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Application of Image Processing And Acoustic Emission Technique In Monitoring of Friction Stir Welding Process

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Abstract

Digital image processing involves use of digital computer for processing the digital image in order to improve the visual appearance of images to a human view and preparing images for measurements of its features and structures present. With growing demand of industrial automation in manufacturing, machine vision and image processing techniques play an important role in quality inspection and process monitoring.

In the present study the applicability of Acoustic Emission (AE) technique in the analysis of FSW joints by combining with image parameters has been done. It has been observed that both the Image parameters and AE-parameters follow a similar trend with respect to a particular set of input process parameters for producing Friction Stir Welding (FSW) joints.

Keywords:*Friction Stir Welding; Image processing; Acoustic emission; Metal flow.*

1.Introduction

With the advent of speed of general purpose computers and powerful high speed vision systems, image analysis have become easier, faster and more flexible having advantage of being non-contact and capable of using in any kind of industrial environment. Most materials and structures emit energy in the form of mechanical vibrations (Acoustic Emission (AE)) as a result of sudden change or movement of which is due to defect-related phenomena such as cracking or plastic deformation. These acoustic emissions propagate from the source, throughout the structure. The technique of electronically “listening” to the acoustic emission is used worldwide in detecting and locating defects as they occur across the entire monitored area providing early warning of pending failure, in a timely and cost effective manner.

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1.1 *Friction Stir Welding (FSW)*

FSW is a solid-state, hot-shear joining process as shown in Figure1.1[7] in which a constantly rotated cylindrical-shouldered tool with a profiled nib is transversely fed at a constant rate into a butt joint between two clamped pieces of butted material. The nib is slightly shorter than the weld depth required, with the tool shoulder riding atop the work surface. The shoulder makes firm contact with the top surface of the work piece. Frictional heat is generated between the wear-resistant welding components and the work pieces. This heat, along with that generated by the mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to soften without melting. As the pin is moved forward, a special profile on its leading face forces plasticized material to the rear where clamping force assists in a forged consolidation of the weld. This process of the tool traversing along the weld line in a plasticized tubular shaft of metal results in severe solid state deformation involving dynamic re-crystallization of the base material[2][6].

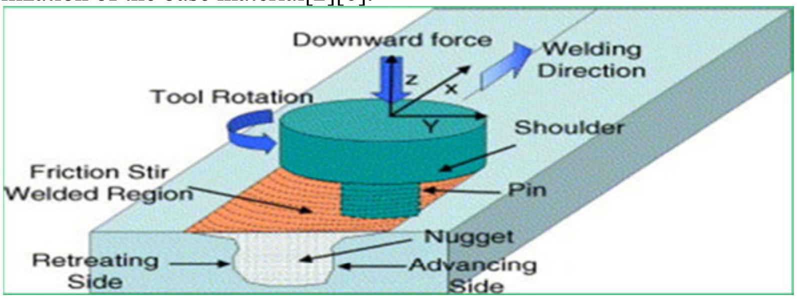

Fig. 1.1 Schematic Drawing of Friction Stir Welding

1.2 Tool Geometry

Tool geometry is the most influential parameter which mainly controls material flow and heat generation. FSW tool consist of a shoulder and a probe (pin) which can be integral with shoulder or as a separate insert possibly of a different material**.** The important tool parameters are tool pin profile, tool shoulder diameter, pin diameter, tool inclined angle, included angle of pin and ratio of shoulder diameter to pin diameter. The design of the shoulder and of the probe or tool tip is very important for producing quality welds. The probe of the tool generates the initial heat and stirs the material being welded, but the shoulder plays an important role by providing addition frictional treatment resulting in the temperature of the metal as well as preventing the plasticized material from escaping from the weld region. The plasticized material is extruded from the advancing side to the retreating side of the tool but is trapped under the shoulder which moves along the weld to produce a smooth surface finish [4]. Different tool profile probes are required depending on the thickness of the material to be joined. Example of different shoulder profiles are shown in Figure 1.2,[7].

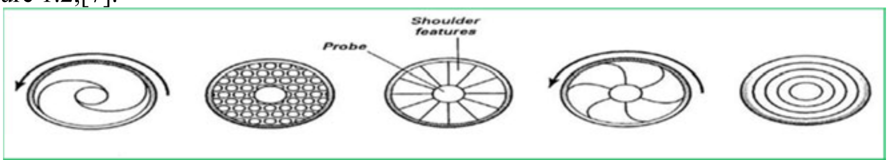

Fig. 1.2 Different Shoulder Designs

2.Experiment: Specimen-1 is welded by using Tool (Concentric shoulder with conical threaded pin).

FSW joint were prepared with tool rotational speed 1000 rpm during welding, weld traverse speed of 100mm/min and plunge depth of 4.93 mm and weld bead length 230mm. These parameters were selected to study and analyze the AE signal pattern generated during welding. The photograph of FSW joint prepared along with process parameters is shown in Fig. 2.1(a). The radiography image of joint is shown in Fig.2.2(b). The AE signal patterns; RMS, Energy, Amplitude and Counts are shown in Fig. 2.3(a), 2.3(b), 2.3(c) and 2.3(d) respectively. The first order