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Modeling friction stir welding of Al 2024-T3

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Friction stir welding (FSW) is a modification of the traditional friction welding. It is a process patented by The Welding Institute in Cambridge, England in 1991. It is a mechanical process whereby solid-state welding is performed using heat generated from the friction of a rotating tool. Two plates of metal are butted together and held in place against a backing material using a clamping system. The rotating tool is then slowly plunged with a downward force into the weld joint. It remains stationary for a few seconds while enough heat is generated due to friction that the welded material will begin to flow around the tool. Once this point is reached, the tool is traversed along the joint forming the weld behind the tool as it moves along. The main benefits of friction stir welding come from the fact that the melting temperature of the work piece is not reached during the weld. The mechanical properties of welded metals are retained and even improved when the correct welding parameters are utilized—an area of valuable research as FSW is a relatively new process. By varying the downward plunge force, the depth of the penetration of the tool, the rotation speed of the tool, and the linear velocity at which the tool traverses the joint in the welding process, the optimum mechanical properties of the resulting weld can be obtained. This research is concerned with modeling the temperature distribution in the work piece materials during the weld using analytical methods, based on fluid dynamics method. (GAMBIT/FLUENT). A model of the work piece and tool is created and the calculated amount of heat generated by the friction of the tool is applied to this model. It is important to understand the temperature distribution of the welding process because it directly determines the resulting mechanical properties of the weld. This temperature distribution model is compared to actual experimental data and will help to determine the optimum weld parameters.