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Optimization of Defects Encountered in Manufacturing of Radiator

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Abstract: *Radiator is equipment which helps engine to cool down by heat transfer of engine heat to coolant& from coolant to the atmosphere. Radiators are used to cool large size engines. A water jacket is provided around which the coolant is provided so due to heat realized from the engine the coolant gets heated up & is cooled down by the radiator. The problems occurring during the assembly or during the manufacturing process are being studied and their possible solutions in this paper. It may also help in increasing the efficiency of manufacturing process and the cost reduction of the radiator by costing parameters.*

Keywords: *Radiator, Assembly, Manufacturing, Cost.*

I. INTRODUCTION

Automobile Radiator are becoming highly power-packed with increasing power to weight or volume ratio. Increased demand on power packed radiators, which can dissipate maximum amount of heat for any given space. For over 70 year now, small change has occurred to the design and manufacturing of automobile radiator. However, cheaper and better advanced designs of radiators are available to industries.

Radiator is a heat exchanger that removes heat from engine coolant passing through it. Heat is transferred from hot coolant to outside air. Radiator assembly consists of three main parts core, inlet tank and outlet tank. Core has two sets of passage, a set of tubes and a set of fins. Coolant flows through tubes and air flows between fins. The hot coolant sends heat through tubes to fins. Outside air passing between fins pickups and carries away heat.

Performance of radiator is influenced by factors like air and coolant mass flow rate, air inlet temperature, coolant fluid, fin type, fin pitch, tube type and tube pitch etc. While designing cooling system three worst conditions considered based on above parameters.

High altitude: At high altitude, air density becomes low and hence affects air mass flow rate.

Summer conditions: During summer surrounding air is hot i.e. air inlet temperature is more.

Maximum power: Engine condition producing maximum power like when vehicle is climbing uphill, maximum heat rejection is required during this condition.

Radiator consists of different elements like hoses, fins, alloy pipes, plastic tanks, drain valves, tubes, fan, water pump, thermostat, pressure cap, safety valve, vacuum valve, etc., are used in the assembly of the radiator. The problems arising in the manufacture of radiator are fin bond failure, internal deposit, fan damage, cracked plastic tank, blown tank to header seal, & loose side piece.

II. MANUFACTURING PROCESS

Raw material of radiator (copper and brass stripes) comes in industry which is stored in the warehouse. These materials are kept in a safer place away from other machinery and sharpen material which may damage raw materials. The raw material contains copper and brass stripes, which are mainly used to manufacture radiator because it can be repaired easily. There are many different types of machinery and process use to manufacture a copper and brass radiator.

Fig: 1 Radiator Core

First of all the radiator core is manufacture in industry which is main part of radiator. The brass stripes from the warehouse is send to Tinning machine which coats them in tin, the tin layer on the strips is around 0.2 to 0.3 micron after the completion of Tinning process. The brass stripes are coated with tin because after the bending of tubes from the brass stripes there remains a gap between metal surfaces which is filled by melting of the tin in furnace.

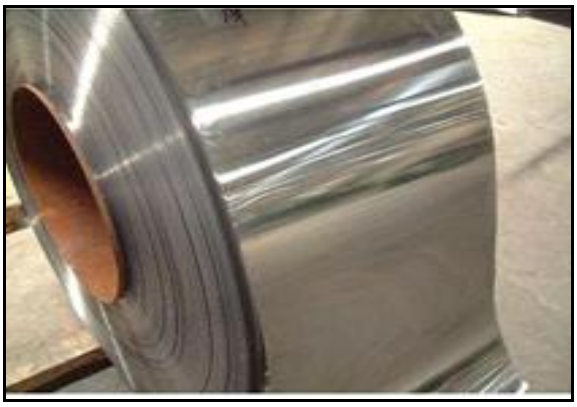

Fig: 2 Brass Coated with Tin

The roll of lead tube is switch over the Single tinning tube mill radiator machine. The machine is programmed to bend the corrugated brass metal stripe in required dimensions as per the requirement of the customer. With the help of sensor the tube is cut by machine in equal length as per the size of radiator core. This tube should be accurate so that while in assembly of radiator it can be fitted through the fins of radiator core. Along with the production of tubes the fins of radiator is produced. The fins of the radiator are produced in Standard Flat Fin Machine. This Machine consists of a cylindrical die which rotates in circular motion with the help of motor. According to the design and type of tubes used in radiator, the pattern on the fins is decided. The die for the fin machine is created according to the required pattern on the fins.

Fig: 3 Fins

As shown in figure 3 from one end of machine the copper strip roll is set and the strip goes from different rolling dies and comes out with pattern printed on it and with the help of sensor it is cut into required length. Now the two header plates will be produced in a hydraulic press. The header plate consist of a pattern same to the pattern on the fins. The pattern on fins and header plate is made to pass the tubes through them. The ram of the press consist of a punch and a die is kept below the punch, when the ram comes down the metal plate between the punch and the die gets pattern of punch on it.

