

FEM ANALYSIS OF FLARING PROCESS OF ALUMINUM 6061 TUBE USING PRESSING PROCESS

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Abstract - This paper describes about the tube end flaring which is also termed as end forming. Tube end forming is a process that involves extending, reducing, flanging, and tapering tubes to create a range of end forms. This technology is advantageous for fabricating tubular components with a thin wall thickness, such as pipe fittings and energy-absorbing products, Petroleum industries, aerospace, automobile, permanent locking and house appliances. Most of the industries have opted to automation. Considering the fact that in automation industries the production rate is high with minimum time and reaches the quality of work as well. In this work we will come across pressing process which is used at three different pressures to determine stress deformation, strain rate and total deformation of the tube at each bar of pressure. To do this we have considered Aluminium tube of dia 20mm, 1.5mm thickness and 50mm long in this experiment.

Key Words: flaring, pressing, production.

1.INTRODUCTION

Tube end flaring may be used to create a variety of end shapes for a variety of purposes. End Forming (also known as End Finishing or Forming) is a method that is used to alter the structure of a tube. Tube flaring is a form of compression fitting that is often used for metal tubing made of soft steel, ductile steel, or aluminum. Tube flaring is often using to adjust the diameter of the tube's end, although other shapes are often possible. Tube flaring is a Sort of forging which is typically a cold working operation. Flaring is used to link two tubes of the same inner and outer diameters. This technology has a broad range of uses in the manufacture of thin walled tubes like pipe fitting, locking systems, in automobile sectors, petroleum and gas industries, and house appliances. While cold-end forming has existed for an extended period of time, the automotive industry has made numerous improvements. The search of safer, lighter, and more efficient means of transporting fluids through the structures used in automobiles has accelerated research into stronger end forming.

Tolerances have been prioritized in order to mitigate the possibility of leakage. The elimination of brazing has also resulted in several improved designs. Due to this history and invention, the tube end shape has been a vital component in fluid handling systems used in a wide variety of items.

1.1 What is Tube End Forming?

Tube end forming is the process is the method by which a connection is made to one medium to another medium such as a tube, hose, or block. Tube end forming applications are utilized in a number of industries that include tube end forming, such as the automotive industry where a parts has to be reduced and to create a leak-proof environment which is important to functioning of machinery.

1.2 How Forming of Tube End is done?

Tube end forming can be done physically in instances where a dedicated piece needs one or several engineers to shape it the way it needs to be, or it can involve machinery to form it into the projected shape. When the tubing is small and made of a soft material, the assembly may be formed during construction by hand bending. Without the use of machines, hand bent tubing with a diameter of 1/4inch or greater is inefficient. Segmented tool sizing, ram forming, rotary forming, roll forming, and rotating are the basic end forming techniques. Typically, the ram style end forming method involves firmly clamping a tube in a series of clamp dies as a ram tool forms the tube's end.

Traditionally, tube end flaring is accomplished by axially compressing the work piece with a hydraulic press, and any adjustments in the tube caused by the pressing operation are mostly determined by the tool's measurements. The aluminum 6061 tube measures 20mm in diameter, 1.5mm in thickness, and 50mm in weight. This method of tube end flaring is accomplished with the help of a hydraulic press fitted with a specialized instrument and work holding piece. Tubes are flared in hydraulic presses using hydraulic oil, which distributes pressure evenly around the aluminum tube. As a result of the pressure added to the tube, the tube ends begin to flare. The length and radius of flared portion mainly depends on the angle of the tool.

