

研究生:	林俊賢
研究生(英文姓名):	Chun-Hsien Lin
論文名稱:	大型區域空調氣流精細控制之實驗與數值模擬研究
英文論文名稱:	Field Testing and Numerical Simulation for The Precise Thermal Control of Large L
指導教授:	柯明村
指導教授(英文姓名):	Ming-Tsun Ke
學位類別:	碩士
校院名稱:	國立臺北科技大學
系所名稱:	冷凍空調工程系所
學號:	92458015
學年度:	93
語文別:	中文
論文頁數:	171
關鍵詞:	大區域空調空間；分層空調；流體力學；空氣換氣率；射距
英文關鍵詞:	The large-scale air conditioner area ; Delaminate air conditioner ; computational fluid dynamics (CFD) ; air displacement rate ; throw
被引用次數:	0

【摘要】

本研究主要針對某國家研究中心的實驗區域進行空調氣流模擬分析，藉由實地量測空調系統作為計算流體力學(CFD)最合適該中心現況之送/回風口條件與配置，預測其效益性作為空調工程上的輔助與驗證。空調系統的優劣取決於送風口之平均面速度有關，噴流行經之距離則與送風速度、風量、送風口面積和速度分佈形狀有關連，因此、對於本文研究目的為確保精密儀器設備可在恆溫恆濕之空調環境下正常操作而且能減少量測誤差，探討如何使大型空間數值模擬分析與空調設計概念，嘗試提出符合實際現場要求之空調改善方式。研究顯示利用低溫差送風、適當的送室內氣流溫度均勻混合，可使該實驗區域內部之室內溫度變動能控制在 $\pm 0.5^{\circ}\text{C}$ 左右之範圍內。

【英文摘要】

This research simulates and analyzes the airflow in the experimental area of a national research center. According to the system, boundary conditions of computational fluid dynamics (CFD), can be deduced, and the airflow simulation of the present space under various design cases. The air side performance is predicted to provide assists and evaluate the air supplying system depends on the shapes and positions of the air outlets. Many researches show that in isothermal space of the outlet, and the jet distance is related to the velocity, volume, the mean area of the outlet and the distribution of the parameters of the air supplying system.

The goal of this research aims to ensure that the precision instruments in the research space air in an environment with low temperature fluctuations, and discuss the environmental temperature stability in a large space under simulation and analysis and the concept of air-conditioning system design, a design solution is proposed that fits the basic concept is to use raised temperature air supply (lowered the temperature difference between the space and the high air displacement rate (increasing the supply air flow rate) to take the sensible energy load away, make the air temperature within $\pm 0.5^{\circ}\text{C}$.

【論文目次】

目錄	
摘要	i
ABSTRACT	iii
誌謝	vii
目錄	ix
表目錄	xiii
圖目錄	xv
第一章 緒論	1

1.1 前言	1
1.2 背景	2
1.2.1 中心簡介	3
1.2.2 研究動機	6
1.3 研究目的	11
1.4 文獻回顧	12
第二章 研究方法	17
2.1 文獻方法探討	17
2.2 空調現場實測方法	18
2.3 理論數值方法	19
2.4 模擬假設	20
2.5 空氣分佈基礎理論[11]	20
2.5.1 空氣噴流特性	20
2.5.2 室內空氣擴散方式	31
2.5.3 空氣擴散性能指標	34
2.5.4 選擇與應用送風口之重要考慮因素	35
2.6 研究進行方式	37
第三章 量測設計及規劃	39
3.1 量測項目與注意事項	39
3.1.1 溫度量測	39
3.1.2 濕度量測	39
3.1.3 風速量測	39
3.1.4 壓力量測	40
3.1.5 流量量測	40
3.2 量測規劃	41
3.3 量測儀器及設備	42
3.4 量測進行方法	48
3.4.1 風速量測	48
3.4.2 電力量測	49
3.4.3 流量量測	50
3.5 現有空調設備檢討	50
第四章 空調負載估算與系統規劃	52
4.1 設備負荷	58
4.2 環境條件	58
4.3 通風系統規劃	59
4.3.1 風口設計考量	59
4.3.2 最佳性能的回風設計	64
4.3.3 鑲嵌型天花板擴散系統	64
4.4 工業應用	66
4.4.1 工業工作區域的熱標準	67
4.4.2 隔離熱源之熱曝曬控制	67
4.4.3 一般通風	67
4.4.4 局部送風	67
4.4.5 局部區域或點冷卻送風之準則	68
第五章 數值模擬	70
5.1 模擬軟體解析	70
5.2 模擬假設	71
5.3 數值理論	71
5.3.1 統御方程式	71
5.3.2 紊流傳輸模式	75
5.3.3 離散化方法	76
5.4 離散化方法與鬆弛因子	85
5.5 幾何外型	86
5.5.1 建構之CFD架構	86
5.6 邊界條件	90
5.7 收斂條件	93
5.8 穩態假設	94
5.9 格點獨立分析	95
5.9.1 空間格點獨立	95
第六章 結果與討論	101
6.1 實驗量測結果	101
6.1.1 空氣側溫度之監測	101