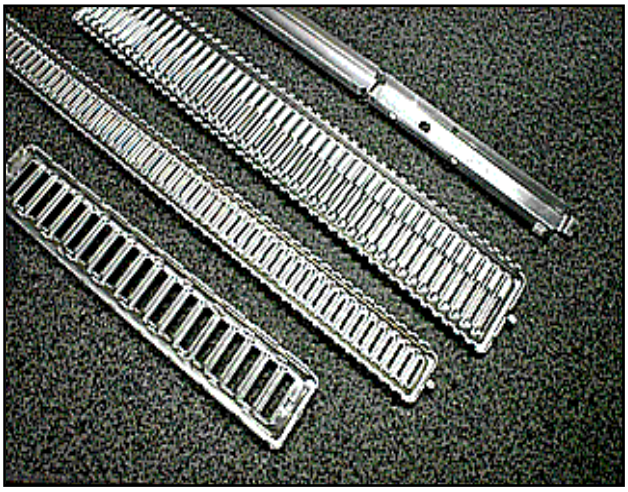

Fig: 4 Header Plate

The metal used is thick because header plate is used to hold the radiator core firmly and fixed on one place. Now when tubes, fins and header plates are produced they are to be assembled on a jig to form a radiator core.

Fig: 5 Assembly Jig

As shown in figure the fins are kept on the jig and it is checked that each and every hole of the tube is aligned or not because if one of the fin is not in alignment while poring the tubes through them the whole core becomes a piece of waste. After pouring all the tubes through the fins it is ready to send to the baking department of the industry. The baking department consists of a shouldering tub and a low capacity furnace. First the radiator core is dipped into the shouldering tub; it contains shouldering iron which helps to fill the tiny holes or cavity in the core.

Fig: 6 Furnace

Now after shouldering the core it is put in the furnace, the temperature in the furnace is about 350°C; the shouldering metal melts and fills the tiny holes of the cavities in the core. After taking the core out of the furnace, it is send to the testing department, hears it is filled with pressurized air and kept in water for few minutes. If air bubbles comes out the leak is repaired and then tested again.

Fig: 7 Testing Machine

The cores passed from the testing department are now fitted with the header plates, top tank and bottom tank. Now the radiator is ready to be used for cooling the large capacity engines and the manufacturer gives a one year warranty to the customer.

III. COSTING OF ELEMENTS

- **Total Material Used**

(i) BRASS- 8 Kg (ii) COPPER- 22 Kg (iii) TIN- 400 Gram

1) **Brass header plate**
   =Material used × Material cost
   = 8×428
   = 3424 Rs…… (A)
2) **Labour cost of header plate**
   =20 % of material cost
   = 684 Rs…….. (B)

3) **Copper tube**
=Material used × Material cost
= 17×180
= 3060Rs……(C)

4) **Labour cost of copper tube**
=20 % of material cost
=612 Rs…… (D)

5) **Copper Fins**
=Material used ×Material cost
=5×180
= 900 Rs…… (E)

6) **Labour cost of copper fins**
=20 % of material cost
=180 Rs…… (F)

7) **Copper Tube Coating Cost**
=Material used × Material cost
=0.4×246
=98.4 Rs…… (G)

8) **Labour cost of copper tube coating**
=20 % of material cost
=19.68 Rs…… (H)

9) **Power consumption**
=Power used × working hours
=2.3kw/hrs. × 18hrs
=41.4 KW

10) **Power cost**
=Total power consume × Rate/unit
=41.4 × 18.3
=757.62 Rs…… (I)

11) **Total cost**
=(A)+(B)+(C)+(D)+(E)+(F)+(G)+(H)+(I)
=3424+684+3060+612+900+180+98.4+19.68+757.62
=**9735 Rs.**

IV. PROBLEMS ENCOUNTERED IN DIFFERENT PARAMETERS OF MANUFACTURING PROCESS

- **Furnace:** In furnace the temperature is to keep 350°C. If the temperature increase more than 350°C the fin and tube starts melting and if the temperature decreases to less than 350°C the fin and tube will be not fix it properly. The gap will be not filled between tube and fins. Also the temperature at the end is more than at the centre.
- **Assembly:** While when the assembly is done of the fins and tube, the fins are fixed in the jig and tubes are passed from it with the help of equipment named as sword. While at this time the tube may be not fixing at right place, it can move up or down direction so the fins are broken.
- **Testing:** While the testing the radiator core, core is filled with pressurized air and dipped in a water tank to check the leaks in radiator core, if there are any leaks then they are removed with the help of sholder.
- **Internal Deposits:** The most frequent problems a cars cooling systems faces are clogging caused by radiator internal deposits. Rust and leak inhibitors can form solids that collect in the radiator cooling system and restrict flow. Radiator leak repair and other debris can block airflow through the radiator's core and reduce its ability to dispel heat.
- **Cracks In Plastic Tank:** This tank has been damaged by steam. Steam is many times hotter than a radiator tank can tolerate. The edges of the hole show signs of the plastic melting. Often such damage is the result of a warped or cracked cylinder head or blown head gasket. Combustion entering the coolant will produce steam that can melt radiators, intake manifolds and more. Such damage calls for a much higher level of diagnosis and repair.

