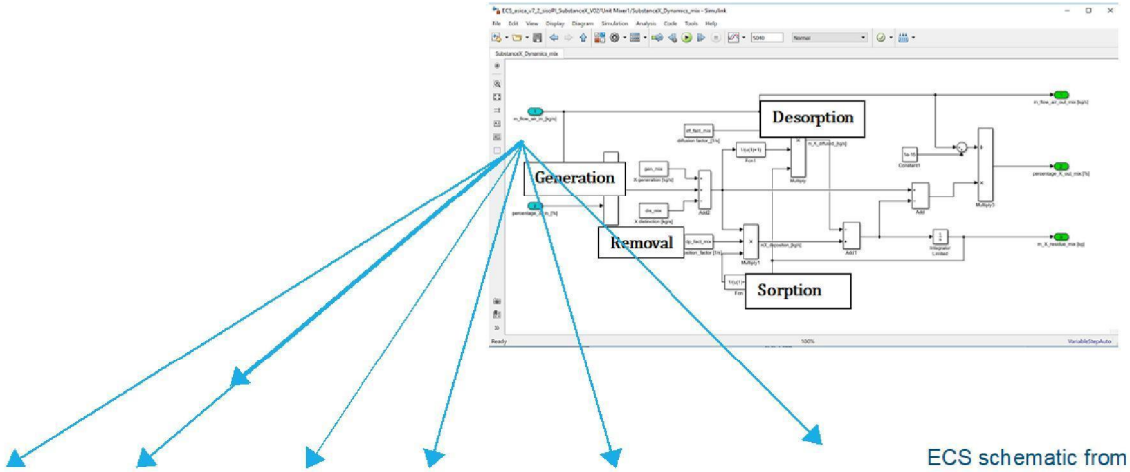
Cabin lay-out (Embraer site; public communication)

- Architecture
- In- and outflows positioning
- Quantities/directions during flight
- Boundary conditions (floor, wall, ceiling): temperature
- Separators

https://www.embraercommercialaviation.com/clean-air-clean-cabin-safe-flight/

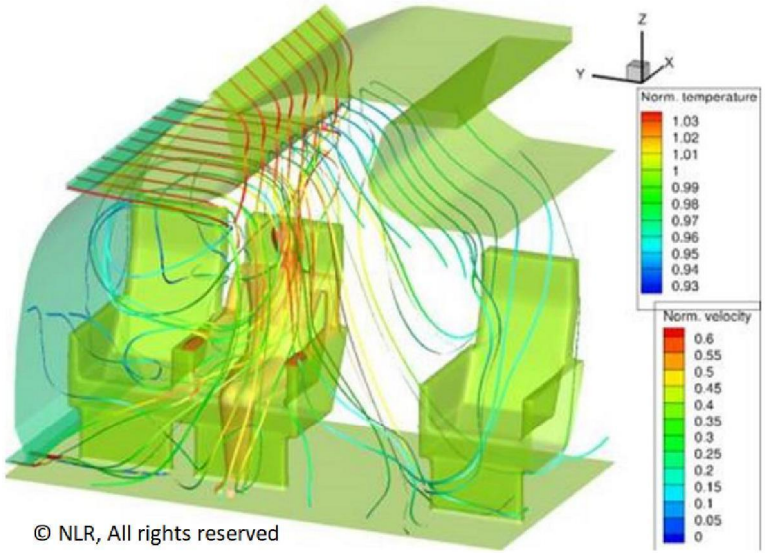
modified

Modelling: flow and particle spread in the system



ECS schematic from *[1] H. Yin et al., "Modeling dynamic responses of aircraft environmental control systems by coupling with cabin thermal environment simulations," Build. Simul., vol. 9, no. 4, pp. 459–468, 2016*

Modelling: flow and particle spread within compartments (with and without passengers)



Boeing, 2015

Scenario selection for detailed simulations

Exposure, exposure time, frequency during flight for different scenarios: distance-based (no flow simulation)

- Index passenger coughs into face of neighbour
- Index passenger loads/unload luggage in bins
- Index crew member in aisle and at entrance
- Index passenger goes to toilet
- Etc..

SARS-CoV-2 specific input data (from RIVM) for detailed simulation

- Virus droplets as exhaled: cloud of droplets or concentration in breathing zone (dependency on passenger characteristics (superspreader, country of origin, ...)
  - Droplets positions and velocity (or breathing zone)
  - Droplets geometry and weight (sphere radius + “density as water”)
  - Volume fraction virus (solid matter) in droplet
  - Exhaled air temperature
  - For different events: talking, cough, breathing (+ frequency), ..
- Effect of masks on the above characteristics (exhalation/inhalation; time on/off)
- Virus droplets as inhaled:
  - Breathing zone
- HEPA filter efficiency; if timely known in CORSICA; otherwise 100% efficiency assumed

Consistency with previous RIVM studies

Potentially relevant (if already done by RIVM):

- Virus droplet geometry behaviour in air, after exhalation (effect of temperature, humidity, ozone, sunlight (UV effect), etc..)
- Splitting and/or co-agulation
- Absorption of droplets by cabin interior

Potential simulation output (check with RIVM; for discussion)

Simulation output has to be relevant for infectivity of passengers (though dose – response is not modelled).

- Doses over a flight per passenger: total (weight? Volume?) of virus (or virus droplets) inhaled by passenger during the flight?
- Single exposure / Short and long duration limits?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Fully engaged
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