Applied Thermal Engineering 36 (2012) 87–95

Contents lists available at SciVerse ScienceDirect

Applied Thermal Engineering

journal homepage: www.elsevier.com/locate/apthermeng

Performance investigation of ground cooling for the airbus A380 in the United Arab Emirates

Brendan Savio Aranjo [a], Ben Richard Hughes [b,*], Hassam Nasarullah Chaudry [b]

[a] Mechanical Engineering, School of Engineering and Physical Sciences, Heriot-Watt University, Dubai International Academic City, Dubai, United Arab Emirates
[b] Dubai Energy Research Group, School of Engineering and Physical Sciences, Heriot-Watt University, Dubai International Academic City, Dubai, United Arab Emirates

ARTICLE INFO

Article history:
Received 5 June 2011
Accepted 3 December 2011
Available online 13 December 2011

Keywords:
Computational Fluid Dynamics
Analysis
Energy
Cooling
Pre-conditioned air
Thermal Comfort

ABSTRACT

A combination of the United Arab Emirates (UAE) climate and the increased size of the super jumbo, Airbus A380, have exceeded the working capacity for current ground cooling techniques. These are evident when the aircraft is being prepared for flight and when in the hanger under maintenance with internal cabin temperatures reported at above 30 °C. The existing system used, delivers air at 11.6 °C after which the cabin temperature is still at a high temperature of 31 °C and unable to cool down due to the temperature rises caused by climate conditions and heat dissipation from the electronics in the cabin. The CFD based temperature profile results highlighted that a decrease in inlet temperature to −18 °C at a constant pressure and mass flow rate is sufficient to provide efficient cooling to the cabin at 22 °C. Boundary conditions are determined to specify a new effective cooling system and resolve the ground cooling issue.

1. Introduction

Emirates was the first airline to place an order and is currently the largest operator of the Airbus A380,with 15 in service out of its total of 90 on order, which is the largest amount of any carrier. Emirates uses the original A380-800 configuration that carries 517 passengers in a three-class configuration for long range flights or 600 passengers in a two-class configuration for medium range flights [1]as shown in Table 1.

Emirates airlines operate out of Dubai where the temperature at the airport during the summer months is at an estimated average of 37 °C, with temperatures sometimes exceeding 40 °C.

The combination of the climatic conditions and the size of the A380 have created cooling issues with the aircraft when on ramp at concourse being prepared for flight and when in the hanger under maintenance, using current Pre-Conditioned Air (PCA) systems. When the aircraft is in the air, the external airflow cools the skin of the aircraft and the Auxillary Power Unit (APU) cools the cabin. But when the aircraft is stationary on the ground and the APU switched off, external cooling needs to be provided.

The high external temperature heats up the skin of the aircraft during pre-flight procedures. Emirates Engineering provides cooling with external PCA supply units which goes through long lengths of flexible ducting before reaching the cabin. Because of the sheer size of the aircraft, this cooling method is inadequate to cool the aircraft even with an additional PCA unit attached. Therefore the APU is switched on for effective cooling, but this is very inefficient in terms of fuel usage. The APU uses between 100 and 600 L of fuel per hour to cool the aircraft cabin, and because the alternative refrigeration systems cannot cool the large aircraft due to the external temperatures, the APU is constantly deployed. Considering the number of Airbus A380s at the Dubai airport and Emirates maintenance hangar, a considerable amount of fuel is consumed per hour to run the APU which is unsustainable in the current aviation market [4].

A similar problem is faced while the aircraft is under maintenance in the hangar. The existing PCA Unit is unable to cool the A380 effectively. Cooling from the PCA unit is supplied using two supply ducts, and for cooling the A380 an additional PCA unit with two extra supply ducts is used. During maintenance, pre-conditioned air from the units is supplied directly into the cabin through the doors. Substantial cooling is lost from the ducting due to the PCA unit being more than 75 m away from the aircraft.

Emirates Engineering uses ADX type PCA units from CIAT which are self-contained, aircraft cabin air-designed to provide the airflow and pressure required for cooling or heating and ventilation of parked commercial passenger aircraft. The PCA units are designed as standard for installation outdoors at point of use (POU) without any special weather protection [5] shown in Fig. 1.

* Corresponding author.
E-mail address: B.R.Hughes@leeds.ac.uk (B.R. Hughes).

1359-4311/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.applthermaleng.2011.12.002