Chapter 7

Optimization of Laser Transmission Welding Parameters Using Chicken Swarm Optimization Algorithm: Chicken Swarm Algorithm Optimization of Laser Transmission Welding

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ABSTRACT

The ever-increasing demand of high quality joints with improved cycle times leads the industries, those involve welding of plastics, to use laser for welding plastics. Laser transmission welding is the latest development in the field of welding of plastics. In present research work, experimental investigation, parametric modeling and optimization of laser transmission welding of polycarbonate is carried out. A systematic experimental plan is executed using central composite design of response surface methodology (RSM). Mathematical models are developed using RSM for establishing an interrelationship between the process parameters and the responses of interest. Chicken swarm optimization (CSO) algorithm is employed with the developed RSM models to set the optimal process parameters combinations to achieved desired weld qualities. Here, the objectives are set as to increase the weld strength and decrease the weld width independently, as well as simultaneously. The interdependent parametric trends are also studied and discussed.

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1. INTRODUCTION

Now-a-days, the applications of plastics can be found almost everywhere, from a simple product to the extremely hi-tech. As the use of plastic components become more widespread, joining techniques play an important role in their processing. Since making the complex plastic components in one piece is not always practical and cost effective, various joining techniques have been developed including plastic adhesive joining, mechanical fastening and welding. The general advantages of welding techniques over other joining techniques are the fast and easy processing, tightness of the joint and high strength. The most widely used plastic welding procedures are hot gas or hot tool welding, vibration welding, and ultrasonic welding. In the case of hot gas and hot tool welding the residues and contaminations may result in undefined weld strength of weld zone. Again, the fluff development in the ultrasonic welding is still a problem (Herfurth et al., 1999; Bonten and Tüchert, 2002).

In this context, more favorable presupposition is offered by heating of infra-red radiation, because the heat is transmitted without any contact to the plastic parts. Infra-red radiation can be transmitted by infra-red lamps and also by infra-red lasers. Laser can be used in two general ways: (i) irradiating the surfaces to be joined directly or (ii) passing through one transparent material and directly heating only the second material, precisely at the mating surface. This later process is known as laser transmission welding (LTW) process. This is a clean and flexible process for joining similar or dissimilar plastics (Baylis, 2002). In this process the heat is generated at the joint interface, the area where melting is required to join the mating surfaces, thus, reducing the energy input to a minimum (Hansch et al., 1998). Figure 1 shows the operational procedure of laser transmission welding process.

*Figure 1. The working principle of laser transmission welding*