شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومـــــات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد اعدت دون آية تغيرات

يجب أن

تحفظ هذه الأفلام بعيداً عن الغبار

في درجة حرارة من 15 – 20 مئوية ورطوبة نسبية من 20-40 %

To be kept away from dust in dry cool place of
15 – 25c and relative humidity 20-40 %

بعض الوثائق

الأصلية تالفة

بالرسالة صفحات

لم ترد بالأصـــــل

Mathematical Simulation of Heat Flow and Microstructure Prediction for GTAW

By

Moetaz Mohamed Nabil Mohamed Mohamed Ahmed

A Thesis Submitted to
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
METALLURGICAL ENGINEERING

FACULTY OF ENGINEERING – CAIRO UNIVERSITY
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Abstract

The objective of this work is to establish a thermal simulation for the gas tungsten arc welding process. Two computer programs, based on the 2-D heat flow models, have been developed to analyse the welding thermal data. The models consider the moving of heat source with a constant welding speed over the workpiece surface.

Two approaches have been adopted for the two models. One was analytical and the other was numerical. The first approach; the analytical; was a simplified model with practical descriptions of welding parameters, whereas more detailed and accurate descriptions of these parameters were incorporated in the second model. The metal was assumed to be a solid with constant properties far from the arc heat source in the analytical model.

The unsteady-state numerical thermal model based on the finite difference technique and the dependence of physical properties on temperature, has been formulated and the resulting heat conduction equation was solved. The model considers a Gaussian distribution of heat flux supplied by the arc. The release rate of latent heat of fusion was treated as an effective specific heat term over the temperature range from solidus to liquidus points. Radiative and convective heat losses were allowed to change over the weld plate. The heat transfer coefficient was taken as a function of plate surface temperature.

The models are capable of computing the temperature distribution through the weld plate during the welding process in the form of thermal cycles, time-temperature profiles, and isotemperature contours. The two programs have been used to determine the peak temperatures in the heat-affected zone and the weld pool. In addition, heat-affected width and weld bead half-width were estimated for different conditions.

The effect of various welding parameters such as (heat input, welding speed, and preheating temperature) and plate thickness; on the thermal behaviour of weldments; has also been studied. Furthermore, fraction of solid, solidification time, and cooling rates at different sections from weld centerline were also estimated. Reasonable results were obtained from the numerical model. Analytical results as compared to those predicted numerically showed over-estimated temperatures at weld pool, dimensions of heat-affected zone, and weld pool sizes.

Finally, an experimental work was done to verify the numerical model. Series of bead-on-plate welds were produced on low carbon steel plates having different thicknesses under different welding conditions. These were then simulated using the numerical model. A continuous cooling transformation [CCT] diagram was projected on cooling curves estimated from the numerical model for the same conditions. The microstructures were predicted at weld centerline and heat-affected zone. These results showed good agreement with the actual microstructures. Furthermore, weld bead and heat-affected zone widths predicted by the numerical model were in close agreement with those obtained from experimental results.

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Finally, I seize this opportunity to show my thanks and gratitude to my mother and my father who sacrificed much for my sake.

Moetaz Nabil