6.1.2 長期監測環境溫度	103
6.1.3 全日環境溫度監測	108
6.1.4 全日電力消耗監測	112
6.1.5 長期送/回風溫度監測	115
6.1.6 現場量測結果	118
6.1.7 空調箱容量量測	120
6.2 模擬結果	122
6.2.1 現況模組 case 0	123
6.2.2 改善模組 case 1 (VUM)	127
6.2.3 改善模組 case 2 (VTDUM)	130
6.2.4 改善模組 case 3 (VTUM)	134
6.2.5 理想模組 case 4	137
第七章 建議與檢討	141
7.1 空調系統量測與評估	141
7.1.1 現場量測	141
7.1.2 空氣側評估	141
7.1.3 冰水測評估	143
7.1.4 儲能環內部電力負載估算	144
7.1.5 現有空調系統評估	144
7.2 模擬結果討論	145
7.2.1 實際狀態與模擬討論	145
7.2.2 改善方案之模擬討論	146
第八章 結 論	159
8.1 模擬步驟	159
8.2 實驗與模擬方法比較	159
8.3 實際現況與模擬改善	161
8.4 改善設計建議	164
參考文獻	166
符號彙編	168

[參考文獻]

參考文獻

- [1] Cebeci, T., et al., "A General Method for Calculating Three-Dimensional Compressible Laminar and Turbulent Flow," 1997.
- [2] Baldwin, B.S. and Lomax, H., "Thin Layer Approximation and Algebraic Model for Separated Turbulent Flow," 1978.
- [3] Agarwal, R.K. and Bower W.W., "Navier Stokes Computations of Compressible 2D Impinging Jet Flowfield," 1980.
- [4] Agarwal, R.K. and Bower W.W., "Navier Stokes Computations of Turbulent Compressible 2D Impinging Jet Flowfield," 1980.
- [5] Looney, M.K. and Walsh, J.J., "Mean Flow and Turbulent Characteristics of Free and Impinging Jet Flows," 1980.
- [6] Launder, B.E. and Spalding, D.B., "The Numerical Computation of Turbulent Flows," Computer Methods in Applied Mechanics, 1974.
- [7] Launder, B.E., Pridden, C.H., and Sharna, B.I., "The Calculation of Turbulent Boundary Layers on Spinning Discs," 1997.
- [8] Lin, R.S. and Chang, K.C., "Predictions of Free Jet Flow Field Using Various Turbulence Models," J of the Chinese Society of Mechanical Engineers, 1997.
- [9] Yu, etc. "Three-Dimensional Calculation of Supersonic Reacting Flows Using an LU Scheme," Sverdrup Technology, Cleveland, Ohio, 1989.
- [10] Chen, Q., "Comparison of Different Models for Indoor Airflow Computations," Numerical Heat Transfer, Part B, 1997.
- [11] "Space Air Diffusion," ASHRAE Fundamentals Handbook, ch. 32, 2001.
- [12] Suhas V. Patankar, "Numerical Heat Transfer And Fluid Flow," HEMISPHERE PUBLISHING CORPORATION, 1980.
- [13] H. Xing, A. Hatton, H. B. Awbi, "A Study of Air Quality in the Breathing Zone in a Room with Displacement Ventilation," 1999.
- [14] Joseph C. Lama, Apple L.S. Chanb. "Cfd Analysis and Energy Simulation of a Gymnasium," Building Environment, 2001.

-
- [15] Juan Abanto, Daniel Barrero, Marcelo Reggio, Benoit Ozell, “Airflow Modeling in a Computer Room,” Bu
-
- [16] David S. Dougan, and Leonard A. Damiano, “Ventilation for Acceptable Indoor Air Quality,” ASHRAE Sta
-
- [17] “Design and Application of controls,” ASHRAE HVAC Applications, ch. 46, pp. 46.1-46.19, 2003.
-
- [18] Qingyan Chen, Ph. D.,” Couputational Fluid Dynamics for HVAC: Successes and Failures,” ASHRAE T
-
- [19] H. K. Versteeg and W. Malalsekera, An introduction to computational fluid dynamics The finite volume meth
-
- Technical, New York: Wiley, 1995.
-
- [20] ” Hvac Computational Fluid Dynamics,” ASHRAE Fundamentals Handbook, ch. 33, 2001.
-
-