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論文名稱(中) 超級市場節能技術之研究

論文名稱(英) A Study on Energy Saving Techniques for Supermarkets

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關鍵字(中) 超級市場

冷凍系統

開放型展示櫃

溼度

節能

模擬

關鍵字(英) Supermarket

Refrigerating System

Display case

Humidity

Energy Saving

Simulation

摘要(中) 超級市場中以冷凍系統所佔耗能比例最大，適度降低賣場溼度等於提高舒適度，空調耗能增加冷凍則減少，溼度與耗能之間存在最佳化的操作點。本論文依據台灣氣候特性，以提高能源使用效率之目的，進行全年實測研究與使用含有冷凍模組之 DOE-2 動態模擬程式，解析超級市場各項耗能因子，建立九種不同空調除濕模式、四種不同冷凍系統並聯模式，分析賣場空間相對溼度對冷凍空調系統產生之效應，並結合各項節能手法達系統之最佳化。

開放型展示櫃設備最具節能潛力者為除霜控制的改善，熱氣除霜定時定溫建築節能達 8.8%為最高，低溫櫃壓縮機熱氣旁通容量控制 5.7%居次。在具熱回收前提下，最節能的空調除濕模式為低溫送風具除霜及防汗控制之固體吸附式，在 25℃ 最佳相對溼度設定點為 60%其建築節能達 19.22%，當冷凍系統最佳化後，在相同條件下節能潛力由 19.22%提升至 23.36%。

摘要(英) The refrigerating system accounts the highest percentage of energy consumption of the supermarket. When the market place humidity is reduced appropriately, the space comfort level will be improved and the energy consumption of the air conditioning system increases, however the energy consumption of the refrigeration system will be reduced. Hence there is an optimum operation point existing between humidity and energy consumption. Base on the characteristic of climate in Taiwan and the purpose of increasing energy use efficiency, this thesis have conducted round-the-year field study and used DOE-2 dynamic simulation program which includes Refrigeration Module to analyze various energy consuming factors of supermarket and established 9 different air-conditioning dehumidification model and 4 different paralleled refrigerating system modes for analyzing the influences of relative humidity of market space on the refrigerating and air-conditioning system. Different energy saving approaches are incorporated to achieve the system optimization.

This thesis shows the defrost control is the most energy-saving potential measure. Among the several energy saving techniques, the hot-gas defrost system with the time initial and temperature terminate control mode is the most visible measure, saving about 8.8% of the building energy. The next one is the compressor hot-gas by-pass volume control with 5.7%. The most energy-saving dehumidification method of the air-conditioning system is the solid desiccant system incorporated with the defrost and anti-sweat control, the heat-recovery for regenerating the desiccant, and the

low-temperature supply air. Under 25 °C space temperature condition, 60% is the best set-point relative humidity, the building energy saving can reach as high as 19.22%, and when the optimization of refrigeration system is arrived, under the same condition, the energy saving potential lifted to 23.36% from 19.22%.

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- [1] 行政院主計處 URL: <http://www.dgbas.gov.tw/dgbas03/> , 2003.
- [2] Adams P., " Intereffects of supermarket refrigeration and air conditioning, " ASHRAE Journal , 1985, 67(Oct):38-40.
- [3] Howell, R.H., and P. Adams, Jr, " Effects of indoor space conditions on refrigerated display case performance, " Final Report, 1991, ASHRAE-596 RP.
- [4] Howell, R.H. " Effects of store relative humidity on refrigerated display case performance, " ASHARE Transactions, 1993a, 99(1):667-678.
- [5] Howell, R.H. " Calculation of humidity effects on energy requirements of refrigerated display cases, " ASHRAE Transactions, 1993b, 99(1):679-693.
- [6] Arthur D. Little, " Energy Savings Potential for Commercial Refrigeration Equipment, " Final Report, prepared for the U.S. Department of Energy, 1996.
- [7] Michael J. Brandemuehl, and Mukesh K. Khattar, " Demonstration and Testing of an All-Electric Desiccant Dehumidifying System at a New Jersey Supermarket, " ASHRAE Transactions, 1997, 103(1).
- [8] Orphelin M., and D. Marchio, and S. D ' Alanzo, " Are there optimum temperature and humidity set points for supermarkets? " ASHRAE Transactions, 1999, 105(1):497-507.
- [9] Khattar M., and H. I. Henderson, " Impact of HVAC control improvements on supermarket humidity levels, " ASHRAE Transactions, 1999, 105(1):521-532.
- [10] Sweeter R., " Supermarket relative humidity and display-case performance, " Heating, Piping, Air Conditioning Engineering, 2000.
- [11] 蔡尤溪、李文興，醫療百貨類建築耗能總量調查之研究，內政部建築研究所專題研究計畫期末報告，2000。
- [12] 李魁鵬、蔡尤溪，「百貨類建築之耗能監測解析結果與節能潛力分析」，建築物能源管理技術國際研討會，經濟部能源會，2002。
- [13] 李魁鵬，冷凍系統對百貨類建築耗能之影響性研究，國科會研究報告 NSC 91-2211-E-027 -010，2003。
- [14] USDOE, DOE-2 Engineers Manual, Technical Information Center USDOE, Version 2.1A , pp.301~308.
- [15] ASHARE Handbook, HVAC Systems and Equipment, Chapter 22 Desiccant Dehumidification and Pressure Drying Equipment, ASHARE, 2000.
- [16] ASHARE Handbook, Fundamentals, Chapter 19 Refrigerants, ASHARE, 2001.
- [17] ASHARE Handbook, Refrigeration, Chapter 47 Retail Food Store Refrigeration and Equipment, ASHARE, 2002.
- [18] ASHARE Handbook, Refrigeration, Chapter 5 Refrigerant System Chemistry, ASHARE, 2002.
- [19] Datta, D. and S.A. Tassou, " Artificial neural network based electrical load prediction for food retail stores, " Applied Thermal Engineering, Vol. 18, 1998, pp.1121-1128
- [20] Hosoda T.N and Uzaishi H. " Effects of frost on Heat Transfer Coefficient ' ' , Hitachi Revue, Vol. 16, No. 6, 1967.
- [21] Howell, R.H., L. Rosario, and A. Bula, " Effects of indoor relative humidity on refrigerated display case performance, " Proceedings of CLIMA, 2000.
- [22] James J. Hirsch & ASSOCIATES, Building Energy Use and Cost Analysis Program : Dictionary, DOE-2.3 Refrigeration, Vol 2, 2003, pp.49.
- [23] Luis Rosario and Ronald H. Howell, " Relative humidity and temperature measurements and predictions in

supermarkets, " ASHRAE Transactions , 2001, 107(2):415-423.

[24] McQuiston F. C. and J. D. Parker and J. D. Spitler, Heating, Ventilating, and Air Conditioning Analysis and Design,5/E, New York : McGraw-Hill, 2000, pp.49~81.

[25] Stoecker W. F. and J. W. Jones, Refrigeration and Air Conditioning,2/E, New York : McGraw-Hill Book Company, 1982, pp.205~220, pp.281~293.