2. EXPERIMENTAL METHOD AND ANALYSIS

2.1 Tool Design

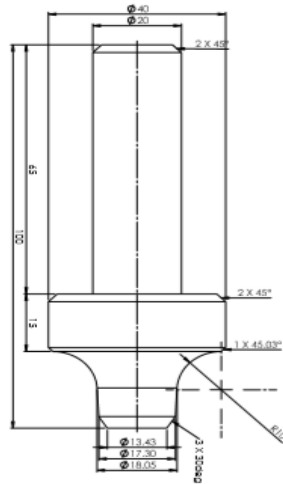


Figure 2

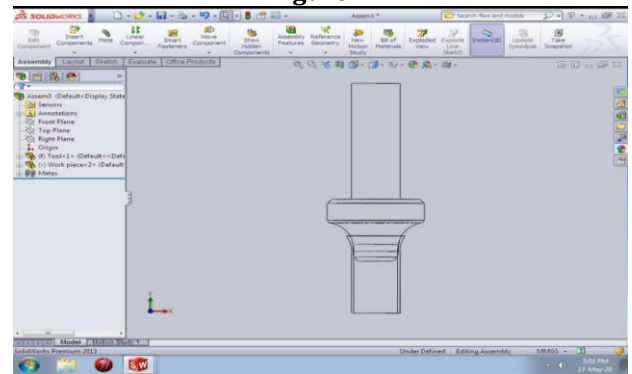


Figure 3

2.2 Material Details

Material details	Density	Young's modulus	Tensile strength	Poisson's ratio
Aluminium 6061 (work piece)	2.70g/cm ³	68.9gpa	124mpa - 290mpa	0.33
Mild Steel (tool)	7.85g/cm ³	200gpa	420gpa	0.25

This process involves a dedicated tool for flaring operation in order to obtain the desired flared tool output in the tube. The tube used for the operation is AL6061 and the tool is made of Mild Steel.

Pressing process for tube end flaring has wide reach for its application which is used in many automotive related industries, aerospace industries, home appliances, oil and gas etc. This helps to avoid leak in any piping applications, reduces material weight and locking of any components.

The operation was conducted using three different pressing pressure that is 1bar, 2bar and 3bar. It was done to check stress, strain and total deformation at each bar and to identify where the tube may get deformed. Keeping time also in consideration and identify where the crack growth starts.

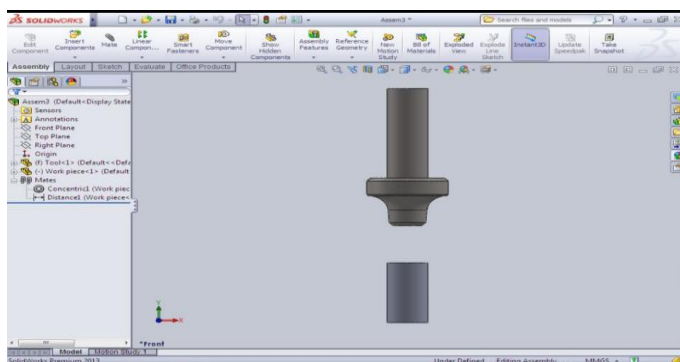


Figure 1

2.3 Analysis Results



Figure 4

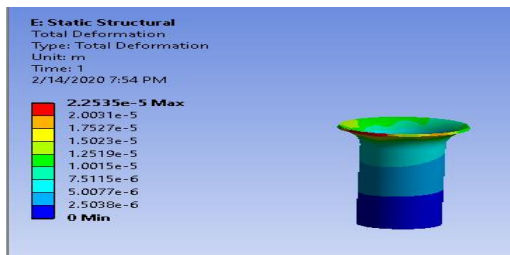


Figure 5

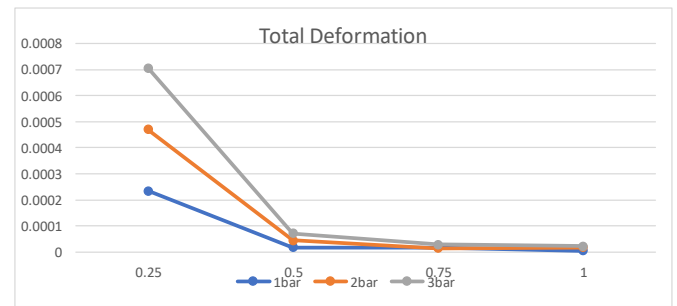


Chart -3: Total Deformation

The above Graph:3 shows how the deformation has occurred in the tube due to the external pressure. It is observed that the total deformation in the at 0.25 while in all the three variable loads the deformation will be high. As the tube starts to flare the deformation in the tube also decreases gradually. But when observed at 0.75 the deformation in the tube is slightly increased, that is because it is the stage where the tube gets the flared shape and again reduces as the tube would have gained the flare shape. Deformation reduces when the flare in tube starts as the opening of the tube end is important and then guides easily in.

