MATERIAL CHARACTERIZATION OF BIMETALLIC TUBE USING FRICTION STIR EXTRUSION PROCESS

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ABSTRACT

The aim was to obtain a bimetallic tube of alloys(Stainless steel- copper , copper – Stainless steel , Brass – Stainless steel) of higher strength andlighter weight than conventional existing alloys and get over mentioned limitations. The friction stir extrusion method was used to obtain the tube needed, and analysis of it was done using optical microscope, scanning electron microscope, and electron dispersive ray.The bimetallic tube were inspected and the parameters was checked.Such a tube can be used for applications that require high corrosion resistance. For instance, in heat pipe applications which carry substances like methanol and ethanol

Keyword : - *By making joined tubes from different materials by lots of shear stress and pressure ,improved mechanical strength.*

1 INTRODUCTION

Bimetallic tubes are a process of two different materials unified into a single homogeneous metallic tube. Usually the inner material is a corrosion resistance alloy (Copper, Aluminum-Brass,Titanium) whereas the outer material is a high stress resistant alloy (Stainless Steel, Carbon Steel, Titanium), depending on application. By making joined tubes from different materials by lots of shear stress and pressure, improved mechanical strength, and ultra-fine-grained microstructures are obtained

1.1 NEED FOR BIMETALLIC TUBES

Since the discovery of iron and steel, they have been used in various fundamental applications, one of the most important being pipes for transportation of fluids. However, these materials are highly susceptible to corrosion by the fluids and oxygen from the atmosphere, and such a process leads to weakening of the entire structure, as well as produces the danger of fluid leaks that may be deadly. One of the possible solutions is to use a different material that is less likely to corrode, but then the material, for example, aluminum, will have different mechanical properties, and suffer from reduced stress resistances and other issue.

Fig -1 Schematic Diagram bi metallic tube

1.2 METHODS OF PRODUCING BIMETALLIC TUBES

Friction extrusion is a thermo-mechanical process that can be used to form fully consolidated wire, rods, tubes, or other non-circular metal shapes directly from a variety of precursor charges including metal powder, flake, machining waste chips or solid billet. The process imparts unique, and potentially, highly desirable microstructures to the resulting products.

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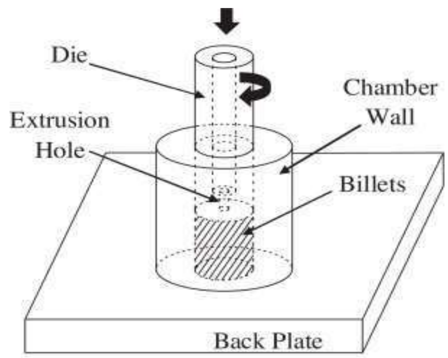


Fig -2 Friction stir extrusion

1.3 WHY FRICTION STIR EXTRUSION

Therefore, in order to retain the high-temperature strength, creep resistance, and homogenous material properties of advanced steels, friction stir extrusion is the most promising candidate for producing such a tube. Friction stir extrusion is done at room temperature or near room temperature. The advantages of this over hot extrusion are the lack of oxidation, higher strength due to cold working, closer tolerances, better surface finish, and fast extrusion speeds if the material is subject to hot shortness.Based on the punch and die design and the resulting material flow, cold extrusion can be classified into three primary processes: forward extrusion, backward extrusion, and lateral extrusion. In forward extrusion, the material flows in the same direction as the punch displacement. In forward extrusion, the diameter of a rod or tube is reduced by forcing it through an orifice in a die. In backward extrusion, the material flows in the opposite direction of the punch displacement.

2. COPPER AND ALUMINUM BIMETALLIC TUBES

Copper (Cu) tubes have been widely used as connecting pipes during the manufacture of air conditioners due to their excellent thermal conductivity.In recent years as the price of Cu increases, the manufacturer have a great interest in the substitute of Cu tubes.However, Al tubes are prone to deform during installation due to the lower strength in comparison with Cu tubes. Consequently, Al/Cu bimetallic tubes are used to increase the performance and decrease the manufacture cost. Previous study showed that compared with Cu tubes, Al/Cu bimetallic tubes can reduce cost by 23–34% and weight by 36.5–46.3%. Therefore, Al/Cu bimetallic tubes combine the advantages of Al.

2.1 DIMENSIONS OF BIMETALLIC TUBES

Specimen A: STAINLESS STEEL - COPPER

Length =200mm

Diameter =70mm

Thickness =1mm

Specimen B: COPPER – STAIN LESS STEEL (LINEAR)

Length =45mm

Diameter =90mm

Thickness =1mm

Specimen C: BRASS – STAIN LESS STEEL

Length =77mm

Diameter =50mm

Thickness =1mm

3 .EXPERIMENT CONDUCTED IN OPTICAL MICROSCOPE

50x

100x

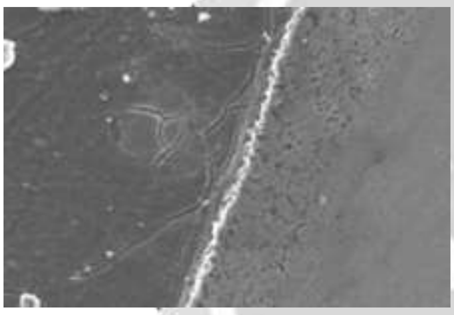
200X

500X

The above picture shows the bonding between bi metallic tubes. The resolution was increased from the 50x to 500x by using the optical microscopy analysis.

