Application of Response Surface Methodology to Predict Ovality of AA6082 Flow Formed Tubes

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ABSTRACT
Flow-forming is eco-friendly, chipless manufacturing process employed in the manufacture of thin walled seamless tubes. Ovality, the out of roundness is one of basic form of errors encountered in the tubular components. In the present research, a response surface model has been developed to predict ovality of AA6082 alloy pre-forms using Design of Experiments. The experiments are performed on a flow forming machine with a single roller. The process parameters selected for the present investigation are axial feed of the roller, the speed of the mandrel, and roller radius. Box-Behnken Design, a standard response surface methodology has been used to conduct the experimental runs. The developed response surface model successfully predicts the ovality of AA6082 flow formed tube within the range of selected process parameters. It has been found that, roller feed is the most important process parameter influencing the ovality of AA6082 flow formed tube.

Keywords: AA6082 Alloy, Flow-Forming, Ovality, Response Surface Methodology

1. INTRODUCTION
Flow-forming is modern, chipless metal forming process which employs an incremental rotary point deformation technique. In flow-forming the length of pre-form is elongated at the reduction in wall thickness without changing the internal diameter. Flow-forming is used in the production of seamless tubes, cylinders, axi-symmetric sheet metal parts for high strength-to-weight ratio flanged components used in automobile, ship building, aerospace and defense applications etc. The roundness error (Ovality) is one of the most important for error encountered in the production of thin walled tubes for aerospace, defense, missile, transportation and other applications. Various process parameters namely roller feed, mandrel speed, roller radius, thickness reduction, roller attack angle influence the ovality of flow formed tube.

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But, very little work has been reported on flow forming of AA6082 tubes. The ovality is one of the important characteristic of flow formed tube. Error free flow formed tubes combined with minimum ovality are desired for critical aerospace, missile, automobile and other applications.


From the literature review it is revealed that, no work has been reported on response surface model for ovality of AA6082 thin walled tubes by flow forming process.

The aim of present work is to generate the response surface model to predict the ovality of AA6082 thin walled tubes manufactured by flow forming process. The input process parameters chosen are axial feed of the roller, speed of the mandrel and roller radius.

2. EXPERIMENTAL WORK

2.1. Flow Forming Process

In flow forming, a short and thick cylindrical blank (Pre-form), is stretched on a rotating mandrel by means of mechanically guided rollers. The pre-form is lengthened by decreasing in wall thickness. It is locked by means of serrations and rotates together with the mandrel at the same speed. The forming roller follows the contour of the mandrel with a preset gap. The gap between the rotating mandrel and the roller acts as an orifice through which the metal flow occurs (extruded). As the forming process produces localized deformation, lower forces are required as compared to other processes. The principle of flow forming is shown in Figure 1.

The flow forming is classified into two types as forward flow forming and backward (reverse) flow forming processes. In forward flow forming, the material flow takes place in the same direction as that of rollers. The forming is done near tail stock and requires tubes with closed ends. Material flows in the opposite
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