國立臺北科技大學
機電整合研究所

碩士學位論文

以恆速控制技術應用於機具提升節能效率

Manufacturing Machine Energy Efficiency Enhancement by Application of Constant Speed Control Technique

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中華民國 105 年 7 月

國立臺北科技大學
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 詹致嘉 君

所提論文 以恆速控制技術應用於機具提升節能效率

經本委員會審定通過，合於碩士資格，特此證明。

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中 華 民 國 105 年 07 月 21 日

摘　要

論文名稱：以恆速控制技術應用於機具提升節能效率

頁數：56

校所別：國立臺北科技大學　　機電整合研究所

畢業時間：一百零四學年度第二學期

學位：碩士

研究生：詹致嘉

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關鍵詞：製程機具、節能、負載控制、矽控整流器

目前國內提高電動機用電效率的研究，並未給予系統化的方式去改進電動機用電的效率，使能迅速判斷用電系統是否最佳化。因此若能藉由系統化方法檢討電動機的用電狀況，降低運轉用電成本，將可作為效率差之老舊電動機是否更換為高效率電動機之替代方法。本研究將使用一種恆速的控制技術應用在製程機具上，依據電動機負載變化量利用最佳化控制觸發 SCR (Silicon Controlled Rectifier, SCR)元件進行相位角度的改變，使電流合理下降以符合電動機最適當之電壓輸出並提供機具最佳扭力輸出，輸出功率可以隨著製程負載的變化而改變；因此在低負載時可以節省不需要浪費的電力，反之當機具高負載運轉時則有效提供扭力需求，有效降低耗能。而本技術不影響原本的機具之運轉狀態，相較於使用變頻器的節能方法，不但未改變電動機轉速，僅在機具外掛一個裝置做最佳化的控制。本研究實際應用於石材廠內的拉鋸機與汙水處理廠內的調節泵，以無裝與有裝進

行驗證比較如: 運轉電流、平均消耗功率與 24 小時耗能度數，拉鋸機此實例節能率分別達到 20%、38.87%與 48.36%，拉鋸機設備每天以 24 小時運轉，以運轉天數 350 天估計，一年預計可以節省耗能度數約為 187,915kWh，減少碳排放量約為 97,903kg，而在調節泵實例中，30 分鐘的累積耗能度數比較下得到 33%的節能率。相較於耗能設備常使用變頻器為節能的方式，本研究控制技術具有自動偵測負載變化能力，其主要可應用在製程中不能改變轉速之設備，提升整體電動機運轉效率並產生節能效果，未來更能廣泛運用到各種行業上，達到產業升級的作用。

ABSTRACT

Title：Manufacturing Machine Energy Efficiency Enhancement by Application of Constant Speed Control Technique

Pages：56

School：National Taipei University of Technology

Department：Graduate Institute of Mechatronic Technology

Date：July, 2016

Degree：Master

Researcher：Chih-Chia Chan

Advisor：Ho-Chiao Chuang

Keywords：Manufacturing machine, Energy-saving, Load control, Silicon Controlled Rectifier (SCR)

This study presents a constant speed control technology applied to the manufacturing process equipment. According to the amount of change of electrical motor (EM) load, a Silicon Controlled Rectifier (SCR) element was used to modulate the phase angle so that the current drops accordingly, to meet the most appropriate output voltage of the EM and providing machine the best torque output. The changes in output power of the EM varies along with different process load, so the unnecessary electricity at low loads of EM can be saved; however, when the equipment is during a high-load operation period, the proposed technique provides a proper torque for it, and thus, reducing the power consumption. The present technique, energy saving technique by constant speed control (ESTCSC), does not affect the ordinary machine, it is just to modulate the load according to the dynamic load

variation of machine. Compared with the most popular inverter, the proposed ESTCSC does not change the EM speed, and it is only an easy and low cost plug-in device. In this study, the proposed ESTCSC was practically applied to the sawing machine in stone industry. The validation experiments were conducted w/o installing the ESTCSC, and the measured total saving rates for operating current, average operating power consumption and 24 hours long-term energy consumption were 20 %, 38.87% and 48.36%, respectively. Because the sawing machine normally operates for 24 hours per day and 350 days per year, the estimated annual energy savings of approximately is 187,915 kWh, reducing carbon emissions of about 97,903kg. With the adjusting of the pump as an example, the energy saving rate achieved from the accumulated consumption after 30 minutes was 33%. Therefore, compared with the frequently used equipment, inverter, for energy-saving purpose, the proposed ESTCSC is functioned with automatic detection of changes in load capacity. Its main applications are the machines that must be with constant speed in the manufacturing process, to improve the overall operational efficiency of EM and achieve the energy-saving effect. Furthermore, it is also suitable for many potential applications in various industries in the near future, to achieve the industrial upgrading effect.