V. SOLUTIONS FOR PROBLEMS ENCOUNTERED IN DIFFERENT PARAMETERS OF MANUFACTURING PROCESS

- **Furnace:** In furnace brazing the whole assembly is heated to a temperature where braze alloy melts and flows into the joint. The temperature of the furnace is kept at 350°C, the radiator is placed in center of the furnace so that the heat is equally distributed.

After heated up radiator is cooled down so that solid joints can be achieved. This process also depends on the soldering process so the soldering should be done perfectly.

Assembly: Assembly jig should be made as per the requirement and specification of the radiator.

First of all copper or aluminium fins should be properly fitted in the jig and the hole of all the fins should be in the straight line.

If the holes are not in straight line then fins can be damage while passing sword in fins.

And the jig should not tight enough that the radiator fins is damage and jig should not be lose that while assembly of radiator failure take place.

- **Internal Deposits:** It's possible to repair the radiator by back flushing your cooling system and using chemical cleaners to remove hard water deposits and rust, but may do little to open up a clogged radiator causing ongoing radiator leaking. Remember to refill the cooling system completely to avoid air pockets in the head, below the thermostat and in the heater core. This will prohibit interference with effective coolant circulation and cooling.

  Leaks caused by internal corrosion may be found almost anywhere on a radiator. The most vulnerable points are usually the seams and where the tubes are joined to the headers. The underlying cause is almost always cooling system neglect, but it may also be due to bad ground connections between the engine, charging system and vehicle body. If the coolant has been changed regularly and tests good, check the engine's ground connections and clean and retighten as needed.
- **Cracks In Plastic Tank:** Go to your local auto parts store or home center and purchase a tube of JB weld. Drain the radiator of fluid enough to where if you push on the crack no fluid comes out. Locate the leak and dry the area as much as possible. Once the area is dry use an extension cord and blow dryer on the crack. Push down on the crack to get in between the crack and dry. Again wipe down with acetone and clean. You need to make sure the area is clean. Use very rough sand paper to rough the area around crack.

  Use a sharp tool to score the plastic near the crack. Be careful that you do not put so much pressure on it that you make it worse, but enough to make some gouges in the plastic. Make sure you rough an area about 3/4 inches all around the crack. Mix the chemical with a stick or plastic fork.

  Generously apply the chemical with plastic knife to the area of the crack. Once you have covered the open crack make sure that you cover up the crack and any gaps or exposed cracks. Once you have applied this chemical, it helps to use your blow dryer again. You need to apply enough material to cover the crack and the 3/4 inch area around the crack; and it must be about 1/8 inch thick. At this point remove tape, and keep the chemical within the square. If you need to put more on after this go right ahead. The dimensions of your patch are very important due to the vibration, pressure, and heat generated by the radiator. Keep an eye on radiator for leaks in and around patch area. You will probably smell radiator fluid and have some steam. This is probably radiator fluid that may be on the engine, but should be gone within 30minutes. If the patch hold with no leaks your good to go.

VI. CONCLUSION

The studies of all process for manufacturing of a radiator are studied. The problems in their manufacturing process are shown and improving some parameters such as furnace temperature, assembly jig, internal deposits and cracks in plastic tank the cost of manufacturing as well as the manufacturing efficiency of radiator can be increased.

VII. REFERENCES

[1] Holman, J.P. Heat Transfer (5th Edition). McGraw-Hill, New York, NY. 1981

[2] P. S. Amrutkar, S. R. Patil, "Automotive Radiator Performance-Review", International Journal of Engineering and Advanced Technology, Volume-2, Issue-3, Feb-2013

[3] JP Yadav and Bharat Raj Singh, ―Study on Performance Evaluation of Automotive Radiator‖ , *S-JPSET: ISSN: 2229-7111*, Vol. 2, Issue 2, 2011

[4] Pitambar Gadhave, Shambhu Kumar, ―Enhancement of forced Convection Heat Transfer over Dimple Surface – Review‖ , *International Multidisciplinary e – Journal*, 2012

[5] D. G. Charyulu, G. Singh, J.K. Sharma, Performance evaluation of a radiator in a diesel engine- a case study, *Applied Thermal Engineering 19(6)*, 1999, 625-639

[6] Designing a more effective car radiator: Application note Maple soft, Maple Inc 2008

