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SIMULATION OF TEMPERATURE, VISCOSITY AND FLOW STRESS DURING FRICTION STIR WELDING ON AA6063 IN T-JOINT

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ABSTRACT
The present paper give study about the Friction Stir Welding on T-Joint using tool as Cold work die steel(H-13) and work piece material as AA6063.The speed of tool (pin and shoulder type), has been taken as 1600 rpm, 1700 rpm& 1800 rpm and its translational speed as 4.23 mm/s. The temperature of the work piece plates is to be 20ºC.The work piece consists of two uniform material plate of aluminum alloy AA6063 for the experiment purpose. This study will show the temperature distribution, the stress distribution and the viscosity flow in the work piece plates at the give parameters at specified boundary condition. The experimental graphs will give the clear idea about the results of the experiment and thus will give the comparison of parameters at different speed of the tool.

Keywords: **T-Joint, Friction Stir Welding, temperature, flow stress, viscosity,AA6063.**

INTRODUCTION
The friction Stir Welding (FSW) is one of the most popular and recently used techniques for the joining of the two similar or dissimilar metal and their alloys. It is a solid state and plastic welding process in which the coalescence is obtained by heat generated due to the mechanically induced pressure and vibration between the work piece and the tool. In this technique the work pieces are hold together firmly under pressure in a clamp and a high speed rotated tool is allowed to slide over the meshing surface. The high friction between the meshing and the tool create the coalescenceby the heat produce by which the metal comes to its plastic stage. Thus after the cooling of this work piece the required joint is obtained.

The Cold work steel(H-13) tool is high-speed tool which falls under the Group M steels and have low initial cost compared to other elements of the same group. Its density is around 7870 kg/m³ (metric) and melting point is 1427ºc (metric) along with the hardness as 25.0-45.0 Rockwell C, Poisson's Ratio 0.287and Elastic Modulus as 200×10^{3} MPa (metric).

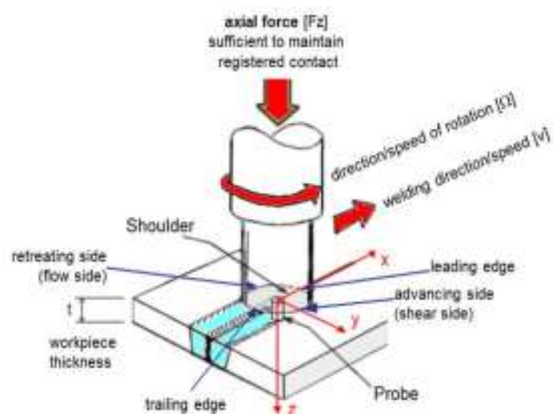

Figure 1: Schematic Diagram of FSW(Reference: 1)

The aluminum alloy series from 7000 onwards are mostly non-weld able by the conventional techniques due to the poor solidified microstructure, porosity in the fusion zone and also due to the remarkable loss in the mechanical properties during the fusion process while compared to their base metals.

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MATERIALS AND METHODS

Some of the given below are the experimental and researches done on the FSW process on different joints i.e. butt or lap and by using different tool pin geometry.

Jaimin B Patel, K.D Bhatt and Maulik Shah presented a new tool pin geometry of a hexagon type for the experimental purpose on AA6061 alloy and presenting its peak temperature and flow process. They after the experiment concluded that comparatively low peak temperature of 450-520°C provides minimum flow stress of 151.8MPa for Hexagonal pin profile as compared to cylindrical pin profile.The peak temperature of ~545°C is achieved for cylindrical pin profile with moderately high flow stresses (~210MPa).

K.D Bhatt and BinduPillaipresent paper is to simulate peak temperature and distribution of flow stresses produced during the FSW of AA7050-T7451 Aluminum alloy. They came to conclusion that at constant tool rotational speed (RS) and tool with the same geometry; variation in tool traverse speed has prominent effects on temperature history & flow stresses developed during FSW of AA7050-T7451 Aluminum alloy.The flow stresses at lower peak temperature of 3400C are as high as 720 MPa but are as low as 680 MPa at higher peak temperature of 3600C. Also with the increase in welding speed, the peak temperature also increase if the rotational speed of the tool is kept constant.

