

Abstract

In the present work, material flow models for similar and dissimilar friction stir welding are developed to study the material flow behavior in the weld region. Prior to developing the material flow models, heat generation equations are derived based on Coulumb friction and the plastic deformation heat generation inside the plate. The laminar and K- ϵ turbulence models are used to study the material flow profile in a commercial finite volume package ANSYS Fluent. The material properties are highly significant in the development of a flow model, therefore temperature and strain rate dependent material properties has been used in the current analysis. The viscosity of the material used in all the models is based on Zener-Holloman parameters which are found to be best-suited for the material flow model. The results obtained from the numerical model are compared with conducted experiments. The numerical models produced best results are further used to study the influence of seven different tool geometries on material flow. It was observed that the tool geometry significantly affects the material flow in the welding region. The best tool geometry is used for conducting the dissimilar friction stir welding of Aluminum AA6061 and copper B-210 alloy. The same tool geometry is used for the study of material flow behavior with volume of fluid (VOF) model. The effect of tool rotation and traverse speed are also studied and the defect-prone area is identified in the material flow model. The VOF model is further used to analyze the material flow behavior of a weldment having worm defect. It is found that the defected plate has lower velocity magnitude in comparison to a defect free weld in the welding region.