PARAMETRIC STUDY OF LASER MARKING PROCESS USING GREY TAGUCHI METHOD UTILIZING FIBER LASER SYSTEM FOR AISI 304 STAINLESS STEEL

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRACT

The laser marking process is a laser-assisted material removing machining technique which utilize heat to remove the material. In laser marking process, the surface of material is heat up and subsequently vaporize the work piece. The study reviews the different laser marking procedure with various input parameters which are taken for different work piece materials. It is difficult to obtain and optimize the cross-relation between the design parameters with input factors that contribute to the output performance factor. This study parametrically optimizes the fiber laser marking parameters for stainless steel AISI 304. The purpose of study is to have marking's quality with short period of time prediction to ensure a lower cost optimization approached. With the use of Grey Taguchi method for the laser marking, different design parameters and input factors are possible to be optimized for better output performance. Design of experiment of the fiber laser marking process was conducted on AISI 304 stainless steel material. L9 orthogonal array was applied it means 9 set of laser marking samples setup were tested. The research applied frequency, marking speed and marking loop as input parameters while the output parameters were the surface roughness, indentation and material removal rate. Based on the design of experiment for the Grey Taguchi approach, an optimum fiber laser design parameters were calculated with the consideration of noise ratio factor. Various process response behaviors were taken into account for full spectrum of the fiber laser marking performance ability. By interpret the Grey Taguchi results, it was concluded that the best setup were at frequency 60 Hz., speed 800mm/s and mark loop at 30 times. It is concluded by verification test, the optimization setup shows a good laser marking performance. The effect of the input parameters were frequency is 33.11 %, marking speed is 24.79% and marking loop is 14.99 % for the optimized laser marking process.

ABSTRAK

Proses penandaan laser adalah teknik penyingkiran bahan berbantukan laser yang mana menggunapakai haba untuk menyingkirkan bahan. Didalam proses penandaan laser, permukaan bahan kerja dicairkan dan seterusnya bertukar kepada wap. Pembelajaran ini mengkaji prosedur penandaan laser yang berbeza dengan pelbagai parameter masukan untuk bahan kerja yang berbeza. Ianya agak sukar untuk menghasilkan dan mengoptimumkan hubungan perkaitan parameter rekabentuk diantara faktor masukan yang menyumbang kepada prestasi faktor keluaran. Dengan menggunakan kaedah Grey Taguchi untuk penandaan laser, beberapa parameter rekabentuk dan faktor input yang berbeza berpotensi dioktimumkan bagi mendapatkan prestasi yang lebih baik. Rekabentuk eksperimen bagi process penandaan laser fiber dijalankan keatas bahan keluli tahan karat AISI 304. Susunan ortorgonal L9 telah digunakan. Ini bermaksud 9 set pelarasan penandaan laser telah diuji. Kajian ini menggunakan frekuensi, kelajuan ukiran dan bilangan lepasan sebahai parameter masukan manakala parameter keluaran adalah kekasaran permukaan, lekukan dan kadar penyingkiran bahan. Berdasarkan rekabentuk eksperimen Grey Taguchi, rekabentuk penandaan laser fiber dikira dengan mengambikira faktor ratio hingar. Pelbagai ciri-ciri tindak balas proses diambilkira dalam mendapatkan gambaran penuh prestasi proses penandaan laser fiber. Dengan mengintrepretasi keputusan Grey Taguchi, disimpulkan bahawa penataan terbaik adalah pada frekuensi 60 Hz., kelajuan 800 mm/s dan bilangan lepasan adalah sebanyak 30 kali. Sebagai kesimpulan, dengan ujian verifikasi, pelarasan yang terbaik menunjukkan hasil prestasi penandaan laser yang baik. Kesan parameter masukan frequency adalah 33.11 %, kelajuan penandaan adalah 24.74 % dan bilangan lepasan adalah 14.74 % untuk proses penandan yang terbaik.

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