Rhodes et al. investigated on the microstructure evolution in AA7075-T651 during FSW process. He concluded that maximum process temperatures are between about 400ºc to 4800ºc in the AA7075-T651.

RESULTS AND DISCUSSION

The properties of the work piece plates and the tool are given in the following tables.

Table 1: Properties of AA6063

Density	2700 Kg/m³
Specific heat	900 J/Kg-K
conductivity	198 W/m-K
Coefficient of thermal expansion	1e-005 1/K
Young's modulus	4.00E+10 Pa
Poisson ratio	3.50E-01

Table 2:properties of cold work steel(H-13)

Density	7870 Kg/m³
Specific heat	460 J/Kg-K
conductivity	24.3 W/m-K
Young's modulus	2.1E+11 Pa
Poisson ratio	0.35

The Boundary Condition Parameters for the T-Joint are stated in the following table

Table 3: boundry condition

Temperature of Plates	20ºc
Translational Speed	4.23 mm/s
Rotational Speed	1600/1700/1800 rpm
Slip Coefficient	1.0e+09

The following figures show the graphical representation of the Flow Stress, Temperature Distribution, and the viscosity flow in the plates at a Tjoint when FSW is applied.

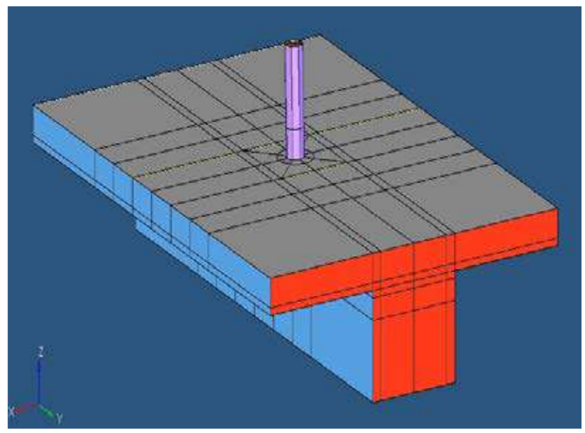

Figure 2: model iso view

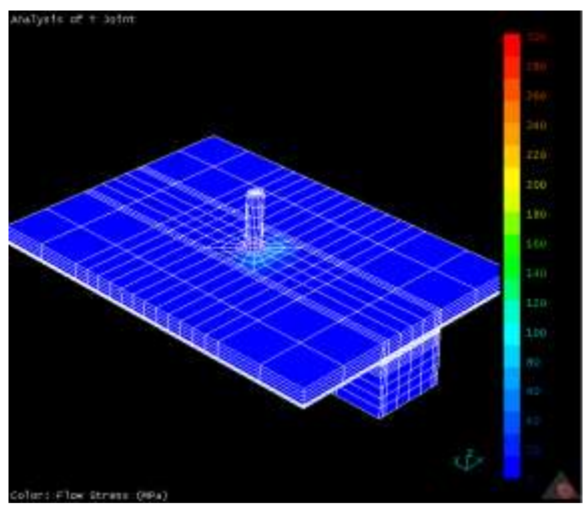

Figure 3:Flow stress at 1600 rpm

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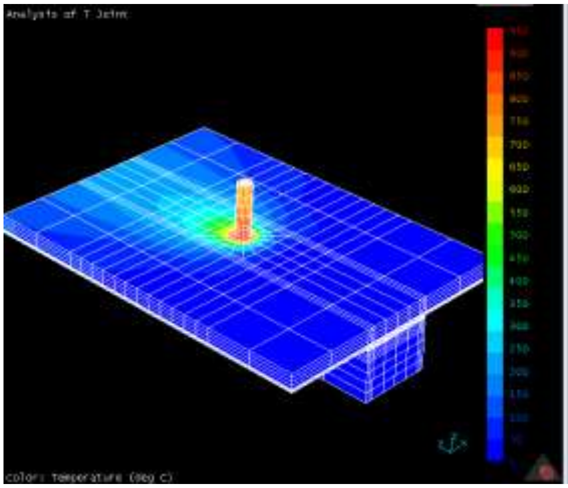

