A study on the arrangement of air inlets in a Class 7 clean room

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Abstract
In this paper, a room with four inlets located at the ceiling in the centre of the room with an exhaust installed at the bottom sidewall was modelled and investigated. The air is supplied through the individual room air inlets filtered by a high-efficiency particulate air filter, and the air is removed from the room via the exhaust located at the bottom sidewall. It leads to two possible inlet arrangements with four inlets: 1 × 4 array and 2 × 2 array. In the modelling, an obstacle is built to represent a workbench located underneath the inlets. Both the array designs are compared on their air flow and ability to remove gaseous contaminants. This study also suggests that the behaviour of the air jet impingement on the surface of the obstacle must also be considered in determining the design of the inlet array in a clean room.

Practical application: This paper is intended to provide a practical guide to building service engineers on the design arrangement of inlets for a Class 7 clean room. By using the same concept, the design arrangement concept can be extended to the sizing of a workbench (i.e. the obstacle) when there is a fixed inlet design.

Keywords
Air inlets, air distribution, airflow, computational fluid dynamics, clean room

Introduction
A large number of studies have been carried out on the airflow in a room to date. For a clean room, the requirement for the air flow pattern is the downward unidirectional airflow. The requirement of downward unidirectional airflow throughout the domain does not apply in a clean room, which is not as stringent as required in electronic industries. For a clean room with the Class ≥7, which is normally an operating room or a pharmaceutical clean room, it does not require the installation of a perforated ceiling. The air is normally supplied through an individual room air inlet filtered by a high-efficiency particulate air filter. The location of the exhaust may vary, although there is a standard, which suggests the location and layout of the exhaust. Hence, the ventilation layout just
of the contaminant at inlet velocity of 0.2 m/s is higher in comparison to the inlet velocity at 0.4 m/s. The array of air inlets does not carry a significant influence on the airflow distribution for the inlet velocity at 0.2 m/s since the buoyant force is dominating the airflow inside the room. For both inlet velocities of 0.2 and 0.4 m/s, the inlets with $1/C_2$ array perform better than the $2/C_2$ array in terms of diluting the contaminant and a better evenness of the temperature distribution in the examined case. In addition, from the present investigation, the behaviour of the air jet impingement on the surface of the obstacle must be considered in determining the design of the inlet array in a clean room.

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Conflict of interest

None declared.

References


Appendix 1

Notation

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<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>$Ar$</td>
<td>Archimedes number</td>
</tr>
<tr>
<td>$D_{r,a}$</td>
<td>diffusion coefficient of air–carbon dioxide</td>
</tr>
<tr>
<td>$H$</td>
<td>height</td>
</tr>
<tr>
<td>$L$</td>
<td>length</td>
</tr>
<tr>
<td>$\dot{V}$</td>
<td>air flow rate</td>
</tr>
<tr>
<td>$W$</td>
<td>width</td>
</tr>
<tr>
<td>$\beta$</td>
<td>air expansion coefficient</td>
</tr>
<tr>
<td>$\Delta T_o$</td>
<td>temperature difference</td>
</tr>
<tr>
<td>$\nu_{in}$</td>
<td>room air inlet velocity</td>
</tr>
<tr>
<td>$\nu_r$</td>
<td>mean room air velocity</td>
</tr>
<tr>
<td>$\rho$</td>
<td>air density</td>
</tr>
</tbody>
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