Report

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Testing and CFD Study of Airius Destratification Fans

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1 INTRODUCTION

Airius Europe distributes a range of novel destratification fans. These fans are thought to be unique in that the fan is enclosed in a casing, which incorporates guide vanes and a nozzle so that the air is thrown in a narrower jet.

This report presents the results of tests carried out on the model 10 and model 25 fan as well as computer simulations of the fans in operation.

The test work firstly involved measuring the flowrate through the fans, so that these could be accurately set in the CFD models. The flowrates were measured in accordance with ISO 5801, in a Type A configuration (free inlet and outlet).

The jet of air from the fans were then measured to ensure the throw from the fans was correctly represented in the CFD simulations. These measurements are beneficial since the geometry of the nozzle and the presence or absence of swirl can influence the jet spread.

2 AIR JET MEASUREMENTS

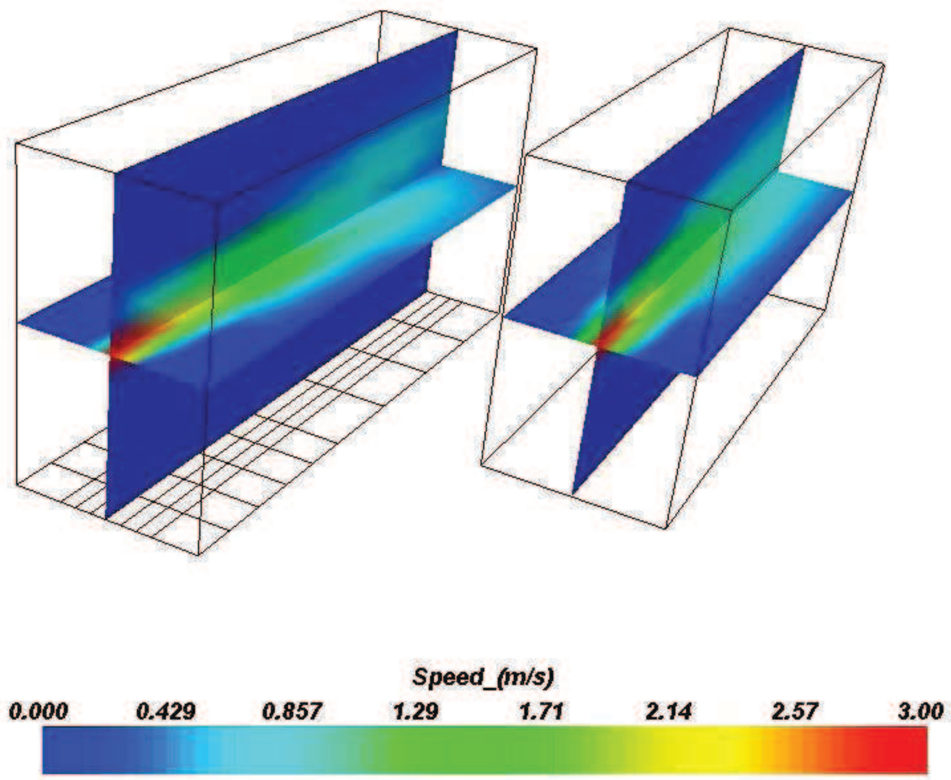
2.1 TEST METHOD

The jet of air created by the model 10 and model 25 destratification fans were measured using hot wire anemometry. Close to the fan discharge where airspeeds were highest, a vane anemometer was used since these speeds exceeded the range of suitability of the hot wire anemometers.

The tests were conducted under approximately isothermal conditions and the fans were tested in a horizontal position. Eleven anemometers were attached along a vertical pole. A grid of points (9x10) was marked out on the floor, covering an area of 1.2 x 4.2 m. The pole of anemometers was then moved from grid point to grid point and all eleven readings were taken at each pole location. This gave a total of 990 air speed measurements (9x10x11). Both fans were tested in this manner.

In order to check the CFD code can correctly predict the spread of the jet, comparisons were made between the measured air speeds and isothermal CFD calculations. Figure 4 shows a comparison of air speeds using colour coded planes through the axis of the jet. The left side show the experimental measurements (grid points are marked on the floor), the right side shows the CFD calculations. A very close correspondence is seen.

Figure 1 Measured airspeeds (left) and calculated air speeds (right) for model 10 fan



3 CFD MODEL SETUP

The flovent CFD code was used to simulate airflows and temperatures three-dimensionally in the example buildings. Steady state results are presented (ie temperatures and airflow patterns after sufficient time for all values to stabilise to constant values).

