Chapter 15
Aerodynamic Isolation of Open Refrigerated Vertical Display Cases using Air Curtains

Mazyar Amin
Miami University, USA

Dana Dabiri
University of Washington, USA

Homayun K Navaz
Kettering University, USA

ABSTRACT
This chapter presents an experimental study on the effects of some of the most important variables that affect the infiltration rate in open refrigerated vertical display cases at steady operation. The variables were defined in dimensionless forms and were categorized in two groups. The goal was to examine the cross-effects of the first group (primary variables) by performing tests on the permutation of the variables, and to obtain some correction functions that contain the effects of the (secondary) variables thought to have smaller impact on infiltration. Tracer gas method, a new means to measure infiltration rate, is described and compared with other conventional methods. Most variables showed noticeable impacts on infiltration either linearly or non-linearly, some of whom did not show very well-defined patterns with infiltration, which indicates there are significant cross-effects among the variables. Others such as temperature difference and relative humidity showed no or negligible effects on infiltration.

INTRODUCTION
An air curtain is usually a straight rectangular or curved jet of air that is intended to separate two spaces that have different properties or characteristics such as different temperatures, relative humidity, and airborne particles such as dust, bacteria, flying insects, hazardous vapors. Air curtains have been widely used and incorporated as part of the HVAC system of buildings at the entrance of residential, commercial

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and industrial buildings. They have other applications in protecting artwork (de Santoli et al. (2005)), fire protection in tunnels (Juraeva et al., 2014; Felis et al., 2010; Guyonnaud et al., 2000), and incineration process (Schapiro, 2002).

Perhaps the second common application of air curtains is in open refrigerated display cases (also called open refrigerated display cabinets), which are normally used to store medium-temperature food products such as unfrozen dairies, meat and vegetables. These systems are manufactured in horizontal and vertical forms, but the focus of this work will be on the vertical type of the systems (Figure 1), which are hereafter called Open Refrigerated Vertical Display Cases (ORVDCs). The most commonly known reasons for having an open frontal area rather than closed are:

1. Increasing the accessibility of the food on the shelves to customers
2. Avoiding formation of a layer of mist on the glass doors after even short open duration, in the cases with doors

There are several heat sources that increase the cooling load in these systems:

- Radiation heat gain from the room and people, especially through the open front
- Radiation heat gain from lighting of the system
- Conduction heat transfer through the system walls

Figure 1. A typical ORVDC
(Courtesy of Hill Phoenix Company)
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