Modeling of Time-Dependent 3D Weld Pool Due to a Moving Arc

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Abstract: Application of a localized heat source is essential in welding process, to minimize size of heat affected zone (HAZ) and hence, reduce unwanted effects such as distortion and residual stresses. Traditionally, in modeling welding phenomena there has been a focus either on the complex fluid and thermo-dynamics local to the weld pool, or on the global thermo-mechanical behavior of weld structure. A variety of simplified models is now frequently employed in simulation of welding processes, but they are totally reliant on the accuracy of model parameters which describe weld pool size and shape.

It is well recognized that the fluid flow is an important factor in overall heat and mass transfer in molten pools during arc welding, affecting geometry of the pool and temperature distribution in the pool and in the HAZ. These in turn influence solification behavior, which determine the mechanical properties and quality of the weld fusion zone.

Numerical simulations of the weld pool were carried out by using **femLego** tool to create a set of C and Fortran code from mathematical equations which were written in Maple format. The code that created by the latest version of **femLego** could be ran parallelly on shared memory as well as distributed memory machines by using MPI libary. The computational model based on a finite element approach was developed to investigate heat and fluid flows in two- and three-dimension, time-dependence and axisymmetry. The physical phenomena such as, surface tension gradients, electromagnetic, buoyancy, arc pressure and heat losses due to radiation and convection and solidification of the weld pool as well as the modeling of heat input from the arc present between electrode and workpieces have been taken into account.

Results observed that the temperature fields were strongly affected by convection, with characteristic velocities $U_s = 10cm/s$, blending the isotherms, for example, at weld pool surfaces. Fluid flows in the weld pool are highly complex and time-dependent (chaotic). They influence the weld pool's depth and width. Moreover, the velocity field at the surface of specimen determines streamlines defining traveling paths of, for example, slag particles.

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