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ORIGINAL ARTICLE

Development and optimization of a prediction system model for mechanical properties in rotary friction-welded polyamide joints using the SVM approach and GA optimization

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Abstract

The objective of this experimental study is to utilize rotary friction welding (FW) for assembling similar polyamide materials. The application of the SVM approach enables the development of a predictive model for estimating mechanical properties in RFW processes. Furthermore, the optimization of RFW parameters through GA proves pivotal in selecting optimal welding conditions, providing a variety of choices. The welding parameters considered in this study included rotation speed at five levels and traverse speed at three levels. The strength of the welded samples was characterized by a tensile test. Additionally, temperature measurements were taken to determine the maximum temperature in the joint area. The results demonstrated the dependence of tensile strength and maximum temperature on the rotation speed. Maximum tensile strength is achieved at an optimal rotation speed. Moreover, analysis of variance (ANOVA) indicates that rotation speed is the parameter most influenced by tensile strength.

Keywords Rotary friction welding · Polyamide · Tensile strength · Temperature measurements · SVM approach · Analysis of variance

1 Introduction

Polymers have been widely used to replace traditional metal materials due to their high specific elastic properties. Although polymer materials can be used more easily in molding, injection or extrusion production, welding is still necessary for assemblies. While early reports indicate the use of friction welding for joining plastics in Germany during World War II, interest in the technique waned for roughly a decade following the war. This decline likely stemmed from the allure of exciting new discoveries regarding the malleability of plastics. However, the 1950s saw a resurgence of interest in plastic friction welding, fueled by its successful application in metal joining. Ironically, despite the wealth of research now available on friction welding of metals, plastic applications remain comparatively underexplored, a situation worth revisiting given the potential benefits of this versatile technique [1]. The economic impact of manufacturing costs and technical requirements on the productivity and quality of finished products during machining requires optimizing manufacturing systems to a compromise between cost and quality, which has prompted researchers in recent years to consider

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