

Weldability Analysis of Spot Welding on Aluminium Alloys Using FEM

ABSTRACT

Resistance spot welding process is the most significant joining process in the automobile industry due to its high speed and suitability for automation. One of the recent demands in the automobile industry is to reduce the vehicle weight so as to improve the fuel efficiency and to meet this requirement, aluminium alloys is being considered as an important alternative for auto-body material. The vehicle corrosion problem can also be squarely dealt with. However, unlike resistance spot welding of steel, joining of aluminium through the same process has met with serious difficulties, because of faster deterioration of electrodes. High electrical and thermal conductivity, high shrinkage during solidification and the presence of natural oxide coating are some of the features that make spot welding process of aluminium alloys markedly different. At a very high temperature aluminium chemically reacts with copper alloy (electrode material). Subsequently random chipping-off of material from the electrode faces takes place and it results in electrode wear. Further, the electrode life reduces drastically when spot welding aluminium alloys. In terms of weldability, this is an extreme negative point since weldability for automobile use is greatly dictated by electrode tip life.

Since the process is very fast, important information, such as transient distribution of current density and temperature, are difficult to obtain from the experimental methods. Thus, it is aimed at the present work to develop an integrated computer simulation model for analyzing resistance spot welding process of aluminum alloys by finite element method. Several calculations have been carried out for different welding current, weld time and electrode force and for different surface conditions of aluminium sheets. Non-linear, temperature-dependent, thermo-physical material properties have been considered. It is interestingly observed that in most cases the nugget diameter is formed well within 0.02~0.04sec and further flow of welding current simply increases the electrode face heating. Also, the initial surface condition influences the nugget formation phenomenon to a great extent. Various other conclusions have been arrived at as a part of this study.