

Design A Tool To Remove Copper Tube From Heat Exchanger

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ABSTRACT

The purpose of the project is to design a tool or any system or process to reduce the scrap of heat exchangers or to exchange copper tubes from heat exchangers like evaporators and condensers. This is undertaken to reduce scrap of company or loss of manufacturer and to increase profit. So we are going to design a tool or any process to extract or to replace the damage tube which will help to increase profit of company. A minor damage may result into overall replacement of assembly and the material, which can incur heavy financial loss. Hence we should device methods for removal and replacement of the damaged parts of the assembly. This can be done only by breaking the mechanical bondage between the copper tubes and aluminum fins.

Keyword : - *u-shape coppertubes, al fins, mechanical bondage, material handling, replacement of tube .*

1. INTRODUCTION

Heat exchangers have been widely used in the fields of refrigeration, air conditioning, space heating and chemical engineering. Fin-tube heat exchanger with two rows of round tubes is widely used in air-conditioning and refrigeration systems to meet such demands as fan power saving and quietness. Traditional heat exchanger devices such as plate type, plate fin type and tubular type operate on the principle of temperature difference between two mediums and can realize efficient sensible heat transfer from one fluid to another. With the development of design of heat exchanger and making some changes without affecting the cost much the heat transfer enhancement can be achieved. One such novel approach is using punched winglet-type vortex generator in fin tube heat exchanger which is proved numerically that it enhance the heat transfer.

During the manufacturing of heat exchangers, u-shaped copper tubes are being passed through the aluminium fins. When a plunger is inserted in the copper tubes, a mechanical bond is established due to expansion of the copper tube. The assembly is extremely prone to damage during material handling as we're using aluminium & copper. A minor damage may result into overall replacement of assembly and the material, which can incur heavy financial loss. We should hence device methods for removal and replacement of the damaged parts of the assembly. This can be done only by breaking the mechanical bondage between the copper tubes and aluminium fins .

2. PROBLEM STATEMENT

During the manufacturing of heat exchangers, u-shaped copper tubes are being passed through the aluminium fins. When a plunger is inserted in the copper tubes, a mechanical bond is established due to expansion of the copper tube. The assembly is extremely prone to damage during material handling as we're using aluminium & copper. A minor damage may result into overall replacement of assembly and the material, which can incur heavy financial loss. We should hence device methods for removal and replacement of damaged parts of the assembly. This can be done only by breaking the mechanical bondage between the copper tubes and aluminium fins.



Fig.1 Cracked or Damaged tube.

Table. 1 Specifications Of tube.

TUBE	Material: Copper Tube(IGT) OR Aluminum Tube(IGT) (As Per Specification)
	Diameter:7.00mm OD for Copper HE & 7.10mm OD for Aluminium HE
	Type: Internally Grooved Copper Tube & Aluminium Tube

3. OBJECTIVES

Design a tool which will extract damaged copper tube from fin and tube heat exchanger. By manufacturing this tool we will reduce scraps and reuse that heat exchanger by replacing damaged tube. Also reworks the damaged and cracked copper tube after expansion of heat exchanger coil to reduce the scrap and increase the profit of company. It can be possible by designing a tool to remove the bonding of al-fin & cu-tube. Hence decrease the loss of company occurs due to scrap formed and increases the profit by replacing that damaged tube.

4. LITERATURE GAP

As per the literature survey we conclude that the study has been occurred on the improvement of conductivity through the heat exchanger and design it light weight. Various tests has done on heat exchanger material. And finally heat exchanger made up of copper tubes covered by aluminium fins. Pure aluminium is highly corrosion resistant, high mechanical strength, suitable to alloying and heat treatment, light weight, has high thermal conductivity because of these properties aluminium used in heat exchanger as fins. Copper has high thermal conductivity corrosion resistance so the copper is used for tubes. As per the need composition of aluminium changes.

It has been observed that the fin and tube type of heat exchanger made in different stages of processes like fining, tube inserts, tube deformation on fins, heat treatment, etc. Like this study has done on heat exchanger.

But as per the our problem statement there no any data or study material available to remove the tube from fin and tube type of heat exchanger. So our aim is to remove the copper tube from heat exchanger to reduce the scrap of material and financial loss of any company.

5. EXPERIMENTATION

Our aim is to remove the copper tube from fin tube type heat exchanger. For that purpose we taken the following tests

5.1 Test 1- Our aim is that to break the mechanical bondage between Al fin and Cu tube from that heat exchangers. It is possible only when we will reduce the friction between tube and fins. The first idea which we thought that we have to create vacuum or negative pressure in copper tube so it will get shrink and reduce the friction between the copper tube and aluminium fins. And it will break the mechanical bondage between the tube and fins. But after

calculations of pressure to create the vacuum inside the tube it comes 102.7 bar. It is so difficult to create this much pressure inside the tube of very small area. So we thought about new idea to compress the tube.