3.1 LABORATORY (SHED TYPE BUILDING)

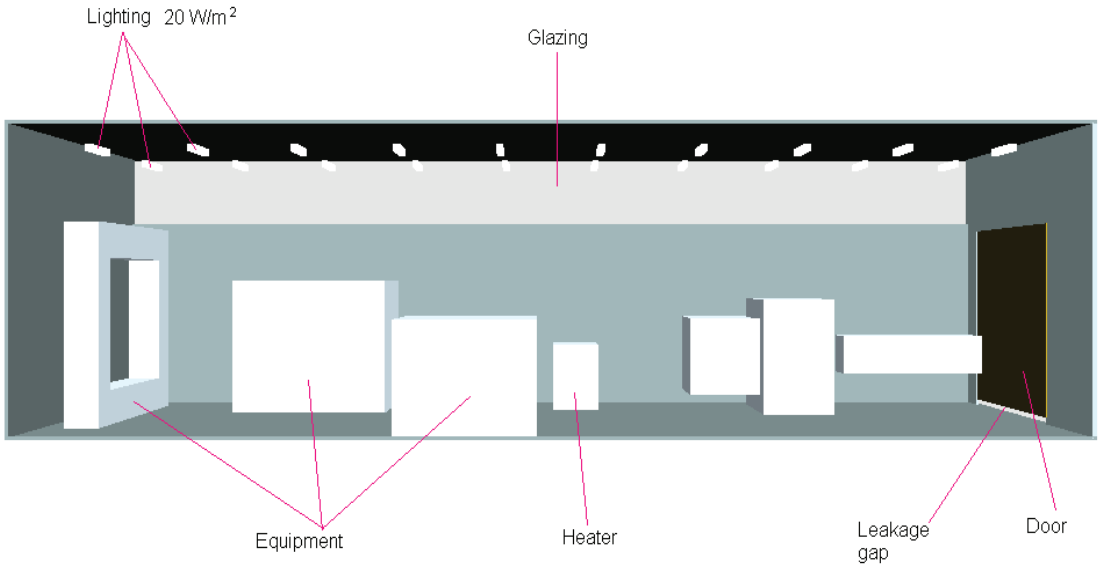
The geometry of the building used to test the model 25 fan is shown in Figure 5. The building is loosely based on one of the BSRIA test laboratories. Floor plan dimensions are 10m x 30m and fan height is 7.5 m. Various test rigs are distributed around the space. One side of the building is glazed at high level.

Fabric losses are based on an outdoor temperature of 2°C and U values of the structure set to coincide with Part L of the 2002 building regulations. To further help the space to stratify a 1.5 cm gap is modelled under the loading door and a similar open area is assumed at high level. By including these openings in the model, cold air tends to flow under the door and contribute to the stratification. Lighting is assumed to amount to 20 W/m^2. This is implemented as 20 heated blocks at ceiling level, each one releasing 300 W.

An oil-fired heater provides further heating. This is assumed to supply 60 $l.s^{-1}$ of air at 80°C. In actuality the heater provides a much greater flow at a lower temperature, but this creates a strong jet that helps to mix the air and reduce stratification. The objective of this work was to investigate the ability of the Airius fans to destratify the space, so the modelled building was deliberately set to encourage stratification.

When simulating the influence of the fans, three, model 25 fans, were arranged along the centre line of the building. Hence a floor area of 100 m^2 per fan, is tested. A further simulation was then carried out with four fans (hence 75 m^2 per fan)

Figure 2 Modelled geometry



4 CFD RESULTS

4.1 LABORATORY (SHED TYPE BUILDING)

In Figure 7 temperature contours are plotted. A colour coded vertical plane through the building shows how temperatures vary with location. The colours relate to temperatures as indicated in the legend. Cold air leaks under the door and spreads along the floor, creating a large region under 17°C. A stratified temperature distribution is predicted with warm air floating towards the roof.

Figure 8 shows the corresponding result with the three fans operating. Since the contour plane passes through the fans, the warm jets can be seen projecting downwards. At the opposite side of the building from the door, destratification is almost complete. Close to the door, the steady flow of air into the building maintains a cold spot at ground level, but the improvement is obvious.