2.4 Graph Results

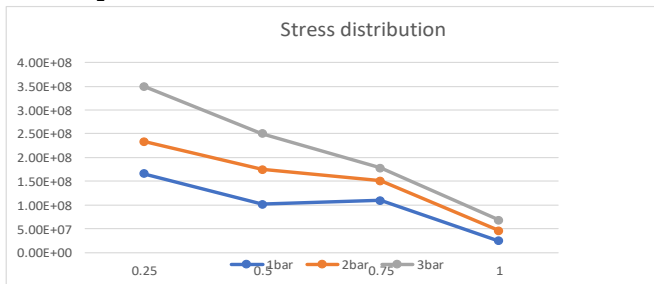


Chart -1: Stress distribution

The above Graph:1 shows how the stress has occurred in the tube due to the external pressure. It is observed that the stress distribution in the at 0.25 while in all the three variable loads the stress is high. As the tube starts to flare the stress in the tube also decreases gradually. But when observed at 0.75 the stress distribution in the tube is slightly increased only at 1bar pressure but at 2 and 3 bar it has reduced, that is because it is the stage where the tube gets the flared shape and again reduces as the tube would have gained the flare shape. Due to change in pressure, flaring dint have any impact on the outcome only when at 3bar pressure few cracks were seen in the tube.

3. CONCLUSIONS

Above process were used to take trials and each trials had 3 workpiece used. Experimental and analytical results were obtained and each process had different results, the following conclusion are drawn comparatively with respect to pressing process.

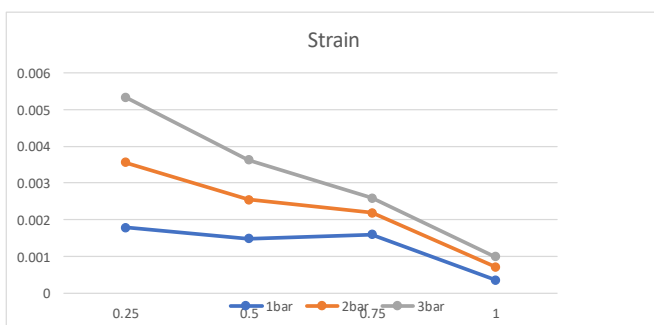


Chart -2: Strain Rate

The above Graph:2 shows how the strain has occurred in the tube due to the external pressure. It is observed that the stress distribution in the at 0.25 while in all the three variable loads the strain rate will be high. As the tube starts to flare the strain in the tube also decreases gradually. But when observed at 0.75 the strain rate in the tube is slightly increased only at 1bar pressure but at 2 and 3 bar it has reduced, that is because it is the stage where the tube gets the flared shape and again reduces as the tube would have gained the flare shape.

1. This process had it own advantages such as good surface finish, appropriate tube wall thickness, good end radius after flaring. As this pressure had different bar pressures used, each bar pressure had different results experimentally and analytically.
2. Experimentally it was difficult to identify the crack development in the tube while doing analysis it was easy to identify where the crack formation was formed.
3. At each bar i.e 1bar, 2bar and 3 bar pressure the tool was fed on workpiece considering time 3sec, 6sec, 9sec, 12sec keeping the time in mind at each bar of pressure the results were noted.
4. Results showed that with respect to time, tool fed on workpiece total deformation gradually decreased, while stress formation increased and strain rate was seen reduced. Time for pressing the tube was considered same for 1bar, 2bar and 3bar pressure.
5. In terms of time, total deformation at first 3 points almost remined same and decreased at last set. Where as stress in the tube increased manually with respect to time and in terms of strain at first 2 points strain rate was high and decreased at last 2 points.

6. Comparing to other process, pressing process had good surface finish of the tube, thickness distribution, shape of the tube after flaring had good results, friction was reduced, strength at flared portion of tube was good, similarly had few disadvantages such as crack growth, buckling, unevenness, distortion.

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