Abstract for AEC2020

New long-range cabin mock-up enabling the simulation of flight cases by means of tempered fuselage elements

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Introduction

Nowadays, tests of novel ventilation concepts, which promise energy and weight saving potential as well as a higher level of thermal comfort, are either conducted numerically or experimentally using ground-based cabin mock-ups, see [1]. However, numerical simulations are either time consuming or use many simplifying models. Experimental investigations on the other hand are mostly restricted to one cabin geometry [2] or allow only static measurements [3]. Moreover, they are often not capable for simulating different flight cases characterized by different thermodynamic boundary conditions.

Discussion

To allow the testing of greener and smarter ventilation concepts for future long range aircraft, a new test facility is currently under construction at DLR in Göttingen. It will allow the installation of different cabin geometries on a 1:1 scale enabling dimensions up to 7.0 x 10.0 x 3.0 m^3 (W x L x H). The main feature of the new cabin mock-up is the provision of thermodynamically realistic boundary conditions facilitating the simulation of different flight cases e.g. hot-day-on-ground, climb and cruise. Furthermore, dynamic changes of the boundary conditions on realistic time scales will be possible. Therefore, the gap temperature, i.e. the temperature between primary (5) and secondary isolation (2), will be provided by a system of temperature-controlled capillary tubes (4) mounted on aluminum sheets (3), see Figure 1(left). To provide a realistic cabin geometry, original sidewall linings (1) including secondary isolations (2), overhead luggage compartments and ceiling panels are constructively enhanced with this new system. By operating at least four different water-glycol temperature control units simultaneously, the gap temperatures on both sidewalls, the crown as well as the floor are controllable individually. A demonstrator for this technique is already setup and successfully tested for a single sidewall element, see Figure 1(middle) and right. Warm and cold gap air temperatures are simulated and the resulting inner surface temperatures of the lining are captured using IR thermography.

Conclusion

At DLR Göttingen, a new aircraft cabin mock-up is setup up allowing to simulate thermodynamically realistic boundary conditions for investigations of different ventilation concepts at ground level.

Thermal manikins, individually controllable, allow the simulation of realistic heat release and obstruction of passengers. Furthermore, the manikins will be equipped with a CO_2 release system simulating the exhalation of the passengers. Latest measurement techniques for velocity field

measurements, high-resolution local measurement probes and tracer gas analysis complete the data acquisition system of the new test facility, facilitating the investigation of new ventilation concepts on ground level under/for different flight phases. Finally, the mock-up is designed for subject tests allowing to validate the objective measurements with human subject questionnaires.

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Bibliography

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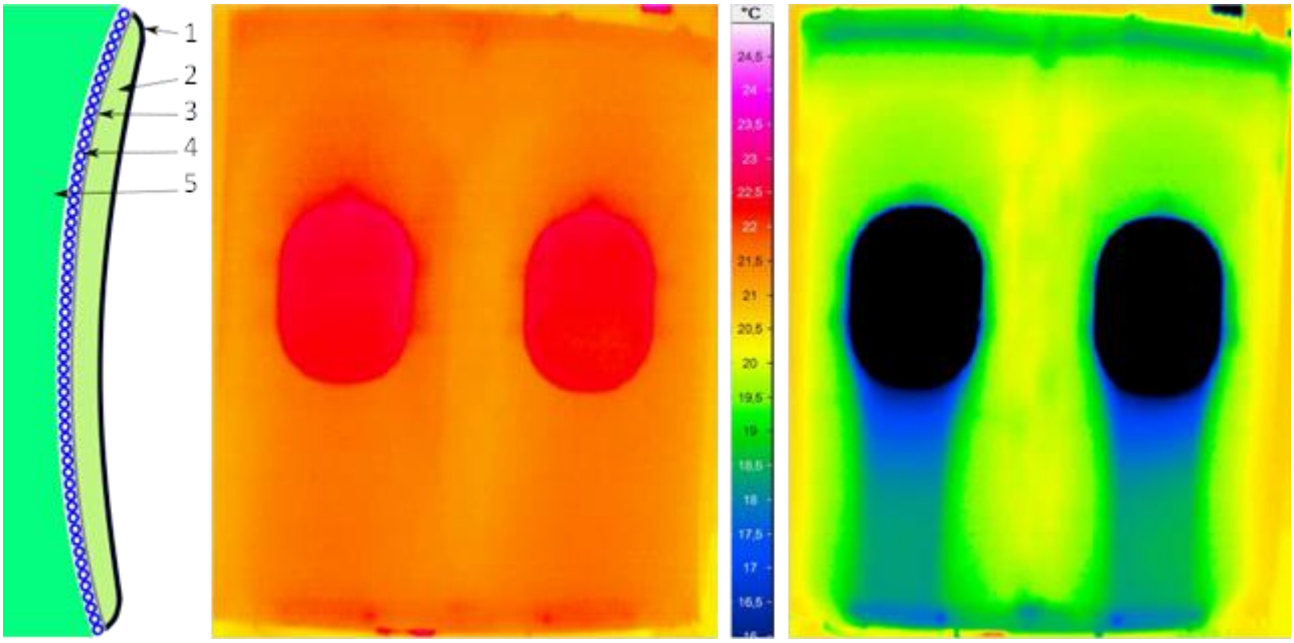

Figure 1: left schematic drawing of layer structure. IR thermography of a single sidewall for warm (middle) and cold (right) gap temperatures.