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Estimation of welded joint strength using genetic algorithm approach

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Abstract

The genetic algorithm approach is extended to the estimation of mechanical properties of the joining of brass materials. The mechanical properties of joint parts can be improved by selecting suitable parameters. The strength of the joint parts is affected by many factors, such as the gap between the parts, the torch angle, the quantity of the shielding gases, the pulse frequencies and the electrode tip angle during welding operations. Since all these factors affect the mechanical properties of the welded joint parts, the effects of these parameters need to be cautiously investigated. The present paper describes the use of the stochastic search process that is the basis of Genetic Algorithms (GA), in developing the strength value of the welded parts. Non-linear estimation models are developed using GAs. Developed models are validated with experimental data. The Genetic Algorithm Welding Strength Estimation Model (GAWSEM) is developed to estimate the mechanical properties of the welded joint for the brass materials. The effects of five welding design parameters on the strength value using the GAWSEM have been examined. The results indicated that the changes of the gap between the joint parts and the torch angle have an important effect on the welded joint strength value and the optimum quantity of the shielding gas and the pulse frequencies exist in the tensile strength of welded joints.

Keywords: Welded joint strength; Genetic Algorithm; Joint strength; Brass; Torch angle; Electrode tip angle; Shielding gas

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1. Introduction

Within the last decades the drive to create joined materials which can withstand ever increasing stresses, temperature and manufacturing effects has led to the investigation of adhesively bonded materials and welded material's behavior. Brass materials are widely used as engineering materials in industry because of their high strength, high corrosion resistance, high electrical and thermal conductivity. They are easily shaped and possess a pleasant appearance. The efforts to supply good quality welding and increase the strength of joining materials is very important since many factors controls the welding. The strength of welded joints are affected by many factors; such as, the gap between the joined parts, the evaporation of materials, the torch angle, the quantity of the shielding gases, the pulse frequencies and the electrode tip angle etc. during welding operation. It is very important to select the welding process parameters to obtain optimal weld quality [1,2].

The evaporation of the some elements during welding is the primary disadvantage of the welding of the brasses. The main problem of these alloys in fusion welding is the evaporation of the zinc and copper during the welding process. Zinc with the lower boiling temperature evaporates before copper [3]. The amount of zinc in the alloy is reduced due to evaporation and causes a porous welding bead and then the brass material loses its physical and chemical properties which it normally possesses.

One important factor effecting the weldability of materials that have a high coefficient of thermal expansion such as copper, zinc etc. is the gap between the joined parts. The gap between joined plates has an important role in the conventional Tungsten Inert Gas (TIG) fusion welding [4]. The heat on the weld pool that causes the tensile and compressive stresses both during and after the welding, result in distortion and expansion of the materials that cause the increase of the distance between joined plates of the unwelded sections [5]. Welding stresses which would probably appear after the welding are likely to be reduced by choosing suitable welding process parameters [6].

Montgomery [7] carried out several experiments in order to observe the effect of the torch angle. He stated that the change in the torch angle resulted in the change of welding current which is the major causal factor on the evaporation. The reason of the change could be explained due to the fact that as the electrode angle increases the effective arc length increases, and hence a decrease in welding current is observed. The quality of the weld generated is generally higher when the torch follows the joint at an angle which is not too sharply inclined to either surface being welded. The change on torch angles has showed that the torch angle has a big influence on the weld bead penetration. Torch angles between 75° and 90° give quality well penetrated welding. Below these angles the torch angle results in low weld bead penetration due to the reduced heat on the welding surface [8].

Another important factor to affect the property of the welded joint of brass materials is the quantity of the shielding gas. The studies conducted by Jakobi [9] indicates that the weld should be shielded by enough inert gas on both sides in order to prevent the increment of zinc and copper oxidation during welding and the gas-nozzle should have a reduced outlet in order to avoid gas-turbulence that increases the zinc evaporation. The minimum flow rate is determined by the need for a stiff stream of shielding gas to overcome the heating effects of the arc and local cross drafts. Turbulence in the gas flow system can cause instabilities in the welding arc [10].