Figure 4 : Temperature Distribution at 1600 rpm

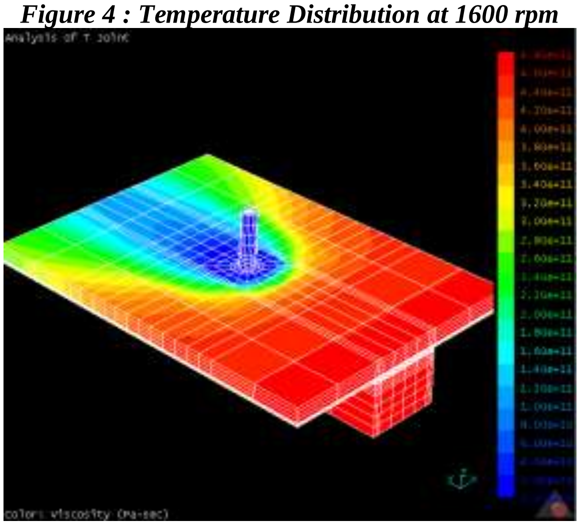

Figure 5: viscosity result at 1600 rpm

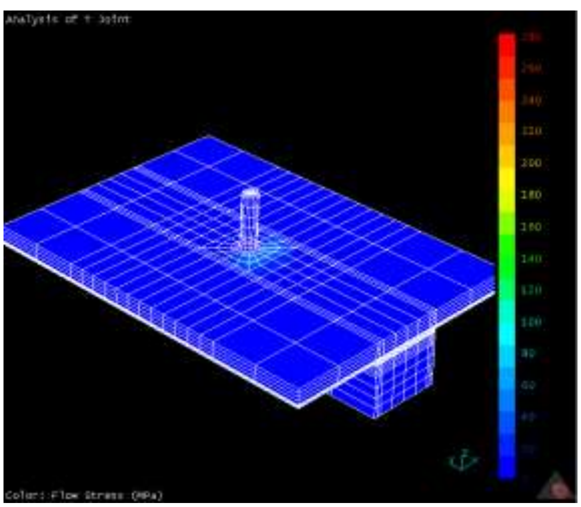

Figure 6: Flow stress at 1700 rpm

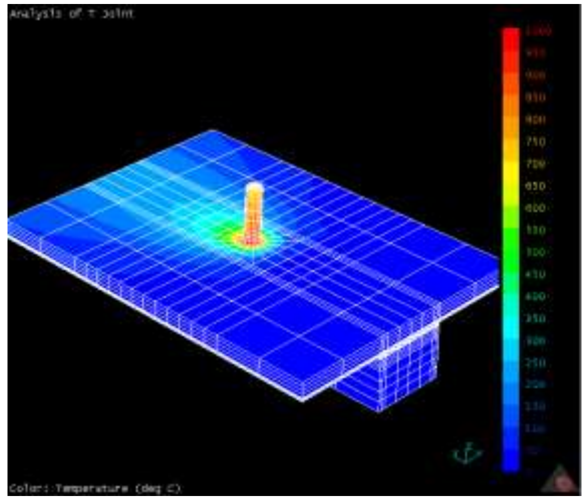

Figure 7: Temperature Distribution at 1700 rpm

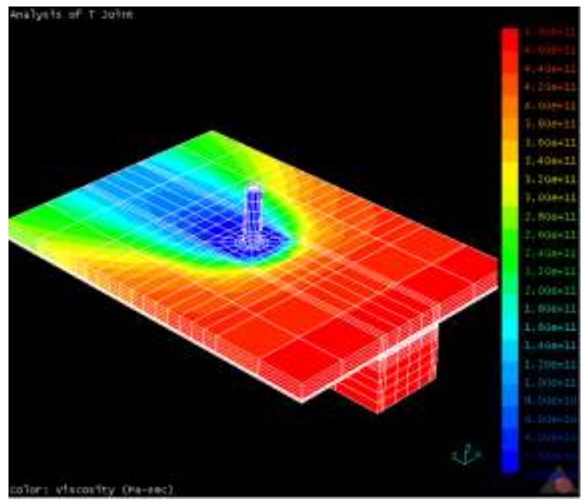

Figure 8: Viscosity Result at 1700 rpm

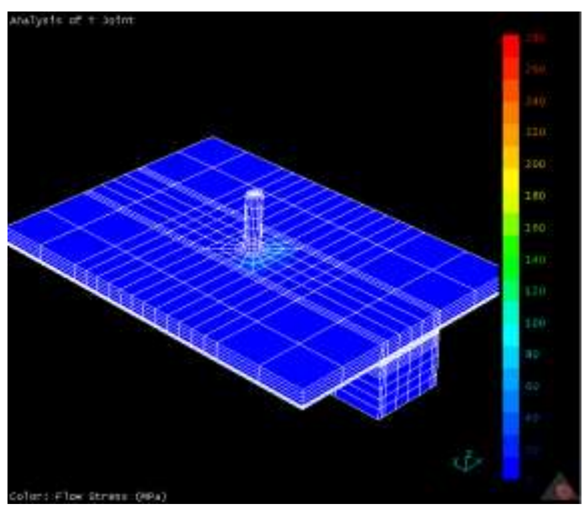

Figure 9:Flow stress at 1800 rpm

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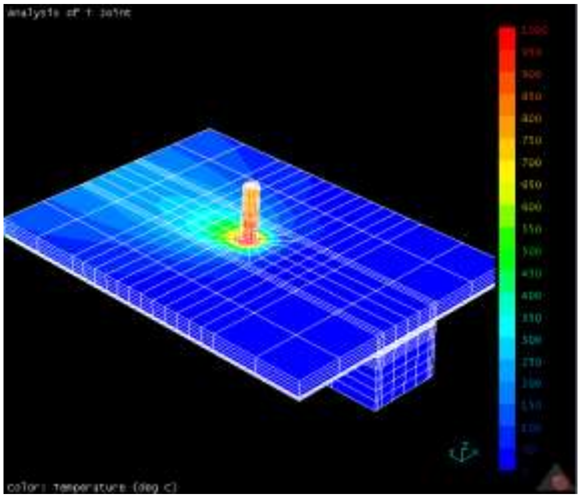

Figure 10: Temperature Distribution at 1800 rpm

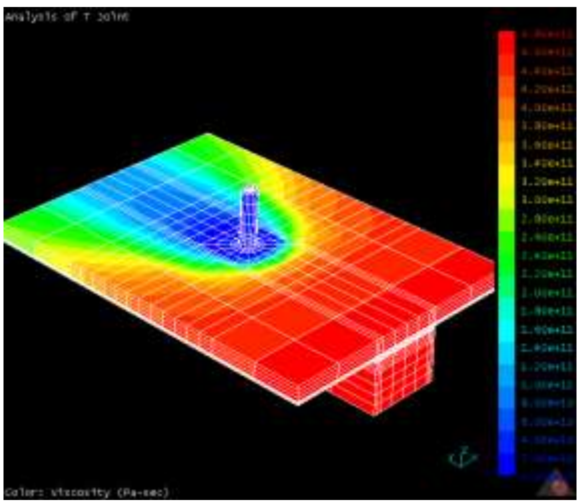

Figure 11: Viscosity result at 1800 rpm

CONCLUSION

From the results of the simulation and analysis of the experiment we arrive at the following conclusions.

1. At 1600 rpm of the tool rotation the maximum flow stress is 300 MPa, the maximum temperature distribution over plates is 950ºc and the maximum viscosity is 4.80e+11Pa-sec.
2. At 1700 rpm of the tool rotation the maximum flow stress is 280 MPa, the maximum temperature distribution over plates is 1000ºc and the maximum viscosity is 4.80e+11 Pa-sec
3. At 1800 rpm of the tool rotation the maximum flow stress is 280 MPa, the maximum temperature distribution over plates is 1000ºc and the maximum viscosity is 4.80e+11 Pa-sec
4. Thus as tool rpm goes on increasing upto 1700 rpm the flow stress decrease , the temperature distribution increases and the viscosity remains constant,but for 1700 rpm and 1800 rpm flow stress,temperature and the viscosity remains constant.

ACKNOWLEDGEMENTS

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