3.1 EXPERIMENTCONDUCTEDINSCANNING ELECTTRON MICRO SCOPE

750x



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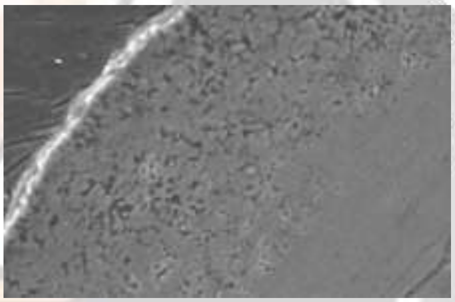

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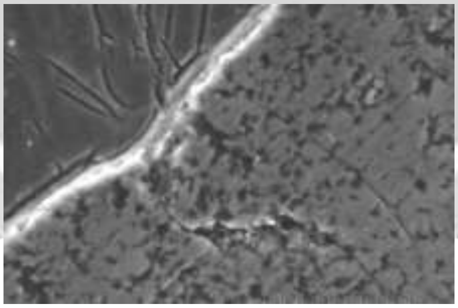

3.2 CONCLUSIONS FOR IMAGES

In the first two samples, one can see a great deal of space between the atoms, as well as cracking. This is due to the lack of threading in the first sample, and an incorrect thread being used in the second. However, in the third, this issue has been fixed. Thus, the third sample is the most feasible of the lot.

CHEMICAL COMPATIBILITY

Looking at the various images, it is obvious that diffusion is maximum in the third sample. This is proved by the bonding seen in the SEM images. You can see the diffusion of the aluminum and magnesium, and this is obvious thanks to the contrast in the image.

MICROSTRUCTURE EVOLUTION OF INTERFACE

Examining the microstructure right at the interface, you can see that there is a band. This can be divided into two regions, one next to the interface and the other further away. In the former, precipitation happens in the grains themselves, as well as at the grain boundaries. In the latter, this mostly happens along the boundaries. This may be because diffusion along the boundaries happens faster, thanks to the area being favorable for heterogenous nucleation.

CROSS SECTION STRUCTURE

On examining the third sample in detail you can see that there are 3 major regions. The first is a continuous layer of crystals of cu which are existing, and the third is a similar lattice for stainless steel. The second however is where grains break away from the first two regions and begin diffusing into the other. This is due to the continuous melting during extrusion process. You can clearly see the inter-granular penetration alongside the boundaries of the grains.

INTERFACE FORMATION MECHANISM

Looking at the samples, it can be seen that bonding happens once the temperature of the atoms exceeds the value of the eutectic temperature. This is facilitated by adding a thread of 8mm in the work piece.

4 .Experiment

Once the assembly is setup in the vertical milling machine, the plunger is made to be in the right vertical axis. Then the compressed billet pushed into the cavity. The speed of rotation is set to 1700 rpm and then the vertical feed is 0.3 mm per division. Once the machine is started, the stirring tool is inserted into the Die Cavity. The heat is produced due to the rotation of the stirring tool and frictional heat is also generated between the Stirring tool and wall surface. That heat is sufficient enough to bring the bimetallic billet into the semi plastic state.

After few minutes, the bi-metallic tube will start extrude with the upward moment of the bed (i.e., Feed Rate =0.3mm/s).

The lubrication has to be done perfectly in order to avoid the surface friction between the plunger tool and the bush metal.

5. RESULT

Table -1 Result

PARAMETERS	Specimen A	Specimen B	Specimen C
Density (kg/cm3)	8,960	8,050	8400
Poisson's ratio	0.38	0.29	0.28
Coefficient of thermal expansion (1/K)	84.2 × 10-6	7.6 × 10-6	7.6 × 10-6
Elastic modulus (Gpa)	62	250	105
Yield strength (Mpa)	360	415	135

5.1 CONCLUSION

A bimetallic tube has been obtained. These tubes are much of higher strength and lighter weight than conventional existing alloys and get over mentioned limitations. Such a tube can be used for applications that require high corrosion resistance.These tubes have been proven to have much better properties than standard alloys in general. These possesses higher tensile strength and can withstand much higher force while weighing a minimum value. copper has good properties like ductility, high strength, and high corrosion resistance. This material combination is a novel attempt. These tubes will have great corrosion resistance and will have a wide variety of applications in the field.A bimetallic tube made was designed and fabricated by extrusion process to improve production and life of pipes. The process was done by friction stir extrusion with optimized set of parameters. The fabrication was done taking care of design stresses of shaft. Thus, the bimetallic tube was constructed

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