國立臺北科技大學
機電整合研究所

碩士學位論文

動態調變電壓激發角最佳化冰箱耗能

Dynamic modulation of voltage excitation angle to optimize energy consumption of the refrigerators

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研究所碩士學位論文口試委員會審定書

本校 ＿＿機電整合＿＿ 研究所＿吳冠霖＿ 君

所提論文＿＿動態調變電壓激發角最佳化冰箱耗能＿＿

經本委員會審定通過，合於碩士資格，特此證明。

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摘　要

論文名稱：動態調變電壓激發角最佳化冰箱耗能

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關鍵詞：冷藏冰箱、電壓激發角、雙向性三極閘流體、耗能、節能率

本研究將動態調變電壓激發角技術(Dynamic modulation of voltage excitation angle)應用在冷藏冰箱上，使冷藏冰箱在最佳耗能狀態下運轉，此技術是利用半導體元件雙向性三極閘流體 (Tri-electrode ac switch, Triac) 作為調控電壓激發角之元件，並開發出新型節能控制器 (novel energy saving controller, NESC)，以冷藏冰箱作為實驗負載設備，主要是因為冷藏設備必須全天 24 小時運轉，而人類對冷藏設備帶來的便利性依賴相當高，但是冷藏設備的高耗電量也成為許多產業的成本負擔。因此透過本研究新型節能控制器能改善壓縮機耗能過多的問題，並達到節能的效果。實驗目的主要驗證此新型節能控制器的可行性，在維持冷藏冰箱未改變製冷能力的條件下，達到節能的目標。實驗設計紀錄 1 小時靜態關門測試與模擬使用狀態的動態開關門測試，分別得到節能率 20.48%與 12.88%。冷藏冰箱是 24 小時運轉不停機的設備，在安裝新型節能控制器後，紀錄一天最佳耗

能為 6.597kWh $24h^{-1}$，與市電耗能比較下降 22.41%。本研究以電流、功率、冰箱內部溫度與濕度和壓縮機機殼溫度為實驗架構參數，控制邏輯是經由感測電流作為回授訊號再決定電壓調變範圍，最後比較冷藏冰箱內部溫濕度變化，驗證製冷能力未被改變。本研究新型節能控制器接法設計為外掛串聯式，不改變原始冰箱內部的結構，安裝便利，使未來廣泛推廣此新型節能控制器的可行性更為增加。

ABSTRACT

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In this study, we applied a dynamic modulation of voltage excitation angle technology, to a refrigerator so that the refrigerator operates at an optimum energy consumption. This technique utilizes a semiconductor element, Tri-electrode AC switch (TRIAC), as a regulatory element for modulating the voltage excitation angle. Thus, a novel energy saving controller (NESC) was successfully developed, and a refrigerator was used as the experimental load equipment. Refrigerators are normally operated 24 hours a day, 365 days per year; so the high power consumption of refrigerators has become a cost burden for many industries. Therefore, through this study, the problem of excessive energy consumption of refrigerators can be improved

by the proposed NESC and thus, achieve the energy-saving effect. In this study, we first validated the feasibility of the proposed NESC; tests were performed where the door is closed for one hour and a dynamic simulation of normal use where the door is opened and closed periodically in one hour. The energy-saving rates obtained were 20.48% and 12.88%, respectively. In addition, a long period of one day tests on refrigerator was also conducted w/o NESC, and the best power consumption was measured at 6.597kWh $24h^{-1}$. An energy-saving rate of 22.41% was achieved. In this study, current, power, temperature and humidity inside the refrigerator compartment, and the compressor casing temperature are considered as the experimental parameters and were monitored during the test. The sensing current is taken as the feedback signal to determine the voltage modulation range. The proposed NESC is designed to be connected externally in series, without changing the original structure inside the refrigerator and it is easy to install.