SUSTAINABLE MANUFACTURING : OPTIMIZATION OF ELECTRICAL ENERGY CONSUMPTION IN PLASTIC INJECTION MOLDING PROCESS

By

NUR ANIS OTHMAN

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Universiti Utara Malaysia

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ABSTRACT

This research discussed the optimization energy consumption in injection molding process to meet energy efficiency in production and get an optimal parameter setting. Injection molding is one of the techniques used in producing plastic product by injecting plastic materials molten by heat into a mold and then cooling and solidifying. It is a very complex process due to various parameters that must be considered. At this time, the industry manufacturer plastic consumes high electrical energy to produce plastic product. This in turn will release carbon dioxide gas which can have adverse effects on the environment. In this research, the all-electric injection molding machine is used because of this machine proven consume less energy compare with hydraulic and hybrid machine. Hence, this gives an advantage to the manufacturer to reduce the energy consumption from the optimization process. To optimal setting up of injection molding process, variables play a very important role in reducing electrical energy consumption to produce product. The variables involved to control settings are holding pressure, injection pressure, injection speed, mold open/close speed and screw rotation speed. Furthermore, this research presents a simple and efficient way to optimize parameter setting in injection molding process by using Taguchi experimental method and signal-to-noise ratio. With using both methods, optimal parameter settings can be achieved. In this research, an orthogonal array (OA) and signal-to-noise (S/N) ratio are employed to conduct optimization of injection molding parameter. As a result, optimization in injection molding can create the better process parameter settings which can not only reduce electrical energy consumption but, be more robust and also enhance the stability of injection process. In addition, this in turn will contribute towards sustainable manufacturing processes and reducing the carbon dioxide emissions.

Keywords: Injection molding machine, optimization, parameter setting, Taguchi Method, sustainable manufacturing

ABSTRAK

Kajian ini membincangkan penggunaan tenaga yang optimum dalam proses pengacuan suntikan untuk memenuhi kecekapan tenaga dalam pengeluaran dan dapat mengoptimumkan penetapan parameter. Pengacuan suntikan adalah salah satu teknik yang digunakan dalam menghasilkan produk plastik dengan menyuntik bahan plastik lebur dengan haba ke dalam acuan dan kemudian menyejuk dan memejal. Ia adalah satu proses yang sangat kompleks kerana pelbagai parameter yang perlu dipertimbangkan. Pada masa ini, pengeluar industri plastik menggunakan tenaga elektrik yang tinggi untuk menghasilkan produk plastik. Ini seterusnya akan membebaskan gas karbon dioksida yang boleh memberi kesan buruk kepada alam sekitar. Dalam kajian ini, semua-elektrik mesin pengacuan suntikan digunakan kerana mesin ini terbukti menggunakan tenaga yang kurang berbanding dengan mesin hidraulik dan hibrid. Oleh itu, ini memberi kelebihan kepada pengeluar untuk mengurangkan penggunaan tenaga melalui proses pengoptimuman. Tetapan optimum daripada pembolehubah proses pengacuan suntikan memainkan peranan yang amat penting dalam mengurangkan penggunaan tenaga elektrik untuk menghasilkan produk. Pembolehubah yang terlibat untuk mengawal tetapan ialah memegang tekanan, tekanan suntikan, kelajuan suntikan, acuan terbuka kelajuan / rapat dan skru kelajuan putaran. Tambahan pula, kajian ini membentangkan satu cara mudah dan berkesan untuk mengoptimumkan tetapan parameter dalam proses pengacuan suntikan dengan menggunakan kaedah eksperimen Taguchi dan dan isyarat-kepada-hingar. Dengan menggunakan kedua-dua kaedah ini, tetapan parameter yang optimum dapat dicapai. Dalam kajian ini, pelbagai ortogon (OA) dan isyarat-kepada-hingar (S / N) digunakan untuk menjalankan pengoptimuman pengacuan suntikan parameter. Hasilnya, pengoptimuman dalam pengacuan suntikan boleh membina proses tetapan parameter yang lebih baik yang bukan sahaja boleh mengurangkan penggunaan tenaga elektrik tetapi, menjadi lebih mantap dan juga meningkatkan kestabilan proses suntikan. Di samping itu, ini seterusnya akan menyumbang kepada proses pembuatan yang mampan dan mengurangkan pengeluaran karbon dioksida.

Kata kunci: Suntikan mesin pengacuan, pengoptimuman, tetapan parameter, Taguchi Kaedah, pembuatan mampan

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LIST OF ABBREVIATIONS

Abbreviations

ANN	Artificial Neural Networks
ABC	Artificial Bee Colony Algorithm
CO2	Carbon Dioxide
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWh	Gigawatt Hour
IMM	Injection Molding Machine
kWh	Kilowatt-hour
MSD	Mean Square Deviation
OA	Orthogonal Array
ROI	Return of Investment
S/N	Signal to Noise Ratio

CHAPTER ONE

INTRODUCTION

1.1 Introduction to the Study

Electricity is the main source for daily life and now it is classified as primary human need. In Malaysia, 90% of electricity generation is divided into two sources in which 60% is from gas and 30% from coal, while the rest of 10% is from hydro and oil (Bakar, 2011). Electricity is used in various sectors including domestic, industrial, enterprise, agriculture and education and so on. In this country, the electricity demand has recorded an increase of 6.1% per year (Consumer Research and Resource Centre, 2012). The electrical energy is generated almost every day to meet the needs of users in daily life. Demand for electricity in Peninsular Malaysia in 2010 continued to increase over 2009 of 7.8% from 94.748 in 2009 to 102.139 GWh (Energy Commission Report Malaysia, 2010). The sources used to generate electricity are based on oil, gas and coal which cannot be renewed due to the shortage of these resources.

Electricity is the most important element in an operating system of a residential or commercial building. Some of the systems within a building include lighting system, air conditioning system, motor equipment systems, communication systems, production systems and etc. The absence of electricity causes the system to stop its work as well as affect the activity of users in various sectors to do their work effectively.

The contents of the thesis is for internal user only

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