

**Design and Validation a Full Scale Experimental
Chamber with Interior Convective Heat Transfer**

by

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Master of Science in Electromechanical Engineering



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**Faculty of Science and Technology
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A thesis submitted in partial fulfillment of the
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Approved by _____
Supervisor

Date _____

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Abstract

DESIGN AND VALIDATION A FULL SCALE EXPERIMENTAL CHAMBER
WITH INTERIOR CONVECTIVE HEAT TRANSFER

by Calisto Lam

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The purpose of this thesis was to design, build and validate an experimental chamber for the study of interior convective heat transfer and indoor air quality. The full-scale chamber with interior dimensions 4.92m x 2.95m x 2.40m, was constructed with 0.04m walls, floor and ceiling. The facility was elevated 37cm above the lab floor and the walls were heavily insulated. By using a removable panel scheme, the room can be configured to study different geometries, different inlet and outlet combinations. A 1450W electrical heater was installed and a unique modular heated panel system was constructed in order to provide a heat source to the chamber. ASHRAE Standard 41.2-1987 (RA 92) was employed for volumetric air flow measurement. A platform moving measuring system had been built inside the chamber in order to measure the temperature at different locations. A water source heat pump provided chilled water to a fan-coil unit which in turn provided conditioned air to the chamber. Two sets of validation tests were performed (one with heat source and the other without heat source) in order to ensure the chamber can achieve the steady state condition and without any heat gain or loss. Two sets of experiment, by using tracer gas concentration decay method, to obtain the air change rate per hour in order to ensure the accuracy of the flow measuring box. Nine more experiments with different inlet and outlet configuration has been done in order to see the volatile organic compound concentration versus time after applying 25ml of paint on an acrylic board (25cm x 50cm). Additionally, an uncertainty analysis was performed for all experiments.

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LIST OF ABBREVIATIONS

VOC	volatile organic compound
TVOC	Total volatile organic compound
ACH	air changes per hour
CFM	volumetric flow rate (ft ³ /min)
EMF	electromotive force voltage
VFR	volumetric flow rate
A_{inlet}	air inlet area
VOL_{ROOM}	volume of the experiment room
ACFM	actual volumetric flow rate (ft ³ /min)
Q	heat gain from heater (W)
\dot{m}	mass flow rate
c	specific heat
T_{inlet}	air inlet temperature
T_{outlet}	air outlet temperature
C(0)	concentration of tracer gas at the beginning
C(t)	concentration of tracer gas at time equals to t

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