5.2 Test 2 The another solution which always hits is if we cool the tube at very low temperature by using nitrogen gas or liquid so tube get so cooled. From that cooled tube we will pass the hot water which as temperature near to 100°C. So there is possibility that tube will get shrink. So this method looks easy. Liquid nitrogen is nitrogen in a liquid state at an extremely low temperature. At atmospheric pressure, liquid nitrogen boils at $-195.79\text{ }^{\circ}\text{C}$ (77 K; $-320\text{ }^{\circ}\text{F}$) and is a cryogenic fluid that can cause rapid freezing. After the cooling of copper tube at that instant if we pass the boiling water through the tube there is possibility of shrink the tube. But the coolants are not available in market easily and has large price value. The installation of assembly as well as the operation cost will be high. So we thought that heat treatment will be beneficial.

5.3 Test 3 When we heat the copper tube to make material elastic, then aluminium fins get damaged and it changes its color before copper reach its elastic limit. So we have a restriction to use this solution for solving our problem.

Aluminium fins get damaged before copper reach at its elastic limit because copper has melting point $1085\text{ }^{\circ}\text{C}$ and aluminium has melting point $660.3\text{ }^{\circ}\text{C}$ because of this difference between melting points of these metals aluminium starts to melt before copper. So we rejected this method.



Fig.5.1 Damaged heat exchanger due to heating.

5.4 Test 4 To dissolve copper we need concentrate acid. We got some ideas about solutions which will be helpful to dissolve copper. After some testing's we got a perfect solution which is dissolving copper material in it. Without taking much more time. Nitric acid (HNO_3) Copper is oxidized by concentrated nitric acid, HNO_3 , to produce Cu^{2+} ions; the nitric acid is reduced to nitrogen dioxide, a poisonous brown gas with an irritating odour.

$$\text{Cu(s)} + 4\text{HNO}_3(\text{aq.}) \rightarrow \text{Cu}(\text{NO}_3)_2(\text{aq.}) + 2\text{NO}_2(\text{aq.}) + 2\text{NO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$$

Nitrogen Dioxide is a poisonous gas, it directly affects on human health. So this method is also not useful.



Fig.5.2 Before and after when reacted with nitric acid.

5.4 Test 5 Our guides suggest us to design tool to cut the tube from inner side of the tube. To break the bondage between the fin and tube to remove the tube without damaging the aluminium fins. We got lot of inspiration to design the tool. And from that we selected to design a tool with creation of pressure by using hydraulic pressure.

Details of tool are given in fig. 4. We designed the rod which has the inner diameter 3mm with outer diameter of 5mm. Hollow rod designed to create hydraulic pressure inside the rod. There was need to calculate the proper cutting force to cut the tube without damaging aluminium fin. After calculation we got the final value of force need to be applied and it is 9.81 N. So we are applying this force by using hydraulic mechanism.

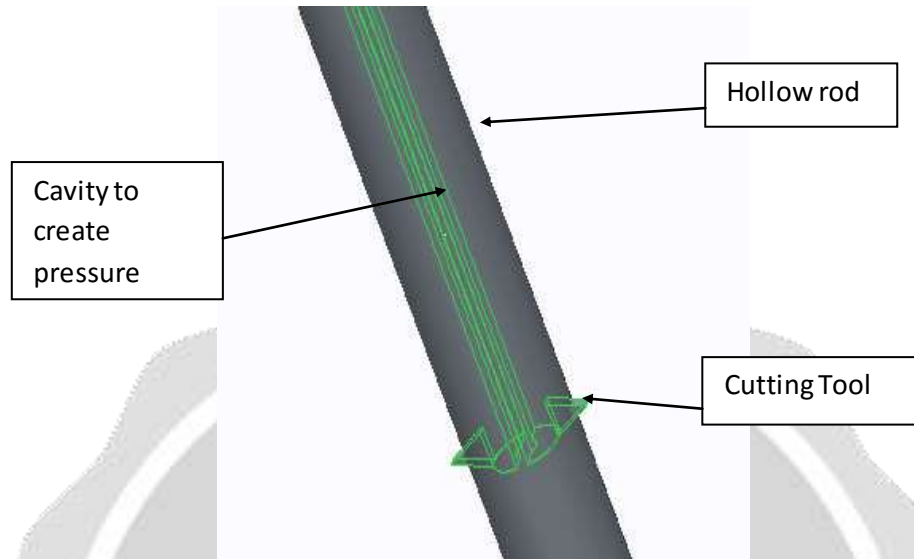


Fig.5.3 Cutting tool by using hydraulic pressure.

6. CONCLUSION

After many trials we got the final solution for replacement of the damaged tube from the heat exchanger assembly. For that our final solution is design a tool for replacement or to remove the damage tube from heat exchanger assembly, to reduced scrap of heat exchanger and to increase the profit of company. It will reduced financial loss of company.

5. ACKNOWLEDGEMENT

I take this opportunity to thank all those who have contributed in successful completion of this dissertation. I would like to express my sincere thanks to my guide **Prof Chakor S. M.**

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