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INFLUENCE OF ENERGY DIRECTOR GEOMETRY ON THE ULTRASONIC WELDING PROCESS OF THERMOPLASTICS

K V Vara Lakshmi[1]

[1]Department of Mechanical Engineering
Gayatri Vidya Parishad College of Engineering (A), Visakhapatnam-530048, A.P., India

Abstract. The utility of thermoplastics in engineering and medical applications is increasing drastically due to their ease of manufacture and processing with high precision. Thermoplastics can replace metals with considerable weight savings and a proper design. Ultrasonic welding has emerged as a vital technique for joining thermoplastics in modern industrial applications. It offers several advantages, such as high surface finish and tool life, less/no wear due to non-contact between tool and workpiece, low cost, and noiseless operation. The energy director is usually a small, elevated feature on one of the workpieces. Its primary purpose is to focus the energy, allowing for the quick softening and melting of the joining surface. The energy director plays a pivotal role in ultrasonic welding, enhancing welding strength and speed. This study focuses on the design of triangular and semicircular energy directors and their performance on thermoplastics such as Acrylonitrile Butadiene Styrene (ABS) and High-Density Polyethylene (HDPE). Viscoelastic heating, a critical mechanism in ultrasonic welding, relies on factors such as the material loss modulus, frequency, and amplitude of the ultrasonic machine. The weld strength is directly influenced by the temperature generated at the weld interface. Consequently, this research aims to analytically evaluate the weldability and maximum interface temperatures of thermoplastics under varying amplitudes.

Keywords. Energy director, thermoplastics, ultrasonic welding, weldability.

1 Introduction

Ultrasonic welding (UW) is used for joining two components by friction and viscoelastic deformation of the components, which include similar metals, metals of different materials, similar plastics, and plastics of different materials. In ultrasonic welding, low-frequency electrical energy is converted into high-frequency mechanical vibrations which, when applied along with force, produce heat energy at the interface of the two mating components. As the components themselves are deformed, there is no need for filler material, adhesives, mechanical fasteners, etc., which makes this process economical and ecofriendly. The main components of the ultrasonic welding machine are