Figure 3 Temperature contours along centreline

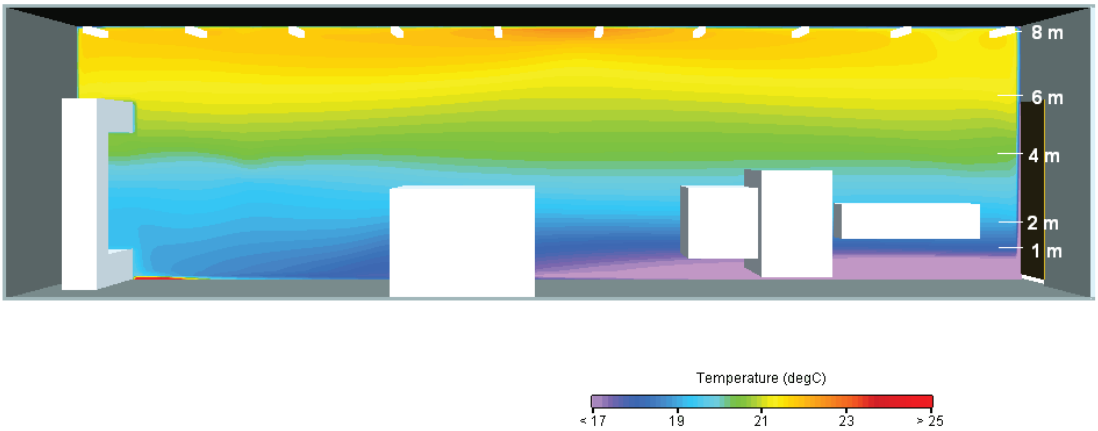


Figure 4 Temperature contours with three fans installed

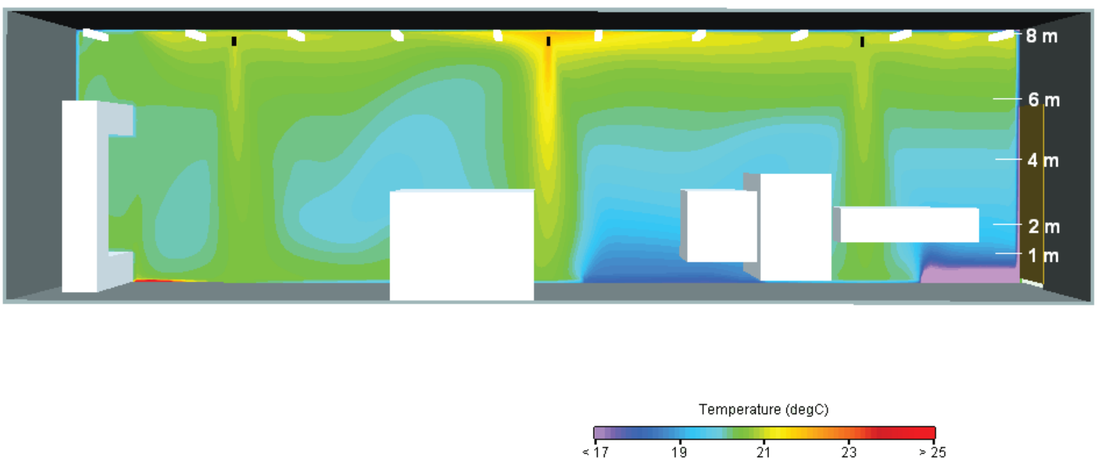
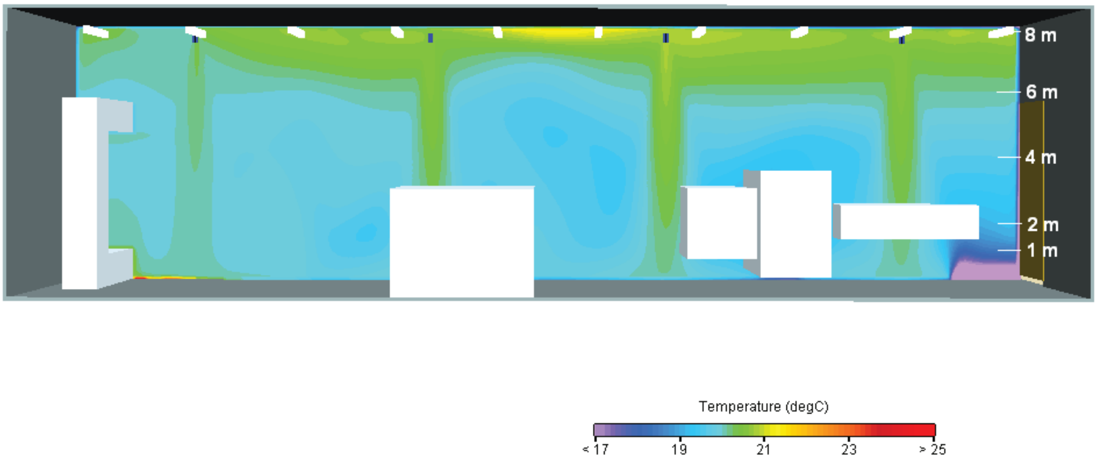


Figure 9 below shows the same building with four fans operating. A further improvement over figure 8 is seen; with an even more uniform temperature distribution.

Figure 5 Temperature contours with four fans installed



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