Abstract

This thesis is concerned with the study of friction stir welding and process for the aluminum alloy 2024-T3, from which 5 mm sheets were chosen for the experimental work, a threaded pin with a diameter of 6 mm and a shoulder of 18 mm was used.

The welding process was performed at different rotational speeds and variable feeding rates. A conventional milling machine was used to perform the welding processes, the specimens were tested to determine the best ultimate tensile strength (σσRult) and the maximum elongation and compared with the as received metal.

The microhardness distribution and microstructure were also investigated during this research and were found to be similar to results of previous studies on the same subject in both orientation and distribution. The minimum microhardness values recorded were 66% of base metal in the HAZ , 71% of base metal in NZ and the maximum elongation and compared with the as received metal.

In addition to friction stir welding (FSW), another phase of welding called friction stir process (FSP) was also used. The best specimens from the first welding process conditions were selected, and the optimum rotation speed and feeding speed in the feeding direction were determined. It was found that the best result is in forward welding travel and counter clockwise tool rotation.

For the second process (FSP), the microhardness and microstructure were again investigated, and the distribution of the microhardness was found to be similar to that of the first welding process in distribution.
The tensile properties was studied for the different welding processes, and from the results, it was found that the maximum tensile strength reached in stir welding process was 72% of the base metal and didn't improve in the FSP process significantly (about 3%).

On the other hand, when the applied bending stress was 185 MPa , the fatigue life didn't exceed 1.3 x10^6 cycle in the best conditions with a single pass FSW while it exceeded 10^7 cycle in double pass process (FSW and FSP) , and this is regarded as a dramatic improvement in the fatigue lives under the dynamic conditions.

A simulation system was constructed by using a neural network (Elman's method), and it is consisted of two parts, the first one is the system identification, from which a mathematical representation for the FSW system was derived. In the second part, a control system was designed by using a neural network for controlling the variables in the welding process to reach the required tensile strength. In both parts of the simulation system, Matlab version 6.5 was adopted for solving the system equations.

The results of the mathematical representation for FSW showed that it was an accurate representation of the FSW and with percentage of error reaching approximately to zero. In addition, the control system proved effective with a rapid response in correcting any disturbance during the welding process.